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Prof. Dr. Aino Kianto
Dr. Ilona Toth

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Edited by

Aino Kianto and

Ilona Toth

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About the 26th European Conference on Knowledge Management, 2025

The European Conference on Knowledge Management (ECKM) is a highly respected academic conference that has been held annually for 26 years, making it one of the longest-standing conferences in its field. ECKM provides an important platform for academics, researchers, practitioners, and industry leaders from around the world to exchange ideas, present research, and discuss developments in knowledge management (KM). The conference is dedicated to advancing the theory and practice of knowledge management across a wide range of sectors and disciplines.

The Proceedings of the 26th ECKM, 2025 includes academic research papers, PhD research papers and Master's research papers as well as work-in-progress papers, which have been presented and discussed at the conference. The proceedings are of an academic level appropriate to a research audience including graduates, post-graduates, doctoral and post-doctoral researchers. All papers have been double-blind peer reviewed by members of the Review Committee.

Aims and Scope

The primary aim of ECKM is to foster a deeper understanding of knowledge management processes, practices, and technologies, and to explore their impact on organizational effectiveness and innovation. The conference seeks to bridge the gap between theory and practice by encouraging the exchange of ideas between academics and practitioners. It also aims to promote interdisciplinary collaboration by bringing together experts from various fields such as business, information technology, education, and public administration.

ECKM's scope is broad, encompassing all aspects of knowledge management, from the creation and sharing of knowledge within organizations to the role of technology in enabling KM processes. The conference addresses both the strategic and operational dimensions of knowledge management, emphasising its importance in enhancing organizational learning, innovation, and competitive advantage.

Topics Covered

ECKM covers a wide range of topics related to knowledge management, reflecting the evolving nature of the field and its application in different contexts. The call for papers asked for contributions that considered the following topics. In addition, the committee welcomed papers on a number of specialist mini-tracks which can be seen at the end of this list.

Knowledge Creation and Sharing:

- Tacit and Explicit Knowledge
- Knowledge Sharing Practices.

Knowledge Management Systems and Technologies:

- KM Tools and Platforms
- Artificial Intelligence and KM
- Big Data and Knowledge Analytics.

Organizational Learning and Innovation:

- Learning Organizations
- Innovation Management
- Communities of Practice.

Strategic Knowledge Management:

- KM and Competitive Advantage
- Knowledge Strategy Development
- Intellectual Capital Management.

KM in Specific Contexts:

- KM in Public Administration
- KM in Education
- KM in Healthcare.

Knowledge Management and Organizational Culture:

- Cultural Barriers to KM
- Leadership and KM
- Change Management in KM Initiatives.

Ethics and Knowledge Management:

- Ethical Issues in KM
- Sustainability and KM.

Emerging Trends and Challenges in KM:

- Digital Transformation and KM
- Globalization and KM
- AI's role in KM
- The integration of KM with other business disciplines
- The evolving role of knowledge managers.

Mini Tracks

Experts in the field proposed mini tracks on the following topics. Papers accepted on these topics after the double-blind peer review process were presented as mini tracks at the conference and are also published in these proceedings.

- Challenges and Solutions for Sustainable Knowledge Management
- How to … Lessons Learned
- Age of Digitalisation
- Knowledge Management in Different Cultural Contexts

The programme from the 2025 conference can be downloaded from the publishing portal and full details about the conference can be seen from the conference website: https://www.academic-conferences.org/conferences/eckm/

ECKM 2025 Editorial

These proceedings represent the work of contributors to the 26th European Conference on Knowledge Management (ECKM 2025), hosted by Lappeenranta-Lahti University of Technology (LUT), in Lahti, Finland on 4-5 September 2025. The Conference Chair was Prof. Dr. Aino Kianto, from LUT Business School, LUT University, Lahti, and the Programme Chair is Dr. Ilona Toth, from LUT Business School, Lappeenranta, Finland.

ECKM is now a well-established event on the academic research calendar and now in its 26th year the key aim remains the opportunity for participants to share ideas and meet the people who hold them. The scope of papers will ensure an interesting two days. The subjects covered illustrate the wide range of topics that fall into this important and ever-growing area of research.

The opening keynote presentation was given by Professor Alexeis Garcia Perez, Aston Business School, Aston University, UK, on the topic of *The Knowledge Paradox: Navigating the future of KM with AI.* The Afternoon keynote was given by Professor Paavo Ritala, LUT Business School, LUT University, Lappeenranta, Finland, on the topic *GenAI and knowledge management – A revolution, an evolution, or something else entirely?* The second day of the conference opened with an address by Professor Susanne Durst, Reykjavik University, Iceland, who will talk about *Responsible Knowledge Management in a Polarized World.*

With an initial submission of 300 abstracts, after the double blind, peer review process there are 140 Academic research papers, 13 PhD research papers, 3 Masters Research papers, 4 Non-Academic papers and 4 work-in-progress papers published in these Conference Proceedings. These papers represent research from Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Colombia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Kazakhstan, Latvia, Lithuania, Malaysia, Netherlands, Nigeria, North Cyprus, North Macedonia, Norway, Peru, Poland, Portugal, Romania, Saudi Arabia, South Africa, Spain, Sweden, Switzerland, Thailand, Türkiye, UK, and the USA.

We would like to thank all those who attended the conference this year.

Dr. Aino Kianto
Lappeenranta-Lahti University of Technology (LUT)
Finland
September 2025

Biographies of Chairs and Keynote Speakers

Conference Chair



Aino Kianto, D.Sc. (Econ. & Bus. Adm.) is a Professor in Knowledge Management in the LUT University Business School, Lahti, Finland. Her research focuses on knowledge and innovation management, intellectual capital, and organizational renewal and resilience. She has published close to 200 research papers, approximately 70 of which have appeared in journals, such as Journal of Business Research, Technovation, R&D Management, Human Resource Management Journal, Journal of Knowledge Management, Journal of Intellectual Capital, and Creativity and Innovation Management. Professor Kianto's research has been acknowledged with several international awards, she has delivered keynote speeches in many international conferences and currently serves in the editorial board of five academic journals. She has acted as the PI in eight research projects and other leadership role in six projects, all of which have involved extensive worklife collaboration and most also international collaboration.

Programme Chair



Ilona Toth, D.Sc. (Econ. & Bus. Adm.) is a Post-Doctoral Researcher in Knowledge Management in the LUT University Business School, Lappeenranta, Finland. Previously she has worked for research projects funded by Finnish Work Environment Fund and State Treasury. Her current research focuses especially on individual worker well-being and its relationship to sustainable performance. Dr. Toth's research articles have been published e.g., in VINE Journal of Information and Knowledge Management Systems, in International Journal of Entrepreneurial Behavior and Research, and in Digital Creativity.

Keynote Speakers



Susanne Durst is Full Professor of Management at the Department of Business Administration at Tallinn University of Technology (Estonia). Her research interests include small business management, SME succession/transfers, knowledge (risk) management, and corporate governance. She has been conducting several national and international research projects. Her work has been awarded different awards and has been published in international peer-reviewed journals. Before joining academia, she worked with private enterprises



Paavo Ritala is a Professor of Strategy and Innovation at the Business School at LUT University, Finland. His main research themes include networks, ecosystems, and platforms, the role of data, algorithms, and digital technologies in organizations, business model innovation, and circular and regenerative economy. His research has been published in outlets including Journal of Management, Research Policy, Academy of Management Perspectives, Journal of Product Innovation Management. He is closely involved with business practice through research projects, executive and professional education programs> He is the Co-Editor-in-Chief of R&D Management and serves on the editorial review board of Journal of Product Innovation Management.



Alexeis Garcia Perez is Professor of Digital Business and Society at Aston Business School, Aston University. He is also Visiting Professor at the Centre for Business in Society of Coventry University, and Visiting Research Scholar at the Department of Communication, Culture & Technology of Georgetown University. Alexeis has led teams delivering Information Systems programmes in both Computing and Business environments, including an MBA in Cyber Security. He is Senior Fellow of the Higher Education Academy and member of the executive committee of the International Association for Knowledge Management

Mini Track Chairs



Stephanie Barnes is a seasoned and visionary executive with over 25 years of success helping global organizations to achieve short- and long-term objectives by driving innovation, technology transformation, cultural change, and continuous improvement. An accomplished Knowledge Management leader with strong expertise in designing knowledge management strategies and frameworks, delivering knowledge management initiatives, and providing essential knowledge management toolkits. She is a strategic thinker with proven expertise in shaping long-range knowledge management strategy, roadmap, and process, as well as aligning people, processes, technology, and departments to achieve corporate goals. Stephanie is an engaging communicator with extensive international working experience in Austria, Canada, China, Germany, Nigeria, United Arab Emirates, and the United States.



Cindy Hubert is an APQC inaugural Fellow in Knowledge Management (KM), responsible for building upon the organization's rich legacy as one of the foremost innovators and leaders in the field of Knowledge Management. She has over her 30 years with APQC, during which she has been instrumental in building the organization's intellectual capital in KM through the design and implementation of various tools, methodologies, and research practices. During her tenure, Cindy has provided leadership and oversight to more than 500 client projects around the world involving the transfer of best practices, benchmarking, knowledge management, and process and performance management using APQC's proven methodologies. She has provided subject matter expertise in APQC's extensive KM research program which has completed more than 35 collaborative research projects and ten Advanced Working Groups on various KM topics.



Emeritus professor PhD Marta Christina Suciu is PhD supervisor on Economics 1 Doctoral School, Bucharest University of Economic Studies. She is a senior researcher at the Romanian Academy National Institute of Economic Research Costin C. Kiritescu and Vice-President of an Interdisciplinary Research Group. She is a corresponding member at the Romanian Academy of Scientists, Economics, Law and Sociology section. Her topics of interest are: KM; Cultural and Creative Economy; Creative and Innovative Management; Start-ups, innovative business and PM; Economics of Education; Intellectual Capital & Intangible Assets. She has coordinated eight research projects won on a competitive basis. She obtained the OPERA OMNIA Diploma in 2006.



Dr. Irina Purcarea is an Assistant Professor in the Management and Organizations Department at Rennes School of Business, France. She earned her PhD in business administration, specializing in innovation and small business management, from the Bucharest University of Economic Studies. Her areas of expertise include: project management and organizational behavior. From 2021 to 2024, as Programme Coordinator at Rennes School of Business, she committed to promoting student development programs through hands



Henri Hussinki, D.Sc. (Econ. & Bus.Adm.), is an assistant professor (tenure track) in business analytics at the Business School, LUT University. His research and teaching focus on information systems business value, especially information systems capabilities that firms need to leverage their information technology investments. His research has been published in, e.g., the Journal of Business Models, Measuring Business Excellence, Journal of Knowledge Management, and Journal of Intellectual Capital.



Walter Vesperi is a Research Fellow in Organization Theory and HRM at the University of Palermo, Italy. His research interests are in knowledge transfer, university entrepreneurship and the agri-food sector. His publications have appeared in academic journals, and he has presented his research at several international conferences. He is also a member of the editorial board for several International Journals



Concetta Lucia Cristofaro is an Assistant Professor in Organization Theory and HRM at the E-campus university, Italy. Her Research focuses on public healthcare, Intellectual capital and HRM. She has presented at national and international conference, and she is the author and co-author of several publications. She is also a reviewer for a number of international journals.



Rocco Reina is full Professor in Organization Studies at the University of Catanzaro "Magna Græcia", Italy, He is on the Board of the Italian Association of Management and Organization (ASSIOA) and a member of the regional board of the Italian Association of Personnel Management (AIDP). His research focusses on intellectual capital, small and medium enterprises, knowledge and change management and human resource management. He has presented at national and international conferences and has authored



Associate Professor Ole Jørgen Ranglund lectures in a variety of fields within the scope of organizational learning and theory, including business strategy, service management, leadership and in strategic management at masters level. His research field is diverse ranging from management and leadership to knowledge management issues. He also has a special interest in the delivery of knowledge to students to support relevance of education and has thus involved himself in projects dealing with formative feedback to students, involvement and engagement of students, and hyflex/syncromodal learning.



D.Sc. Sladjana Cabrilo is a Full Professor of Management at I-Shou University in Taiwan. Her research focuses on intellectual capital (IC), knowledge management, innovation, digital transformation, and international business. She is known in the field of IC for insights from emerging economies and for using complexity theory, configurational analysis, and fuzzy set qualitative comparative analysis (fsQCA) techniques to uncover complex relationships and patterns between IC and organizational performance. Her research has been awarded and recognized as 'most prestigious across knowledge clusters' in ranked journals. She is one of the co-editors of the book "Futurizing intellectual capital - Insights on navigating knowledge-based value creation" that will be published by Springer Nature by the end of 2024.



Dr. Liu Gang earned his Ph.D. from The Hong Kong Polytechnic University. Now, he is an associate professor at Business School, Shenzhen Technology University. His research areas include knowledge management and organizational performance, innovation and entrepreneurship, and cross-cultural management. His papers have been published in Journal of Business Research, Industrial management and Data System, Knowledge Management Research & Practice, Proceedings of European Conference on Knowledge Management, etc. He is a committee member of the European Conference on Knowledge Management. He is co-editor of Management & Marketing and associate editor of International Journal of Knowledge Management Studies..

ECKM Review Committee

ECKM is fortunate to have a significant number of international experts in the field willing to review papers. Care is taken to ensure that a fully double-blind peer review process is followed, and reviewers are not selected if they have any research or organisational connection to the author/s.

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Developing Entrepreneurial Mindset Among Non-Business Majors Through Experiential Learning and AI Tools

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Abstract: Despite the proliferation of entrepreneurship education (EE) programs, conventional pedagogies often fall short in cultivating the critical cognitive and affective dimensions of the entrepreneurial mindset, particularly in areas such as opportunity recognition, creative problem-solving, and resilience. This study addresses this enduring pedagogical challenge by embedding experiential learning and generative artificial intelligence (AI) tools into an entrepreneurship education. Drawing upon Kolb's Experiential Learning Theory and Biggs' Constructive Alignment frameworks, the instructional design integrated immersive fieldwork, problem-based tasks, and iterative AI-supported learning experiences. Generative AI tools were strategically deployed to scaffold ideation, support inquiry, and enhance formative feedback throughout the entrepreneurial process. Using a mixed-methods approach, the study assessed the entrepreneurial mindset (EM) of 92 postgraduate students before and after the intervention. Partial Least Squares Structural Equation Modeling (PLS-SEM) confirmed EE explains 47.8% of the variance in EM. Quantitative findings reveal a statistically significant 35.48% increase in EM scores. Qualitative data, drawn from student reflections and thematic analyses, further underscored the perceived value of AI integration and real-world engagement in fostering entrepreneurial thinking, industry relevance, and innovation capacity. The findings contribute to the evolving discourse on entrepreneurship education by demonstrating the pedagogical value of integrating immersive, AI-augmented experiential learning in developing future-ready entrepreneurial competencies. By incorporating AI into the experiential learning framework, students were not only trained in research methods and entrepreneurial problem-solving but also in AI literacy, which is increasingly seen as an essential futuristic skill. This study makes a theoretical contribution by empirically validating how Kolb's Experiential Learning Theory and Biggs' Constructive Alignment Model can be enhanced through AI integration in entrepreneurship education. It offers actionable insights for educators and institutions seeking to modernize entrepreneurship programs. Our problem-based approach, incorporating immersive field trips, AI-assisted research tools (ChatGPT, DeepSeek), and authentic assessments, proved particularly effective in developing students' critical thinking, opportunity recognition, and adaptive problem-solving skills.

Keywords: Entrepreneurship education, Experiential learning, Entrepreneurial mindset, Artificial intelligence, Constructive alignment

1. Introduction

Traditional theoretical approaches often fail to cultivate essential entrepreneurial competencies such as opportunity recognition, resilience, and creative problem-solving. This is especially evident in educational settings where practical entrepreneurial experience is limited, and students primarily rely on passive learning methods. To address this gap, educators are increasingly adopting immersive, problem-based learning strategies, enhanced by generative artificial intelligence (AI) tools, to foster entrepreneurial mindsets (EM) and real-world readiness (Mugge et al, 2021). The concept of EM refers to a set of cognitive and affective orientations that enable individuals to identify opportunities, navigate uncertainty, and persist in the face of challenges (Mathisen & Arnulf, 2013; Cui et al., 2019). It typically encompasses dimensions such as opportunity recognition, creative problem-solving, resilience, initiative, and risk tolerance (Larsen et al., 2023; Kusumojanto et al., 2021).

This research presents an action-based, pedagogically driven intervention that integrates immersive field trips, problem-based learning, and AI-assisted cognitive tools into a postgraduate course on entrepreneurship and innovation Students were not only immersed in industry contexts, but also equipped with AI-driven tools to assist in ideation, research, writing, and feedback loops throughout the problem-solving process.

The pedagogical design aligns with the UK Professional Standards Framework (UKPSF), on the design of learning activities and teaching effectiveness. A constructive alignment model guided the development of outcomes, experiential activities, and assessments to ensure cohesive and authentic learning. The inclusion of AI tools enhances this approach by enabling students to generate insights, critique content (Huang et al, 2023) and simulate business scenarios, reinforcing iterative learning processes and digital literacy competencies critical to modern practices (Aoun, 2017). Drawing from both student feedback and peer observation, it became clear that there was a need to test whether a combination of immersive, AI-supported experiential learning can significantly impact students' entrepreneurial mindset. Specifically, the study asks:

- Do immersive field trips and AI-integrated learning impact students' perceptions of industry-relevant entrepreneurship education?
- Does entrepreneurship education, enhanced with AI and experiential methods, influence students' entrepreneurial mindsets?

By responding to these questions, this study contributes to the evolving discourse on entrepreneurship education by exploring how real-world engagement and digital augmentation can jointly foster deeper learning, critical reflection, and innovation capabilities among aspiring entrepreneurs. It also responds to recent scholarly calls for greater integration of technological tools in business education and for pedagogies that reflect the complexities of contemporary entrepreneurial ecosystems (Mugge et al, 2021; Selwyn, 2019).

2. Theoretical Background and Hypotheses Development

Entrepreneurship education flourishes when theoretical knowledge is purposefully integrated with active, student-centered learning. Kolb's (1984) experiential learning theory remains central to this approach, advocating a cyclical process of concrete experience, reflective observation, abstract conceptualization, and active experimentation. In this study, students engaged in immersive activities such as analyzing smart city developments and solving real business challenges, which served as the concrete experiences fueling deeper learning. These experiences were paired with reflective discussions, classroom-based conceptual modeling, and iterative assessments, thereby enhancing critical entrepreneurial competencies such as opportunity recognition, creative problem-solving, and resilience (Neck and Greene, 2011; Pittaway and Cope, 2007). Underpinned by Biggs' (1996) Constructive Alignment framework, the curriculum was deliberately structured so that learning outcomes, teaching activities, and assessments worked in synergy. Assessments, ranging from peer-reviewed group work and reflective essays to AI-assisted reports, evaluated students' capacity to bridge theory with actionable insight (Dobson et al, 2021).

A key innovation of this pedagogical model was the integration of generative AI tools, including ChatGPT, DeepSeek, and AI-supported analytics platforms, as digital collaborators in the learning process. Rather than replacing critical thinking, these tools augmented students' cognitive capacities by supporting ideation, business simulation, customer profiling, and rapid prototyping in real time (Mugge et al, 2021). This use of AI aligned with Kolb's (1984) "active experimentation" phase, offering students instant feedback and a low-stakes environment for iterative exploration. Beyond content generation, AI also functioned as a metacognitive scaffold, assisting students in identifying gaps, structuring arguments, and refining inquiry-based outputs (Luckin et al, 2016). Importantly, AI usage followed a human-in-the-loop model where instructors facilitated ethical engagement, critical evaluation, and collaborative refinement (Selwyn, 2019). This approach not only supported reflective practice and collaborative inquiry but also cultivated essential digital competencies for future entrepreneurial contexts (Aoun, 2017). Nevertheless, as Teräs et al (2020) caution, the pedagogical use of AI must be deliberate to prevent superficial learning, reinforcing its role as a supplement to, not a substitute for, authentic educational design.

Experiential learning is particularly powerful when embedded in real-world contexts, offering students meaningful exposure to the complexities of entrepreneurial practice (Fuchs et al, 2008). Dewey (1963) emphasized the value of connecting theory and experience, and modern scholars argue for nuanced strategies to bridge traditional and progressive education (Huang et al, 2023). In China, initiatives like the 'Mass Entrepreneurship and Innovation' policy have expanded the role of entrepreneurship education in higher education (Huang et al, 2023), aimed at fostering innovation and addressing youth unemployment (Wright et al, 2021). While the conceptual roots of entrepreneurship education are often Western, its localization within China's cultural and economic landscape is critical (Bell, 2020; Lyu et al, 2021). Immersive field trips not only expose students to authentic industry contexts but also enhance networking, inspire entrepreneurial identity, and promote the practical application of learned concepts (Larsen, 2022). These opportunities, grounded in experiential and progressive education, support the development of entrepreneurial competencies through real-time engagement with market and technological dynamics.

Moreover, entrepreneurship education fosters the skills, knowledge, and personal attributes required for entrepreneurial action (Cui et al, 2019). It cultivates creativity, risk-taking, initiative, and ambition, key elements of the entrepreneurial mindset, which has been consistently linked to entrepreneurial intention (Kusumojanto et al, 2021). Through confidence-building and practical engagement, such education fosters a mindset of innovation and action. In this study, students were tasked with evaluating real business challenges and developing viable solutions, exemplifying how problem-based learning can nurture opportunity-driven thinking

(Sorensen and Kuada, 2022). Entrepreneurship education influences both cognitive and affective domains, shaping how students think and feel about entrepreneurial challenges (Larsen et al, 2023). Evidence from fields like engineering also demonstrates how problem-based approaches enhance creativity and foster innovative responses to complex problems (Holgaard et al, 2022), supporting the case for embedding such models more deeply in entrepreneurship curricula.

Hypothesis: Entrepreneurship education enriched with experiential learning and AI tools enhances students' entrepreneurial mindset (EM).

3. Methodology

This study adopted an action research approach within a full-credit postgraduate entrepreneurship course, aiming to examine how experiential learning and AI-enhanced instruction influence the development of students' entrepreneurial mindset (EM). The research followed a two-phase, partially mixed methods design (Creswell & Plano-Clark, 2018), incorporating both quantitative and qualitative data to enable a comprehensive evaluation of the intervention.

3.1 Research Design

The study employed a quasi-experimental, one-group pre-test/post-test design without a control group, appropriate for educational settings where random assignment or withholding pedagogical interventions is not feasible. While this limits causal inference, the design still enables the examination of changes over time attributable to the intervention.

Phase 1 involved the pre-intervention administration of validated survey instruments to establish a baseline measure of students' entrepreneurial mindset and perceptions of entrepreneurship education. Phase 2 was the post-intervention phase, in which both quantitative and qualitative data were collected concurrently to assess the outcomes of the learning intervention and gain deeper insight into students' experiences. This design enabled triangulation and helped mitigate some internal validity limitations inherent in the absence of a control group.

3.2 Participants and Procedure

A total of 98 postgraduate students enrolled in the course, of which 92 provided matched responses for both pre- and post-intervention surveys. Participation was voluntary and ethically approved by the university's review board.

The intervention was structured around problem-based and experiential learning activities, including two immersive field visits: (1) a trip to Suzhou's historic water towns to study digital transformation in SMEs, and (2) a visit to a niche e-bike manufacturer navigating domestic market challenges. Students conducted interviews, market research, and developed strategic solutions based on these engagements. These activities were aligned with Kolb's (1984) Experiential Learning Theory and Biggs' (1996) Constructive Alignment model and constructivist pedagogy (Fayolle and Gailly, 2008; Neck and Greene, 2011), while assessments reflected authentic learning practices.

3.3 Quantitative Data Collection and Analysis

Students' entrepreneurial mindset and perceptions of entrepreneurship education were measured using validated instruments of Entrepreneurship Education (EE) adopted from Wardana et al. (2020) and Entrepreneurial Mindset (EM) from Mathisen and Arnulf (2013). Both instruments used a 7-point Likert scale. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to assess the relationships between constructs and the statistical impact of the intervention.

3.4 Integration of Generative AI Tools

The course design integrated generative AI tools (ChatGPT, DeepSeek, Grammarly, Co-Pilot, and AI-enhanced visualization platforms) to scaffold learning. These tools were framed as cognitive supports, enhancing ideation, research, writing, and feedback processes while maintaining a human-in-the-loop model. Students were encouraged to critically evaluate AI-generated content using scholarly and real-world data (Luckin et al., 2016; Selwyn, 2019). This AI-enhanced learning environment was designed to promote metacognition, digital literacy, and critical thinking, in line with Kolb's "active experimentation" stage and Aoun's (2017) future-oriented learning framework.

3.5 Qualitative Strand

To complement and contextualize the quantitative results, the post-intervention survey included three open-ended questions focusing on students' reflections on entrepreneurial mindset development, experiential learning, and AI tool use. Responses were analyzed using thematic coding in NVivo, and a word cloud was generated to visualize key terms and recurring themes. This qualitative data was integrated at the interpretation stage, providing deeper insights into the experiential and cognitive outcomes of the intervention.

4. Results

4.1 Comparison of Mean Scores Before and After the Intervention

The data in Table 1 provides strong support for Hypothesis 1, indicating that entrepreneurship education significantly enhances students' entrepreneurial mindset. The overall mean score for entrepreneurial mindset increased from 3.875 to 5.25 (35.48% improvement). All individual items (EM1 to EM4) showed significant improvements.

4.2 PLS-SEM Results

SmartPLS 4.0 software application was used to analyse data and test the hypothesized relationships in two stages of measurement model and structural model assessment as suggested by Hair et al (2022). The reliability and validity of the constructs are presented in Table 5. Composite reliability (rho_a) values were above the recommended threshold of 0.70, specifically, EE had 0.82, and EM had 0.84, confirming the reliability of the constructs. The average variance extracted (AVE) values were above the 0.50 indicating convergent validity.

Table 1: Entrepreneurial Mindset Mean scores

Items	Mean Score at start	Mean Score at End	Difference	% Change
EM1	3.85	5.2	1.35	35.06%
EM2	3.75	5.5	1.75	46.67%
EM3	3.9	5.25	1.35	34.62%
EM4	4.0	5.05	1.05	26.25%
Overall	3.875	5.25	1.375	35.48%

Discriminant validity was assessed using the Fornell-Larcker criterion, as shown in Table 6. The square root of the AVE (diagonal elements) for each construct was higher than the correlations with other constructs (off-diagonal elements), demonstrating adequate discriminant validity (Hair et al, 2022). The structural model was evaluated by examining the path coefficients, standard deviations, T statistics, P values, and confidence intervals, as shown in Table 2. The path from EE to EM had a coefficient of 0.635 ($T = 8.94$, $p < 0.001$). The r-square values indicate that EE explained 47.80% variance in EM of the students.

Table 2: Structural Model Results

	Path Coefficient	Standard deviation	T statistics	P value	Lower Level Confidence Interval (2.5%)	Upper Level Confidence Interval (97.5%)
EE -> EM	0.635	0.071	8.94	<0.001	0.041	0.902

5. Discussion

Our findings indicate that pedagogically-driven immersive field trips and problem-based tasks indeed have a significant impact on students' perceptions of the effectiveness of entrepreneurship education. This suggests that by immersing students in real-world contexts, these field trips facilitate deeper learning experiences and foster a sense of entrepreneurial identity, as posited by Fayolle and Gailly (2008) and Neck and Greene (2011). Furthermore, results indicate that entrepreneurship education positively influences students' entrepreneurial mindset. This aligns with the progressive education principles and constructivist theory, emphasizing active engagement and practical acumen, which are essential for integrating theory with practice (Felder and Brent, 2009; Kolb, 1984). Through collaborative inquiry and experiential activities, students engage with real-world challenges and develop entrepreneurial competencies in a supportive learning environment (Gibb, 2009) which fosters a culture of continuous improvement and professional development (Biggs, 1996).

The word cloud (Figure 1) visually represents keywords extracted from students' open-ended responses, highlighting their reflections on learning outcomes and course design. Prominent five-letter action words such as "learn," "build," "think," and "solve" reinforce the course's emphasis on active learning and problem-solving. The presence of terms like "A.I," "mindset," and "ideas" underscores the influence of digital tools and cognitive development on students' entrepreneurial thinking. Words such as "teams," "plans," and "start" reflect students' collaborative and solution-focused engagement with real-world tasks. The recurring appearance of these terms suggests that the experiential and immersive teaching strategies successfully translated into lasting conceptual and practical understanding.



Figure 1: Student responses to open-ended questions

This study makes a theoretical contribution by empirically validating how Kolb's Experiential Learning Theory and Biggs' Constructive Alignment Model can be enhanced through AI integration in entrepreneurship education. While prior research (Larsen et al, 2023; Selwyn, 2019) has highlighted the limitations of traditional, theory-heavy EE approaches in developing lasting entrepreneurial competencies, our findings demonstrate that immersive, AI-augmented learning experiences create more sustainable mindset shifts by bridging the critical gap between abstract knowledge and practical application. The research extends current understanding by showing how generative AI tools serve as cognitive scaffolds that amplify Kolb's learning cycle - particularly in the reflection and active experimentation phases - while maintaining human oversight for ethical engagement (Selwyn, 2019). Furthermore, we address contextual debates in EE literature (Sorensen and Kuada, 2022) by providing evidence that properly scaffolded experiential learning, when combined with AI-enabled iteration and feedback loops, can overcome the cultural and implementation barriers that often limit the transferability of entrepreneurial skills across educational settings.

The study offers actionable insights for educators and institutions seeking to modernize entrepreneurship programs. Our problem-based approach - incorporating immersive field trips, AI-assisted research tools (ChatGPT, DeepSeek), and authentic assessments - proved particularly effective in developing students' critical thinking, opportunity recognition, and adaptive problem-solving skills. Three key practical takeaways emerge: First, the interdisciplinary nature of our cohort (students from 10 disciplines) demonstrated how cross-pollination of knowledge domains enhances entrepreneurial solution-building, suggesting curricula should break down traditional subject silos. Second, the AI-human collaboration model provided a blueprint for maintaining academic rigor while leveraging technology's benefits - students used AI for ideation and prototyping but were required to validate outputs through primary research and stakeholder interviews. Third, the partnership with local businesses created a sustainable ecosystem for work-integrated learning, addressing common resource constraints by making field experiences mutually beneficial for students and industry partners. These findings provide a replicable framework for institutions aiming to develop future-ready entrepreneurial competencies through blended digital-physical learning environments.

6. Limitations

This study has several limitations that should be acknowledged. First, the use of a one-group pre-test/post-test design without a control group limits causal inference. Improvements in entrepreneurial mindset scores cannot be definitively attributed to the intervention, as external factors may have influenced the outcomes. Second, while the study employed a concurrent mixed-methods approach, the quantitative phase dominated, and the rationale for integration could be more fully developed. Third, the absence of randomization and reliance on self-reported data may introduce bias and affect internal validity. Lastly, as the study was conducted within a single institution and program, findings may not be generalizable. Future research should consider more rigorous experimental designs, include control groups, and diversify data sources and participant profiles to enhance validity and applicability.

Ethics Declarations: Ethical clearance was obtained from university ethics review committee.

AI declaration: The authors confirm that they themselves are creators of this work and AI tool (ChatGPT) was merely used for language refinement, sentence structure, and grammatical improvements.

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Factors Shaping Knowledge Sharing Behaviour in Remote Work

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Abstract: The discussions that take place in the literature on the subject in relation to the advantages or disadvantages of remote work take on additional significance if employees representing the youngest generation of employees are taken as a reference point. For representatives of this generation, the communication tools used in remote work dominate over the form of direct communication. Through them, young employees build relationships, learn, acquire knowledge and share it. However, the results of the research draw attention to the fact that in relation to Generation Z, there may be problems related to the exchange of knowledge understood as learning and teaching others, which may result from different generational characteristics, including professed values, attitude to work and expectations towards it. The research results presented in the study are part of a quantitative survey on "Managerial aspects of remote work management", carried out among young people working remotely. The survey was carried out in December 2022 and analysed areas of remote work such as knowledge exchange/learning, communication, work organization, WLB, motivation and employee relations. The study diagnoses measurement models using structural modeling (SEM) in the field of latent factors. The analyses were carried out using IBM SPSS and IBM SPSS AMOS software.

Keywords: Learning, Knowledge exchange, Remote work, Generation Z

1. Introduction

In December 2022, a research team from the Częstochowa University of Technology conducted a study involving a sample of 387 remote employees representing Generation Z. The aim of the study was to identify which dimension of remote work plays the most significant role in shaping their attitudes towards this mode of work and their preferences regarding its continuation. Based on a review of the relevant literature and prior research, the following dimensions were selected for analysis: work organisation (O), work-life balance (WLB), motivation (M), knowledge sharing and learning (KL), employee relations (R), and communication (C). Exploratory factor analysis conducted on the collected data revealed some unexpected patterns (Albrychiewicz-Słocińska, 2024a). The analysed group of young and very young people, contrary to the stereotypical perception, appreciates the importance of knowledge of other employees. Rather than relying solely on organisational knowledge repositories, they recognised the importance of interpersonal relationships in enhancing personal effectiveness and learning. These two dimensions were found to be closely interrelated, forming a factor with the highest eigenvalue and accounting for as much as 45.5% of the total variance. Somewhat surprisingly, aspects of WLB, frequently highlighted in the literature as a major advantage of remote work, had only a marginal impact on respondents' perceptions of this work model. In light of the above, the author decided to investigate the relationships between the analysed dimensions, while simultaneously seeking to determine, through the use of statistical models, the position of the knowledge sharing and learning factor. Is this factor influenced by the remaining dimensions, or does it, in fact, constitute a foundation for shaping them? Alternatively, could the relationships between these factors be more complex and reciprocal, with some acting as catalysts or mediators in relation to others?

2. Theoretical Foundations of the Issue

In the theoretical introduction to the paper, the author addresses the ongoing debate present in the literature concerning the validity and correctness of grouping employees by age category, as well as the contested definitions of the term "generation" (Urick et al., 2017). Concerning the issue under study, different authors quote various classifications of generational divisions (Bencsik et al. 2016; Goh and Lee 2018; Kirchmayer and Fratricova 2018). Of particular note in this discussion are the works of Wiktorowicz et al. (2016) and Warwas et al. (2018), which presents an objective overview of sociological, psychological, anthropological, and even cultural interpretations of the term "generation" considering Polish specifics. The perspective adopted for the purposes of this publication defines a generation not only by year of birth, but also by a shared set of experiences shaped by a particular society. For instance, under the generational nomenclature commonly used in the literature, Generation X, in Poland is likely to be characterised primarily by the experiences of the 1990s and the socio-economic transformation of that period. Even within this group, however, it is possible to identify distinct sub-generations, understood as communities of specific shared experiences (Sobierajski&Kuszewska, 2023). The author of this paper deems the perspective grounded in experiences affecting broad social groups to be

conceptually sound. At the same time, she acknowledges that conducting quantitative social research based on populations defined by a perceived connection to particular macro-experiences presents significant challenges. Therefore, for the purposes of the study, it was assumed that the generational categorisation based on year of birth, as presented in the literature, would be the most appropriate for the implementation of the survey. The most popular division assumes that Generation Z, in relation to Poland, includes people born after 1995, although researchers sometimes consider those born in 1990 as its representatives (Wiktorowicz et. al. 2016). However, there are also approaches in the literature that classify individuals born in 2000 and later as belonging to Generation Z (Dreyer & Stojanová, 2022).

The literature describing Generation Z highlights a strong attachment to, or even dependence on, modern information technologies and the tools used to operate them. For Generation Z, smartphones and iPhones are basic communication tools, much more important than face-to-face communication (Astorquiza-Bustos & Quintero-Peña, 2023; Bamieh & Ziegler, 2022, Wiktorowicz et al.2016, Warwas et al. 2018). Through these devices, young employees explore the world, form relationships, learn, acquire knowledge, and share it with others. It could therefore be assumed that remote work, relying heavily on IT solutions, would be their preferred form of employment.

Indeed, the pandemic years, as well as the short period following their conclusion, yielded numerous research findings suggesting that remote work not only contributed to higher levels of satisfaction among young employees, but was also associated with greater efficiency (Emanuel & Harrington, 2020) and enhanced employee wellbeing (Charalampous, 2020) compared to traditional on-site work. For many young individuals, remote work is so attractive and desirable that they are even willing to accept a partial reduction in salary in order to work at a time and place of their choosing (Emanuel & Harrington, 2023b).

However, the findings of the study conducted by the author appear to contradict the assumptions commonly associated with Generation Z's technological preferences (Stohnij, 2020, Nieżurawska & Gałaś, 2021, D'Acunto et al.2025). According authors previous research results (Albrychiewicz-Słocińska, 2024b), among employees with at least six months of remote work experience, remote work was not identified as the most preferred form of work for the future. Only 17.57% of respondents selected it as their preferred option. It seems that this should be linked to the significance of the organisational learning factor, according to which young people recognise the importance of building interpersonal relationships in the workplace, as these relationships condition learning processes and motivation to work. These are key elements for young people gaining professional experience and benefiting from the expertise of colleagues with greater knowledge and work experience. This observation is supported by the research of Dreyer & Stojanová (2022) and Hegade & Shettar (2022), which emphasise the importance of personal contact and direct communication in the workplace, along with the skills associated with these interactions (Hans et al., 2023).

Another contribution to the discussion highlighting the weaknesses of remote work comes from the repeated in-depth studies by Emanuel & Harrington (2023b, 2023a), which draw attention to the negative impact of remote work on employee effectiveness. These patterns were confirmed in the studies of Atkin et al. (2023) and Gibbs et al. (2022). Additional negative factors associated with remote work include issues with team supervision (Wąsik, 2020), work safety regulations, difficulties in ensuring data security, and deteriorating internal communication (Wąsik, 2020). Considering the perspective of the discussed issue, it is of great importance that remote work also causes a decrease in commitment and trust among employees (Tomaszuk & Wasiluk, 2023), deterioration of work quality and a sense of isolation (Bartel et al., 2012). For young employees, remote work is also associated with stagnation in both professional and social development (Yarbrough & Ramos Salazar, 2023). For instance, Emanuel et al. (2023) point out that employees working in office settings acquire the skills necessary for new jobs more quickly.

3. Methodology

3.1 Empirical Analysis. Data Acquisition and Profiling

In the course of the study, 387 surveys were conducted in accordance with the established research indicators concerning the representativeness of the studied population. Based on the Yearbook of Labour Statistics 2021, the size of the population of individuals working in Poland within the age range of interest to the researchers (born after 1995) was determined to be 4,802,000 people. The structure of the surveyed population, divided by gender and age, is presented in Fig. 1. For this estimated population, with the following statistical assumptions: population fraction size: 0.5; confidence level: 95%; maximum error: 5%, the sample size was determined to be 384 individuals (excess surveys do not disrupt the planned structure of the research group) (Fig. 2). The study

was conducted by Fieldstat Sp. z o.o., a specialised market research agency. The research was carried out using quantitative research methods, employing the Computer-Assisted Telephone Interview (CATI) technique for 50% of respondents, and the Computer-Assisted Web Interview (CAWI) technique for 50% of respondents.

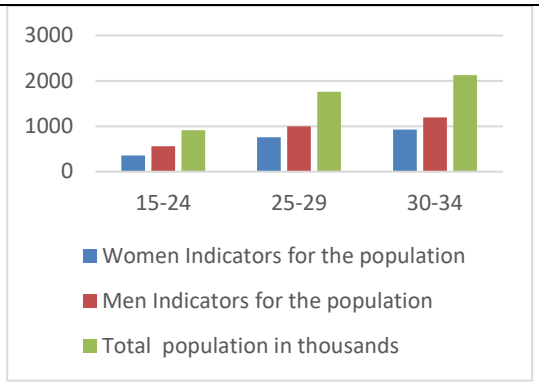


Figure 1: Population structure by age and sex. Source: Own work

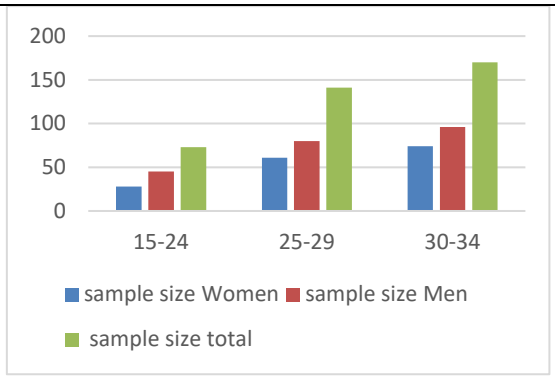


Figure 2: Structure of the study group by age and gender. Source: Own work

The research questionnaire design was based on the analysis of factors influencing remote work, within which a list of primary indicators was constructed (57 items, Likert scale). These primary indicators were then aggregated into 6 secondary indicators (latent factors): learning and knowledge sharing (KL), motivation(M), work organisation (O), employee relations (R), work-life balance (WLB), and communication (C).

The literature review revealed that most of the factors influencing the topic under consideration by the researchers are dispersed, diverse, and lack systematisation. Few researchers also consider the relationship and mechanism of action between these factors. Therefore, based on previous studies, which also served as a form of pilot research to refine the research tool, this paper goal is to analyse the relationship between these factors and organisational learning and knowledge sharing representing by three models – theoretical constructs of relationships between latent factors. The dominant importance of the organisational learning and knowledge sharing domain in relation to remote work was confirmed through principal component analysis (Albrychiewicz-Słocińska 2024b) and exploratory factor analysis (Albrychiewicz-Słocińska, 2024a).

3.2 Structural Equation Model (SEM) and AMOS

Structural Equation Modelling (SEM) is an advanced statistical method that allows for the analysis of complex relationships between variables. SEM can be conducted using various statistical software packages. One of the most popular is IBM SPSS AMOS. Analysis of Moment Structure (Amos) was developed by James L. Arbuckle (2003) and is suitable for covariance structure analysis to examine complex multivariate data. In this process, appropriate hypotheses are proposed, and the Amos structural equation model is used for modelling, analysis, and data processing to verify latent (hidden) factors and relational paths. Structural equation modelling can be divided into measurement modelling and structural modelling. Measurement modelling refers to the relationships between indicators and latent variables. Structural modelling refers to the relationships between latent variables. The study diagnoses measurement models using structural modeling (SEM) in the field of latent factors. The analyses were carried out using IBM SPSS and IBM SPSS AMOS software.

4. Research Results

4.1 Confidence Analysis and Factor Analysis

The adequacy of the correlation matrix is assessed using the Kaiser-Meyer-Olkin (KMO) index. It measures the adequacy of the selection of variables (Kaiser, 1974). The index compares the magnitude of the observed correlation coefficients with that of the partial correlation coefficients. Small KMO values suggest that consideration should be given to the validity of applying factor analysis to such data. Kaiser (1974) suggests the following interpretation of the magnitude of the KMO index: 0.90 - very high, 0.80 - high, 0.70 - medium, 0.60 - moderate, 0.50 - low and less than 0.50 - very low (not acceptable) (Zakrzewska, 1994, p. 56). Some researchers recommend taking 0.7 as the threshold value (Stanisz, 2006).

As shown in Tab. 1, the data reliability analysis revealed a good confidence level of 0.970, indicating that no corrections were required for problematic items. As shown in Tab. 3, the Bartlett's test ($p<0.05$) indicated that

the variables are significantly correlated and suitable for factor analysis. And as a result SEM analysis can be undertaking.

Table 1: KMO and Bartlett test and reliability statistics results

KMO	0,968
Bartlett's test of sphericity Chi^2	20930,68
df	1485
significance	0,0000
Cronbach alpha	0,970

Source: Own work

4.2 Construction of Structural Equation Models

The basis for assessing the acceptability of the theoretical model, in which the directions and the significance of the relationships between variables are hypothetically assumed, is the positive result of the procedure verifying the research hypothesis regarding the acceptability of the model and the estimation of the unknown model parameters, along with the assessment of the significance of these parameters (Januszewski, 2011). The AMOS software used to perform Structural Equation Modelling (SEM) calculates both standardised and unstandardised estimates which can be interpreted according to the purpose formulated by the researcher. The estimates most commonly considered are regression weights.

In the analysis of the research results, the following research hypothesis was proposed: factors such as motivation, work organisation, employee relations, and work-life balance shape behaviours related to organisational learning and knowledge sharing (Model 1) (Fig.3).

Model fit indices were used as a reference before testing and constructing the structural equation model (Tarka, 2017) Tab. 2.

Table 2: Model Fit Results

Test index	X2/df	GFI	AGFI	NFI	CFI	IFI	RMSEA
Recommended value	<3	>0.90	>0.80	>0.90	>0.90	>0.90	<0,08
Model 1	5,538	,410	,365	,624	,669	,670	,108
Model 2	5,143	,393	,346	,651	,698	,698	,104
Model 3	4,943	,432	,384	,667	,714	,715	,101

Source: Own work

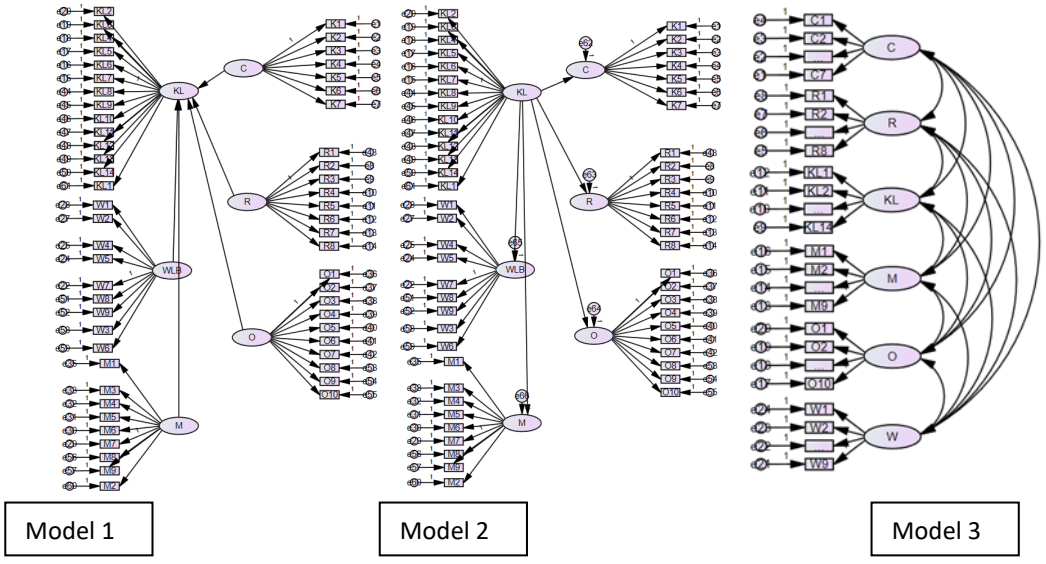


Figure 3: Analysed models. Source: Own work

Unfortunately, the results for Model 1 (Chi-square = 8494.801, df = 1534, probability level = .000) indicate significant misfit, which could be the result of too small a sample size, issues with applying structural models to ordinal data, incorrect directions of certain relationships, or the lack of consideration for the dependencies between latent factors. Therefore, a model adjustment was made, assuming the reverse direction of the hypothesised relationships, so that it is the behaviours related to knowledge sharing and learning that influence areas such as motivation, work organisation, employee relations, and work-life balance (Model 2) (Chi-square = 7889.466, df = 1534, probability level = .000). The fit indices for this model showed much better fit, yet they still did not meet the boundary values that would allow for its acceptance. Thus, another modification was made to the model, assuming mutual dependencies between latent factors – Model 3 (Chi-square = 7533.203, df = 1524, probability level = .000). The obtained values for the model fit indices improved, and in the case of the X2/df statistic, they now allow for model acceptance, assuming the marginal acceptable value of <5.

By analysing the causes of the discrepancy, detailed statistics were examined, which revealed that in Model 1, which assumed the impact of the analysed areas on the KL domain, factors such as C and WLB were found to have no statistically significant relationships with the KL domain. Furthermore, inverse relationships were observed in relation to these two areas. The employee relations domain showed the strongest relationships.

Table 3: Regression Weights Model 1

KL		Other	Estimate	S.E.	C.R.	P
KL	<---	WLB	-.023	.019	-1.235	.217
KL	<---	R	.362	.031	11.775	***
KL	<---	C	-.755	2.857	-.264	.791
KL	<---	M	.304	.028	10.742	***
KL	<---	O	.422	.040	10.668	***

***p<0,001

Source: own work

When examining the relationships between the factors in Model 2 (Tab. 4), it was revealed that KL has positive, very strong, and statistically significant effects on the other dimensions of remote work. Although this model does not demonstrate an acceptable fit of the theoretical construct, its fit results are considerably better than those of Model 1.

Table 4: Regression Weights Model 2

Other		KL	Estimate	S.E.	C.R.	P
WLB	<---	KL	.760	.058	13.036	***
C	<---	KL	.884	.071	12.370	***
R	<---	KL	.917	.064	14.302	***
O	<---	KL	.902	.069	13,021	***
M	<---	KL	.985	.060	16.338	***

***p<0,001

Source: own work

Regarding Model 3, which assumed mutual dependencies between the latent factors, a recursive model was obtained in which all factors exhibited statistically significant interdependencies. It is this model that demonstrates the highest fit indices. The relationships shown in Tab. 5 are of a correlational nature.

Table 5: Covariances matrix Model 3

Factors			Estimate	S.E.	C.R.	P
C	<-->	KL	.528	.068	7.750	***
C	<-->	R	.728	.073	9.984	***
R	<-->	O	.458	.054	8.565	***

Factors			Estimate	S.E.	C.R.	P
M	<-->	O	.638	.062	10.241	***
WLB	<-->	M	.540	.053	10.263	***
KL	<-->	WLB	.480	.051	9.452	***
KL	<-->	M	.653	.061	10.785	***
C	<-->	O	.346	.062	5.565	***
C	<-->	M	.446	.065	6.822	***
C	<-->	WLB	.271	.059	4.564	***
KL	<-->	O	.602	.062	9.730	***
R	<-->	WLB	.364	.047	7.757	***
WLB	<-->	O	.553	.057	9.713	***
R	<-->	KL	.633	.062	10.185	***
R	<-->	M	.564	.056	10.069	***

***p<0,001

Source: own work

5. Discussion

The literature on the subject includes a variety of publications relating to the factors shaping behaviours and attitudes towards knowledge sharing. The main categorisation of these factors distinguishes between internal factors (related to the individual) and external factors connected to the work environment (Zhao et al., 2016). Internal factors were not included in the analysis in this paper. In constructing the dependency models between KL and other areas of work, the author primarily relied on previous own research conducted in this area, as well as on the work of other scholars (Zhao et al., 2016; Connelly et al., 2012; Connelly & Kelloway, 2003). However, it should be noted that these studies did not refer to Generation Z employees, nor did they consider the specific context of remote work. The study by Yuan et al. (2010) does refer to remote work, yet it does not include factors such as communication or WLB, instead focusing more on time pressure and the physical location of work. In light of this, it is difficult to directly compare the current findings with those presented by other authors.

Model 3, which most closely reflects the actual structures found in practice, assumes mutual interdependencies between the analysed areas, and as the results show, these relationships are highly complex. For example, the relationship between KL and R is considerably stronger than that between C and KL, although the relationship between C and R proves to be the strongest among all analysed in Model 3. Another significant association was found between KL and M, while the weakest relationship was observed between C and WLB.

6. Conclusions

The analysis of the constructed models leads to the following conclusions. In Poland, during the first two decades following the 1989 transformation, the uncertain economic situation, rising unemployment rates, and high levels of competition among employees created a context in which knowledge became a source of personal competitive advantage. Consequently, knowledge sharing was contingent upon the quality of interpersonal relationships, the level of trust, and the norm of reciprocity (interpretation consistent with Model 1). Today, stimulating knowledge-sharing behaviours seems to have an equally important, albeit reversed, significance. By provoking and rewarding such behaviours, it is possible to shape employee relations, motivation, and communication (Model 2). Knowledge sharing, therefore, should not be viewed merely as an outcome or effect (Model 1), but rather as a cause (Model 2), and can be considered an organisational practice that enhances the quality of the social work environment. However, the results of the conducted analyses suggest that this perspective remains insufficient, as it does not account for all interdependencies (Model 3). It seems appropriate to undertake further research in this area, incorporating mediators or higher-order factors into the models to more accurately represent the actual relationships between KL and other dimensions of remote work.

Ethics statement: Because this is not an experimental intervention study, and it is not a first in man study, no ethical approval were asked by the ethical committee. The survey was carried out by a specialized external company based on the content of the questions sent by the authors and the research assumptions regarding the structure of the surveyed group.

AI statement: I declare that I did not use AI in this article, all the text was manually written.

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Fostering Knowledge Management Practices Through Artificial Intelligence: Vision 2030 as a Catalyst

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Abstract: The rapid integration of artificial intelligence (AI) into organisational operations has transformed knowledge management (KM) practices, providing opportunities to enhance decision-making, innovation and efficiency. This study explores the adoption and impact of AI on KM practices in Saudi Arabia, focusing on the alignment of these advancements with the Kingdom's Vision 2030 objectives for economic diversification and innovation-driven growth. Using a quantitative methodology, data were collected from management in private and public organisations to analyse the perceptions, challenges and opportunities of adopting AI for KM. While AI tools significantly enhance knowledge sharing, collaboration and the accuracy of knowledge repositories, the findings reveal that AI adoption is hindered by challenges such as limited technical expertise, high costs and resistance to change. The data underscore a strong expectation that AI-driven KM will become essential for maintaining competitiveness in the next decade. Additionally, organisational managers highlight the role of AI in fostering a culture of innovation and entrepreneurship, crucial for achieving the strategic goals of Vision 2030. This research provides actionable insights for policymakers and business leaders, identifying critical enablers of AI adoption, including investments in digital infrastructure, skill development and change management strategies. By addressing these barriers, organisations can optimise the integration of AI to support sustainable development and innovation. The study contributes to the growing body of literature on AI and KM in emerging economies, offering practical recommendations that bridge the gap between technology-driven initiatives and strategic objectives.

Keywords: Knowledge management, Artificial intelligence, Knowledge sharing, Vision 2030, Saudi Arabia, Public and private organisations

1. Introduction

The rapid advancement of artificial intelligence (AI) technologies has transformed business landscapes around the world, enhancing operational efficiency, decision-making and innovation. AI, defined as 'the capability of a computer system to show humanlike intelligent behavior characterized by perception, understanding, action, and learning' (Wirtz et al, 2019, p. 599), has emerged as a pivotal force in transforming knowledge management (KM) practices within businesses (Leoni et al, 2024). KM refers to the systematic process of creating, sharing and leveraging knowledge within an organisation to achieve strategic goals (Aljuwaiber, 2021). The integration of AI into KM aligns with the resource-based view (RBV), positioning AI as a critical resource that enhances organisational capabilities (Barney, 1991).

In Saudi Arabia, the integration of AI into business practices supports Vision 2030, a national plan which seeks to reduce dependence on oil revenues and promote a knowledge-based economy. KM is central to this transformation, as it enables innovation, improves decision-making and fosters organisational agility (Memish et al, 2021). To date, there is a lack of empirical research on KM practices and implementation in public sector organisations in Saudi Arabia (Algahtani, 2019). Furthermore, the existing literature often overlooks how KM initiatives align with the objectives of Vision 2030, requiring an assessment of sector-specific challenges and opportunities in this context (Yusuf & Lytras, 2023). This study fills this research gap by exploring how AI technologies – such as machine learning, natural language processing and intelligent automation – enhance KM processes in Saudi businesses. By focusing on identifying synergies between AI-driven KM and broader economic transformation goals, the research aligns with the objectives of Vision 2030.

This research critically addresses the following research questions:

RQ1: How has Saudi Vision 2030 encouraged the use of KM practices in Saudi Arabia? 1

a) How do key enablers drive the success of KM practices under Vision 2030?

b) What factors hinder the successful alignment of KM initiatives with Vision 2030?

RQ2: How do AI technologies influence KM practices in both public and private sectors in Saudi Arabia?

RQ3: What are the specific expectations and future roles envisioned for AI in enhancing KM processes?

RQ4: What are the primary challenges and enablers of employing AI in KM?

This study provides insights for policymakers, business leaders and scholars by linking KM to Saudi Vision 2030 and emphasizing the strategic role of AI in achieving national objectives. It offers practical recommendations for businesses to enhance their KM practices and contributes to the literature on KM in emerging economies, particularly in the Middle East. The study addresses a gap identified by Leoni et al (2024) and Al-Shboul (2024), who noted the lack of empirical research on the role of AI in KM. Unlike prior research which has focused exclusively on private businesses, this study also explores managerial perspectives in the public sector (Neumann et al, 2024), revealing the contextual factors that influence AI adoption and its impact on KM practices.

2. Theoretical Background

2.1 Organisational Knowledge Management Practices

KM practices are essential for improving organisational performance and innovation. Effective KM strategies enhance knowledge sharing and foster continuous learning, which directly impact organisational outcomes (Aljuwaiber, 2021). Silva and Fain (2024) found that improvements to KM capabilities, such as organisational structure or knowledge processes, lead to better performance in educational institutions. Khanal and Paudyal (2017) similarly found that KM strategies positively affect financial institution performance. Olan et al (2022) emphasised that aligning KM with organisational processes boosts employee motivation and stakeholder satisfaction, contributing to operational success. Ting et al. (2021) highlighted how transformational leaders in public service firms can drive KM adoption through strategic alignment.

Technology plays a key role in KM. Saratchandra and Shrestha (2022) found that cloud computing enhances KM capabilities in small and medium-sized enterprises (SMEs) by improving knowledge acquisition, sharing and utilisation. Leoni et al (2024) explained the transformative role of AI in automating KM processes and personalising knowledge delivery, exemplified by Amazon's use of big data for customer knowledge. The utilization of cutting-edge technologies, including AI in KM, along with its advantages, desirable for future investigation (Liu et al., 2023).

In Saudi Arabia, KM is critical for achieving the goals of Vision 2030, which focus on economic diversification, innovation and creating a knowledge-based society. A comprehensive approach to KM that integrates technology, leadership and organisational alignment is needed to foster innovation and improve performance (Aljuwaiber, 2020). Accordingly, the first aim of this study is to explore how KM practices contribute to innovation, collaboration and alignment with Vision 2030 goals.

2.2 Role of Artificial Intelligence in Public and Private Sectors

AI is transforming both public and private sectors, driving efficiency, innovation and improved decision-making in KM. Its ability to analyse vast datasets, predict outcome, and automate processes has made it a cornerstone of modern organisational strategies (Olan et al, 2022).

In the public sector, AI improves service delivery, resource allocation and citizen engagement. Saudi Arabia's Ministry of Health, for example, uses AI for predictive health analytics, aiding in early epidemic detection and personalised care (Kumar et al., 2025). Neom City, located in North of Saudi Arabia, integrate AI for urban planning, cybersecurity, traffic management and environmental monitoring, aligning with the sustainability goals of Vision 2030 (Hassan, 2020). Public organisations, particularly those implementing AI practices, are responsible for ensuring that AI applications are consistent with essential public values, including efficiency, fairness, accountability, transparency and responsiveness to human needs (Neumann et al, 2024). This alignment is crucial for maintaining public trust, promoting equity and safeguarding the integrity of public services. Wirtz et al (2019) stressed the potential of AI in public organisations but also highlighted the need for more research on its adoption and implementation.

In the private sector, AI can enhance a variety of business functions, especially human resources and operations. AI can stimulate creative thinking, foster shared memory among team members, and enhance feedback and peer review processes, promoting collaboration and innovation (Jarrahi et al, 2023). Wijayati et al (2022) highlighted the role of AI in improving employee performance, particularly in data-driven sectors like banking and services. Amazon's AI recommendation engines, for instance, personalise the customer experience, boosting sales; many Saudi retailers use AI to predict trends and optimise supply chains (Alhumaid et al., 2025). In banking, AI facilitates fraud detection, risk assessment and personalised financial advice, improving competitive advantages and customer service (Al-Baity, 2023). However, there remains a lack of research on the long-term effects of AI on workforce dynamics and organisational culture.

The lack of long-term studies presents an opportunity for future studies to investigate the ethical frameworks necessary for responsible AI implementation in both public and private sectors, ensuring that the benefits of AI are realised without compromising social equity or organisational integrity. This paper seeks to fill this gap by analysing the impact of AI technologies on KM practices in public and private Saudi organisations.

2.3 Adoption and Effectiveness of Artificial Intelligence Technologies for Knowledge Management Practices

AI plays a crucial role in knowledge dissemination within digital organisations, improving the delivery of information (Rhem, 2021). A key advantage of AI is its ability to uncover patterns and generate insights beyond human capabilities. AI-driven recommendation systems promote organisational learning by suggesting relevant documents, training materials or collaborators based on user behaviour (Jarrahi et al, 2023). AlQahtani (2024) found that AI adoption in Saudi enterprises improved knowledge dissemination and retrieval, enhancing organisational learning and fostering innovation. Successful AI adoption in KM depends on the technology's compatibility with organisational goals and infrastructure. As Alharbi and Aloud (2024) noted, businesses with advanced IT systems are better positioned for effective AI integration. Despite its potential, AI adoption in KM faces challenges such as data privacy, technological complexity and employee resistance (Leoni et al, 2024). Thus, it can be argued that robust change management strategies and alignment with the organisational culture can assist in mitigating such challenges of AI adoption. Rhem (2021) highlighted the importance of addressing ethical concerns and aligning AI with organisational objectives.

If AI is to effectively advance KM practices, businesses must balance technological advancements with human-centric approaches. A culture of innovation and continuous learning is essential for AI adoption (Alqahtani, 2024). Adequate IT infrastructure and access to quality data are also critical, as noted by Alharbi and Aloud (2024). Many Saudi SMEs face challenges related to outdated IT systems. Supportive policies and guidelines, such as those of Vision 2030, have positively impacted AI adoption rates in Saudi Arabia (Yusuf & Lytras, 2023). Accordingly, this research provides an overview of the factors that promote or hinder the implementation of AI in KM practice.

2.4 Contribution of Artificial Intelligence-Enabled Knowledge Management to the Goals of Saudi Vision 2030

The integration of AI into KM practices is crucial for achieving Saudi Vision 2030, which aims to diversify the economy, enhance public sector efficiency and improve citizens' quality of life. AI-powered KM systems facilitate knowledge capture, sharing and utilisation, driving innovation and improving operational efficiency. The Saudi Data and Artificial Intelligence Authority (SDAIA) supports Vision 2030 by enhancing data-driven decision-making within government agencies (Memish et al, 2021). The potential of AI to improve organisational performance through streamlined knowledge processes is essential for the public sector transformation envisioned under Vision 2030 (Memish et al, 2021). AI-driven KM enables Saudi businesses to optimise and innovate, contributing to economic diversification and non-oil revenue growth (Yusuf & Lytras, 2023). AI also supports the development of a knowledge-based economy by fostering the creation and sharing of knowledge across sectors (Alharbi & Aloud, 2024).

However, there are gaps in the KM literature regarding the long-term impacts and challenges of AI. More research is needed to address ethical issues, workforce roles, and the societal and economic impacts of AI adoption (AlQahtani, 2024; Rhem, 2021). Additionally, the role of AI in fostering collaboration between sectors, which is crucial for the holistic development of Vision 2030, remains underexplored. Closing these gaps will enhance our understanding of how AI may contribute to Saudi Arabia's strategic goals and guide effective implementation. As a result, this study aims to provide actionable recommendations that address integration challenges and optimise AI-driven KM strategies.

3. Methodology

This study follows a positivist philosophy, making a deductive approach logical and appropriate. A quantitative strategy was employed to obtain generalisable results within acceptable error limits (Fisher, 1993). Given the exploratory nature of the study and limited access to the population (Ahmed, 2024), non-probability sampling, specifically snowball and purposive sampling techniques, was selected.

3.1 Data Collection and Sampling

Data were collected from middle and executive management in both public and private organisations in Riyadh, Saudi Arabia using a structured survey. Participants were selected for their expertise and ability to provide reliable insights into AI adoption in KM, its challenges and enabling factors (Kukah et al, 2022). Purposive

sampling enabled the researcher to select individuals who were best suited to provide relevant insights, and snowball sampling helped expand participation through referrals, tapping into participant networks. The initial sample was sourced from industry contacts and academic networks, ensuring representation from both public and private organisations of varying sizes and scopes. The total sample consisted of 87 respondents, with 47 (54.0%) from the private sector and 40 (46.0%) from the public sector. Of the total, 52 (59.8%) held middle management roles, while 35 (40.2%) were part of executive management. A majority of respondents (60.9%) had been with their organisations for over 10 years.

3.2 Measures

A self-administered online questionnaire was used to collect data. The questionnaire consisted of a total of 28 primary items, encompassing four general and demographic pieces of information, as well as two questions featuring multi-optional selections were part of the 28 items**.** All items were measured on a 5-point Likert scale (1 = *strongly agree* to 5 = *strongly disagree*). Participation was voluntary and anonymous, and all possible attempts were made to reduce bias (Podsakoff et al, 2003).

3.3 Statistical Analysis and Results

This study utilised SPSS Version 28 for data analysis. Cronbach's alpha was calculated to ensure the reliability of the survey instrument, and Pearson's correlation coefficient was used to assess the internal consistency of survey items and the construct validity of the study axes. Kurtosis and skewness values were used to evaluate the normality of data distribution. Descriptive statistics, including means, standard deviations, item rankings and percentages, were also computed. For inferential analysis, the study employed one-sample and independent sample t-tests. Cohen's d was used to measure the effect size, offering insights into the practical significance of the findings. Levene's test for equality of variances was applied to assess the homogeneity of variances between two groups.

3.3.1 Reliability and validity

As seen in Table 1, Cronbach's alpha exceeded 0.70 for all axes and the overall study, indicating high stability and excellent reliability for field application.

Table 1: Study reliability

Axis	No. of items	Cronbach's alpha
Impact of Saudi Vision 2030 on KM	4	0.786
Understanding enablers of KM success in the context of Saudi Vision 2030	3	0.714
Challenges to KM alignment with Saudi Vision 2030 goals	10	0.783
Impact of AI technologies on KM	5	0.717
Complete study	**22**	**0.789**

The Pearson correlation coefficients for the survey items range from 0.382 to 0.857 (see Table 2), indicating a strong positive correlation between items and the overall axis. All correlations are significant at the 1% level, confirming a high degree of internal consistency and validity.

Table 2: Pearson's correlation coefficients for the study items

Impact of Saudi Vision 2030 on KM		Understanding enablers of KM success in the context of Saudi Vision 2030		Challenges to KM alignment with Saudi Vision 2030 goals		Impact of AI technologies on KM	
Item	**Correlation coefficient**	**Item**	**Correlation coefficient**	**Item**	**Correlation coefficient**	**Item**	**Correlation coefficient**
1	0.832**	5	0.794**	8	0.515**	18	0.578**
2	0.857**	6	0.818**	9	0.428**	19	0.724**
3	0.682**	7	0.774**	10	0.679**	20	0.768**
4	0.745**			11	0.670**	21	0.727**
				12	0.638**	22	0.789**
				13	0.734**		

Impact of Saudi Vision 2030 on KM		Understanding enablers of KM success in the context of Saudi Vision 2030		Challenges to KM alignment with Saudi Vision 2030 goals		Impact of AI technologies on KM	
Item	**Correlation coefficient**	**Item**	**Correlation coefficient**	**Item**	**Correlation coefficient**	**Item**	**Correlation coefficient**
				14	0.762**		
				15	0.715**		
				16	0.388**		
				17	0.382**		

Note: ** indicates significance at the 1% level.

Correlation coefficients were calculated between each study axis and the overall study to determine the construct validity (Table 3). All correlations were positive and significant at the 1% level, confirming the validity of the constructs.

Table 3: Correlation coefficients for the overall study

Axis	Correlation coefficient
Impact of Saudi Vision 2030 on KM	0.526**
Understanding enablers of KM success in the context of Saudi Vision 2030	0.534**
Challenges to KM alignment with Saudi Vision 2030 goals	0.778**
Impact of AI technologies on KM	0.617**

Note: ** indicates significance at the 1% level.

3.4 Descriptive Analysis

3.4.1 The impact of Saudi Vision 2030 on KM practices

The results show that Saudi Vision 2030 has a statistically significant positive impact on KM practices, t(86) = 21.39, $p < .001$. The overall mean of 4.331 for the measure indicates a strong consensus on the role of Vision 2030 in fostering KM adoption. Cohen's d was 2.29, exceeding the large-effect-size benchmark of 0.8, reinforcing Vision 2030's substantial influence. The coefficient of determination of 0.842 indicates that 84.2% of the development in KM practices can be attributed to the encouragement provided by Saudi Vision 2030. As seen in Table 4, participants were in agreement that Saudi Vision 2030 influences KM investments (mean = 4.38, SD = 0.751) and promotes knowledge sharing for innovation (mean = 4.24, SD = 0.762).

Table 4: Participants' views of the impact of Saudi Vision 2030 on KM practices

Items	Mean	SD	p.c. (%)
Saudi Vision 2030 has encouraged my organisation to implement knowledge management practices	4.33	0.787	86.60
Saudi Vision 2030 has influenced investments in knowledge management systems or tools in my organisation	4.38	0.751	87.60
Saudi Vision 2030 has inspired my organisation to prioritise knowledge sharing	4.37	0.667	87.40
My organisation encourages the concept of knowledge sharing among employees to stimulate creativity and innovation	4.24	0.762	84.80
Mean Total	**4.331**	**0.580**	**86.62**

3.4.2 Key enablers driving the success of KM practices under Saudi Vision 2030

The results confirm that key enablers (i.e. organisational culture, leadership and technological tools) significantly drive KM success under Saudi Vision 2030, t(86) = 15.16, $p < .001$. A Cohen's d of 1.63 indicates a large effect size, reinforcing this impact. The coefficient of determination of 0.728 shows that key enablers account for 72.8% of KM success variations. Table 5 shows that participants feel that leadership supports KM implementation

(mean = 4.09, SD = 0.802) and technological tools aid KM (mean = 3.99, SD = 0.869). The overall mean (4.031) confirms a shared belief that key enablers drive KM success under Saudi Vision 2030.

Table 5: Participants' views of enablers for KM success in the context of Saudi Vision 2030

Items	Mean	SD	p.c. (%)
Organisational culture in my organisation supports knowledge management practices due to its dynamism, flexibility and quick response to any changes or developments	4.01	0.723	80.20
Leadership in my organisation is committed to implementing knowledge management practices	4.09	0.802	81.80
Technological tools in my organisation enable effective knowledge management practices	3.99	0.869	79.80
Mean Total	**4.031**	**0.634**	**80.62**

3.4.3 Key factors hindering the successful alignment of KM initiatives with Saudi Vision 2030

Table 6 highlights key challenges in aligning KM with Saudi Vision 2030, including a lack of management support (mean = 4.31, SD = 0.811) and the absence of a clear KM strategy (mean = 4.29, SD = 0.776). Other obstacles include poor alignment with Vision 2030 goals (mean = 3.98, SD = 0.976) and AI integration challenges (mean = 3.89, SD = 0.841). The overall mean (4.122) suggests a strong consensus among respondents on these barriers.

Table 6: Participants' views of key factors hindering the successful alignment of KM with Saudi Vision 2030

Factors	Mean	SD	p.c. (%)
Lack of management support	4.31	0.811	86.20
Resistance to change among employees	4.06	0.826	81.20
Inadequate digital infrastructure	4.17	0.879	83.40
Lack of a clear knowledge management strategy	4.29	0.776	85.80
Insufficient resources (time, budget or staff)	4.20	0.819	84.00
Poor communication or collaboration between departments	4.14	0.795	82.80
Poor alignment with Vision 2030 goals	3.98	0.976	79.60
Lack of training programs for career development	4.05	0.963	81.00
The integration of AI into knowledge management faces significant challenges in your organisation	3.89	0.841	77.80
The use of AI in knowledge management raises ethical concerns	4.15	0.755	83.00
Mean Total	**4.122**	**0.493**	**82.44**

3.4.4 The influence of AI technologies on KM practices in public and private sectors

AI technologies have a significant positive impact on KM practices in both the public and private sectors in Saudi Arabia $t(86) = 22.41$, $p < .001$). The overall mean = 4.291 and large effect size Cohen's d = 2.40 confirm this influence. Additionally, an R-squared value of 0.854 indicates AI accounts for 85.4% of changes in KM practices.

Table 7: Participants' views on the impact of AI technologies on organisational KM practices

Items	Mean	SD	p.c. (%)
AI's potential in enhancing knowledge management practices is underutilised in my organisation due to insufficient digital infrastructure	4.126	0.974	82.52
I believe that AI adoption in KM will become essential for businesses in Saudi Arabia to remain competitive in the next 5–10 years	4.448	0.678	88.96

Items	Mean	SD	p.c. (%)
AI tools help organisations make better data-driven decisions	4.299	0.764	85.98
AI improves the accuracy and reliability of organisational knowledge repositories	4.302	0.704	86.04
Adopting AI in knowledge management practices contributes to supporting sustainable economic development in Saudi Arabia	4.299	0.649	85.98
Mean Total	**4.291**	**0.538**	**85.82**

The highest-rated item in Table 7 is AI's role in business competitiveness (mean = 4.448, SD = 0.678). Respondents also agreed that AI improves knowledge accuracy (mean = 4.302, SD = 0.704) and supports economic development (mean = 4.299, SD = 0.649), though its potential is limited by inadequate digital infrastructure (mean = 4.126, SD = 0.974). The overall mean (4.291) reinforces this consensus.

3.4.5 Differences in workers' responses across work sectors

The results from Levene's test show a *p*-value of 0.550, indicating equality of variances. Therefore, equal variances were assumed for the t-test analysis. The t-test in Table 9 had a *p*-value of .449, indicating there is no statistically significant difference in workers' responses between work sectors. In other words, opinions on the impact of AI on KM practices do not vary by sector.

Table 9: Independent Sample t-test results (equal variances assumed)

Axis	Sector	N	Mean	Std. Deviation	T	*p*-value
Impact of AI Technologies on KM Practices	Private	47	4.33	.516	0.760	.449
	Public	40	4.24	.564		

3.4.6 The specific expectations and future roles envisioned for AI in enhancing KM processes

Figure 1 shows that the majority of the sample (60.9%) expects AI to play a critical role in enabling seamless knowledge sharing and collaboration in the future. Another 35.6% believe AI will moderately support these efforts, while only 3.4% have no opinion on the matter.

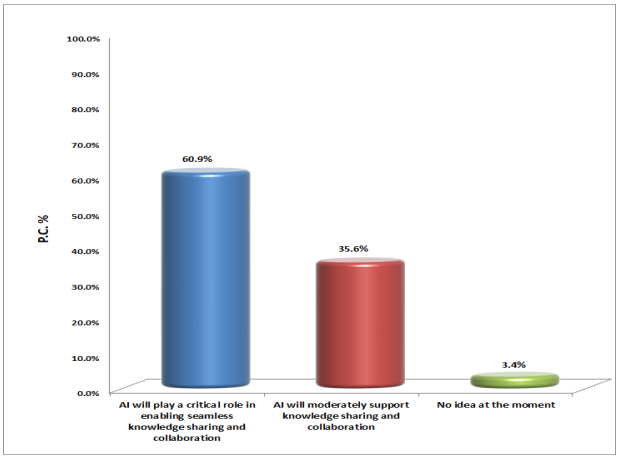


Figure 1: Expectations and future roles envisioned for AI in enhancing KM practices

3.4.7 The primary challenges facing organisations in integrating AI into KM practices

As shown in Figure 2, the majority of participants (62.1%) identified a lack of technical expertise as the main challenge in integrating AI into KM. This was followed by resistance to change among employees (52.9%), concerns about data privacy and security (46.0%), and the high costs of AI technologies (43.7%). Data quality issues were seen as a challenge by only 29.9% of the sample.

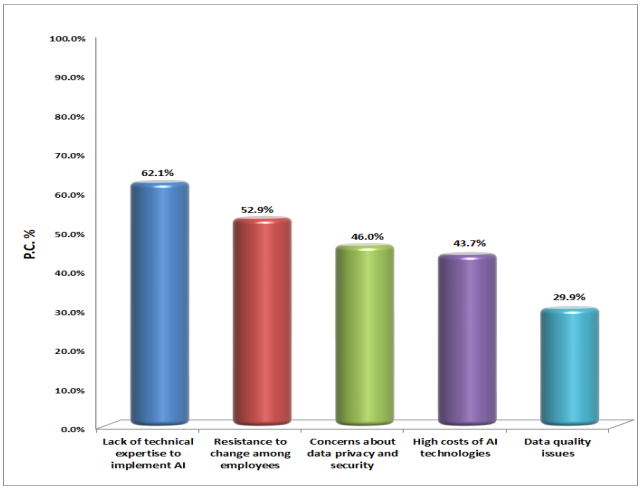


Figure 2: Primary challenges facing organisations in integrating AI into KM practices

4. Discussion

The findings of this survey confirm that Saudi Vision 2030 has significantly influenced organisational investments in AI for KM. Vision 2030's focus on digital transformation, economic diversification and human capital development has led to the increased adoption of KM tools and systems, which organisations now view as vital for innovation, efficiency and competitiveness. Vision 2030 has also fostered a culture of knowledge sharing, supporting collaboration, transparency and continuous learning, which in turn enhances productivity, adaptability and decision-making in Saudi Arabia's rapidly evolving economy. A similar pattern of results in the study by Liu et al. (2021), which indicated that knowledge-friendly organisational culture significantly shapes organizations' perspectives and practices regarding KM. Leadership emerged as a critical enabler of successful KM practices within the context of Saudi Vision 2030, with executive support, strategic vision and top management commitment identified as essential for effective KM implementation. The study also identified key barriers to aligning KM initiatives with Vision 2030, including a lack of management support, unclear KM strategies and insufficient resources. Without strong leadership, KM initiatives struggle to gain traction, and resource constraints and unclear strategies further hinder effective integration. Interestingly, AI integration was seen as a lesser challenge, with ethical concerns about AI in KM ranking moderately among various impediments.

AI technologies are expected to play a crucial role in shaping KM practices in Saudi organisations. The majority of participants believe AI adoption in KM will become essential for business competitiveness in the next 5–10 years, supporting global trends. AI enhances KM by improving knowledge accuracy, retrieval and decision-making through tools like natural language processing and machine learning, while also enabling personalised knowledge recommendations. Participants concurred as to the potential of AI to transform knowledge sharing and collaboration within organisations, with 60.9% of respondents expecting AI to play a critical role in knowledge exchange. Thus, the findings of this study might be considered a promising aspect of future research that highlights the KM across borders (Zhao et al., 2024) in the context of AI. Challenges to AI integration remain, however, including a lack of technical expertise, employee resistance due to concerns about job displacement and workflow changes, and data privacy and security concerns, particularly in the evolving data governance landscape within Saudi Arabia.

5. Conclusion and Implications

The integration of AI into KM practices offers substantial benefits for Saudi businesses and aligns with the objectives of Saudi Vision 2030, particularly in enhancing efficiency, innovation and economic diversification. Successful adoption will rely on factors like organisational readiness, technological infrastructure, a skilled workforce and supportive regulatory frameworks. Addressing these factors is crucial for maximising the contribution of AI-driven KM to Saudi Arabia's transformation goals and ensuring businesses remain competitive. This study provides a roadmap for businesses to leverage AI while supporting the nation's vision for economic diversification and sustainable growth.

The study's findings have both theoretical and practical implications for the integration of AI and KM. There is a need to expand traditional KM theories to incorporate technological advancements, particularly AI, in processes like knowledge creation, sharing and retention. This requires the development of new models that reflect the

role of AI in knowledge process automation and organisational learning (Al-Shboul, 2024). Leadership has been identified as a key enabler of KM success, suggesting a need for updated leadership and change management theories that reflect the management styles required for AI adoption (Ting et al., 2021). The study also identified barriers for AI implementation such as technical expertise gaps, resistance to change, data privacy concerns and data quality issues, which may provide a basis for developing more comprehensive theories on AI adoption in KM.

From a practical standpoint, it is essential that organisations overcome technical expertise gaps by investing in AI and data management training programs in the workforce. Organisations should implement structured change management strategies that address employee resistance to AI adoption and promote a culture of innovation. Addressing data privacy and security concerns requires robust cybersecurity protocols, transparent data management policies and compliance with data protection regulations. Ensuring high data quality is also critical, and organisations must establish data governance frameworks that support the effective integration of AI in KM systems (AlQahtani, 2024).

Several limitations of the study should be acknowledged. The research sample was limited to 87 individuals from managerial positions in Riyadh, making it difficult to generalise the results to other regions or populations. The limitations of quantitative data collection methods should also be considered when interpreting the results. Future research should investigate optimal methodologies for AI-driven KM implementation across diverse contexts. Additionally, this study is a good starting point for discussion and further research to explore the application of advanced technologies, including AI in KM (Liu et al., 2023), along with the benefits they offer, as previously indicated.

Ethics declaration: Ethical approval was not required for the research.

AI declaration: The research has employed AI tools to gather information on the subject matter, facilitate comprehension of various concepts, and support the rephrasing of certain sentences.

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Generative AI Applied to the Design Thinking Process in Knowledge Engineering Projects

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Abstract: The need for user-centered and agile solutions has driven the adoption of methodologies such as Design Thinking in knowledge engineering projects. While the Design Thinking emphasizes empathy, iteration, and innovation focused on user experience, the knowledge engineering aims to build intelligent systems based on formalized expert knowledge. Despite the conceptual alignment between these approaches, the integration of Generative Artificial into this context remains underexplored. This study proposes a model that incorporates generative AI tools into the design thinking process to accelerate and enhance the development of knowledge-based systems. Based on the Design Science Research (DSR) methodology, a narrative literature review and exploratory research were conducted to identify generative AI techniques applicable to each design thinking phase: Empathize, Define, Ideate, Prototype, and Test. A total of 17 generative AI approaches were mapped and organized into a model that supports small and agile teams in knowledge engineering projects. The model was instantiated through the development of GPT-based agents customized for specific tasks, such as persona generation, empathy mapping, requirements analysis, and prototype creation. These agents leverage prompts containing transcripts, observations, or interview data to generate detailed and realistic outputs, streamlining processes that are traditionally manual and time-consuming. One example presented is the Persona Generation Agent, which creates structured user profiles and illustrative images from simple textual input. This integration contributes both theoretically and practically by demonstrating how generative AI can be used to enhance user experience (UX) focused design processes in knowledge engineering. The proposed model promotes more efficient workflows, while keeping the user at the center of development. It also supports interdisciplinary collaboration, faster iteration cycles, and the creation of intelligent systems that are more aligned with user needs. Future work includes empirical validation of the model in diverse application contexts, aiming to refine its use and encourage widespread adoption in knowledge engineering and related fields.

Keywords: Knowledge engineering, Design thinking, UX, Generative AI

1. Introduction

As the demand for increasingly effective, personalized, and adaptable digital solutions continues to grow, user-centered methodologies based on iterative cycles have gained prominence in the development of products and services. Among these approaches, Design Thinking stands out for its creative, collaborative, and user experience-oriented nature, fostering a culture of continuous experimentation, rapid learning, and hypothesis validation based on real usage evidence (Brown, 2010).

These characteristics make Design Thinking particularly promising for fields such as knowledge engineering, whose main goal is to develop intelligent systems based on specialized and structured knowledge. Knowledge engineering requires approaches that enable a deep understanding of usage contexts, user profiles, and the specificities of the domains in which the systems will be applied (Walch & Karagiannis, 2020). The convergence between Design Thinking and knowledge engineering thus emerges as a strategic opportunity to create more effective, usable, and context-aware technological solutions.

Despite the potential synergies between these approaches, the literature still lacks in-depth investigations into how emerging technologies, such as Generative Artificial Intelligence, can be integrated to enhance development processes in both areas (Allen et al., 2024). With its ability to generate original content from large volumes of data and interact through natural language, Generative AI presents itself as a powerful ally for automating tasks, extracting insights, and accelerating iterative cycles, especially within the Design Thinking process applied to knowledge engineering projects (Orenga-Roglá & Chalmeta, 2019).

In this context, this study conducts a narrative review and exploratory research to identify Generative AI techniques that can be applied at different stages of the Design Thinking process. Based on this investigation, the objective of this work is to propose a model that combines Design Thinking principles with the strategic

use of Generative AI tools, aiming to support the development of intelligent systems in the field of knowledge engineering, particularly in environments with small teams, tight deadlines, and high demands for innovation.

2. Methodology

This study adopted the Design Science Research (DSR) model as its methodological foundation, as it is a widely recognized approach in the field of information systems and is well-suited for the development of innovative and applied solutions. DSR is characterized by the construction and evaluation of artifacts, which may take the form of models, methods, system instances, or frameworks, with the goal of solving real-world problems through scientific rigor (Hevner et al., 2004).

In this context, the model proposed in this study is conceived as the central artifact of the research, and its applicability to knowledge engineering projects is treated as the practical instantiation of that artifact. Instantiation refers to the application of the model in real or simulated contexts, aiming to assess its feasibility, usefulness, and potential for generalization.

For this work, the implementation was based on the Design Science Research Methodology (DSRM) proposed by Peffers et al. (2007), which structures the project into six steps:

1. Problem Identification and Motivation: In this initial phase, the general problem and the justification for the development of the study were analyzed;
2. Definition of the Solution Objectives: Based on the problem analysis and motivation, the objectives of the work to be developed were established;
3. Design and Development of the Artifact: Following the objectives outlined in the previous step, the proposed artifact (model) was designed based on the needs identified in the literature;
4. Demonstration: As the next part of this thesis, the artifact was instantiated through the development of agents, based on the proposed model;
5. Evaluation: Evaluation of the artifact instantiation, a step currently in progress using the developed agents;
6. Communication: Communication to the community, where the present work is part of the publication strategy to disseminate the project's preliminary results.

To support the model construction, the study was structured around a narrative literature review aimed at identifying previous approaches that explored the use of Design Thinking methods in the context of knowledge engineering. The review was based on articles, preprints, and theses published since 2019. It also included foundational literature from the relevant domains, particularly the conceptual and methodological foundations of Design Thinking and knowledge engineering. The analysis focused on recent publications that highlight emerging trends and underexplored gaps, especially regarding the integration of emerging technologies, such as Generative Artificial Intelligence, into iterative and collaborative system development processes.

3. Design Thinking in the Knowledge Engineering Context

Design Thinking is a human-centered methodology widely used in the development of innovative solutions. This approach aims to create products, services, or experiences that effectively address real user needs, while also encouraging interdisciplinary collaboration, creativity, and continuous experimentation. It promotes empathy with users, rapid prototyping, and iterative testing elements that are especially valuable in dynamic and uncertain contexts. By adopting Design Thinking, professionals are able to overcome traditional silos and barriers between different areas of knowledge, fostering environments that are more conducive to innovation and integrated problem-solving. Additionally, this methodology enables teams to remain agile and responsive to changing market demands and emerging user expectations, making it a strategic tool for organizations striving to remain relevant and competitive in a fast-evolving landscape (Brown, 2010).

When applied to knowledge engineering projects, Design Thinking supports the understanding of user needs, pain points, and behaviors in relation to the systems being developed. While knowledge engineering plays a fundamental role in the formalization and structuring of knowledge, often in the form of intelligent systems, ontologies, or knowledge bases, Design Thinking contributes by placing emphasis on the human experience of interacting with these systems. This user-centered approach ensures that the design and functionality of knowledge management systems are not only technically robust, but also intuitive, relevant, and usable, especially when incorporating emerging techniques such as machine learning and generative artificial intelligence (Walch & Karagiannis, 2020; Allen et al., 2024).

Moreover, knowledge engineering itself can be enhanced by leveraging Design Thinking principles. It can be used to build systems that gather and process contextual user data, which in turn can inform the ideation and prototyping phases of Design Thinking. This synergy between the two fields allows for the co-creation of solutions that are not only technologically robust but also aligned with real-world user needs an essential focus of the model proposed in this study.

4. Generative AI in Design Thinking

In the research and reviews that gave rise to this study, several works were identified that propose trends and tools leveraging Generative AI to accelerate and automate processes involved in digital product design projects aimed at meeting user needs (UX), with a focus on Design Thinking processes.

The application of generative AI within the context of Design Thinking has emerged as a promising yet still underexplored frontier in academic literature. The possibilities are vast: from automating stages such as persona creation, storyboarding, and interactive prototyping, to providing creative support during the ideation phase, where AI-powered agents can suggest innovative solutions based on contextual data. Furthermore, Generative AI tools can significantly contribute to the analysis of qualitative data derived from interviews, observations, and user testing, transforming large volumes of information into actionable insights in a faster and more accessible manner. However, despite these promising applications, there remain several research gaps that need to be addressed. One of the main challenges is understanding how to balance the use of AI with the core principles of Design Thinking, particularly empathy and human collaboration, which are foundational to the approach. Another critical issue involves validating the effectiveness of AI-generated solutions in real-world environments, as well as managing the risks of bias in both input data and generative models themselves. Additionally, there is a significant gap in understanding how multidisciplinary teams handle the integration of AI into traditional Design Thinking workflows and how this integration impacts creative dynamics and decision-making processes. Thus, while Generative AI holds substantial potential to enhance productivity and enrich user-centered design processes, further research is essential to develop hybrid models, validated methodologies, and best practices that preserve a balance between automation and human sensitivity in the development of innovative solutions (Walch & Karagiannis, 2020; Chung, 2024).

Among the studies that demonstrated applicability to the model proposed in this work, particular emphasis is given to those focused on automating product ideation activities, such as the analysis of sticky notes (Walch & Karagiannis, 2020) and the automatic construction of personas from transcripts of user interactions. Additionally, notable approaches include the automatic generation of storyboards and user flow narratives (Jansen et al., 2021; Salminen et al., 2019; Chung, 2024; Liang et al., 2024), as well as the structuring of software requirements based on text transcripts (Ronanki et al., 2024; Sami et al., 2024).

For prototyping, studies such as those by Takaffoli et al. (2024) and Chivukula et al. (2024) suggest techniques for wireframe creation and layout optimization. Other approaches address automatic prototype generation, transforming low-fidelity versions into mid-fidelity, and these into high-fidelity prototypes (Suleri et al., 2019). In the field of prototype evaluation, noteworthy contributions include simulator agents, usability analysis tools, and emotional state recognition of users (Wallach et al., 2020; Chivukula et al., 2023; Chasalow & Levy, 2021).

5. Proposed Model

Based on the theoretical framework explored throughout this study and focusing on the strategies, trends, and contributions of Generative AI analyzed in the research, this work proposes a Knowledge Engineering project model that leverages Generative AI to accelerate product development processes with a focus on user experience.

The core premise of this model is to involve users, domain experts, and the technical development team throughout the entire process, aiming to ensure the success of knowledge engineering projects by grounding them in Design Thinking principles applied to the development of intelligent knowledge management systems. The proposed model is informed by narrative literature reviews of previously proposed approaches regarding the use of Design Thinking methods in knowledge engineering, as well as foundational literature on both knowledge engineering and Design Thinking, with an emphasis on identifying unexplored potential highlighted in recent studies.

To systematize the proposed model, a graphical representation was developed using the stages of Design Thinking arranged in a circular format, aiming to illustrate the iterative nature of the process as applied to knowledge engineering projects. This representation is shown in Figure 1.

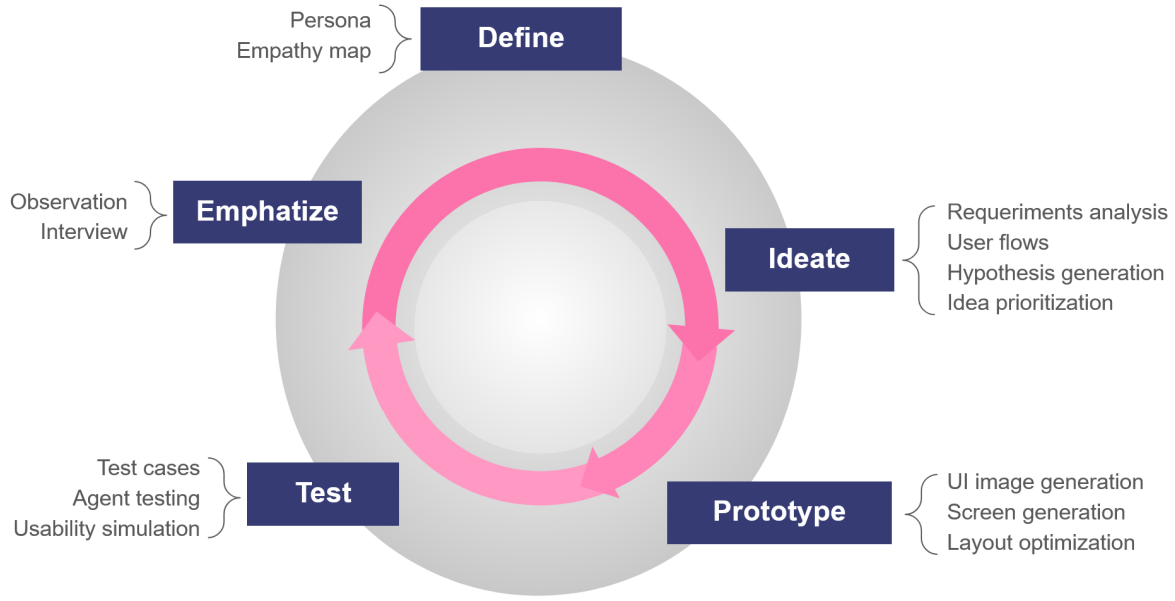


Figure 1: Proposed Model

In the figure, the stages of Design Thinking (empathize, define, ideate, prototype, and test) are displayed in a circular layout, along with the corresponding Generative AI approaches suggested by the model for each stage. These AI approaches were selected based on the research and reviews presented in this study and serve as a foundation for knowledge engineering teams to accelerate their processes within projects, with a focus on enhancing user experience satisfaction. The agents proposed for each stage of the model are listed in Table 1.

Table 1: Agents and Steps

Step	IA Agent	Reference
Emphatize	Observation analysis	Walch & Karagianni (2020)
	Interview analysis	Walch & Karagiannis (2020)
Define	Persona generation	Schuller et al. (2024)
	Empathy map generation	Schuller et al. (2024)
Ideate	Requirements analysis	Ronanki et al. (2024); Sami et al. (2024)
	User flows	Jansen et al. (2021); Salminen et al. (2019)
	Hypothesis generation	Chung (2024); Liang et al. (2024)
	Idea prioritization	Salminen et al. (2019)
Prototype	UI image generation	Takaffoli et al. (2024); Chivukula et al. (2024)
	Screen generation	Suleri et al. (2019)
	Layout optimization	Bilgram & Laarmann (2023)
Test	Test case generation	Nama et al. (2023) Ouédraogo et al. (2024)
	Agent testing	Wallach et al. (2020) Chivukula et al. (2023)
	Usability simulation	Chasalow & Levy (2021)

6. Results

Following the premise of DSR, in which artifacts are realized through their instantiation, and aiming to demonstrate how the model can be used in practice, the instantiation of this artifact was based on the operationalization of the proposed stages and Generative AI agents. To materialize this artifact, the stages

based on and Design Thinking, proposed for the development of knowledge engineering project, were enhanced by the integration of Generative AI agents.

These agents were implemented according to the structure proposed by the model, using GPT (Generative Pretrained Transformers) technology, specifically customized versions of OpenAI's ChatGPT. GPTs are agents developed to perform specific tasks and meet particular needs. These models can be trained using databases, manuals, historical records, or other relevant sources, enabling them to understand technical terminology and the specificities of particular domains.

GPT agents can be created using tools such as OpenAI's GPT Builder and can be made available through the GPT Store, OpenAI's platform for creating, publishing, and monetizing custom GPTs. This marketplace provides an environment for developers and organizations to share their GPT-based solutions with the public.

To illustrate the instantiation of the proposed model through GPT agents, Figure 2 presents the persona generation agent. This agent, part of the second stage of the proposed model (Define), accelerates the work of the knowledge engineering team by automatically constructing the ideal persona framework for use in knowledge management systems.

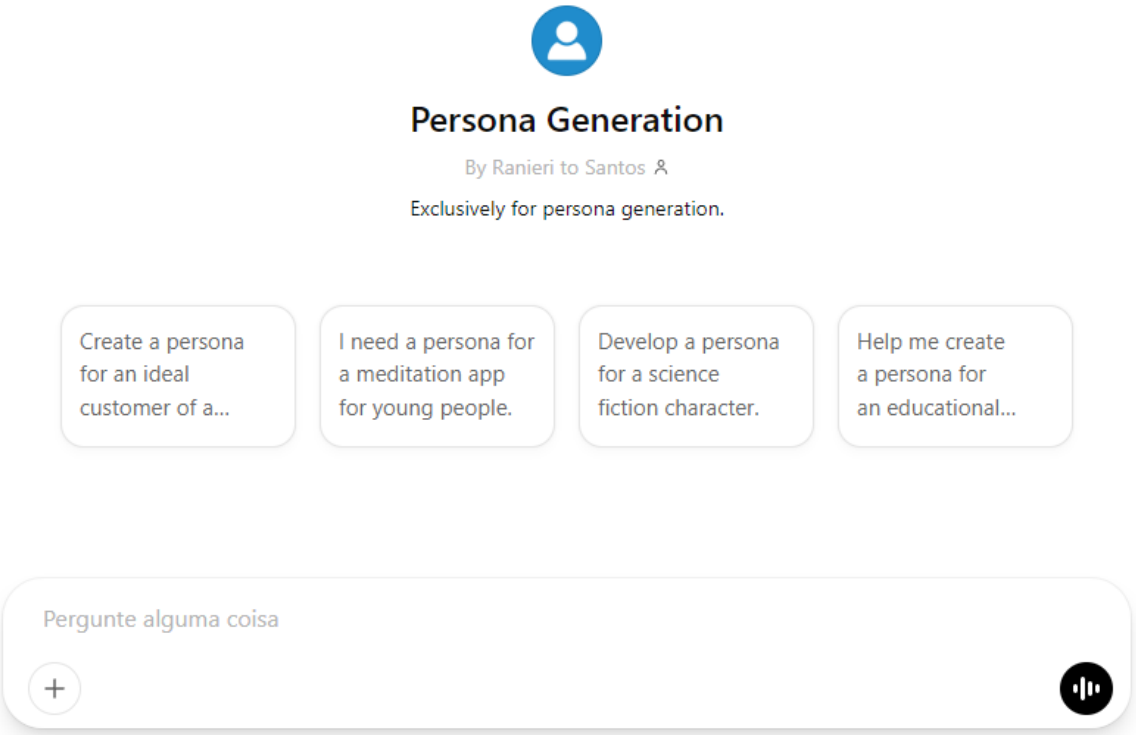


Figure 2: Persona Generation Agent

Using the specific GPT agent, the knowledge engineering specialist can generate a persona for their product by entering a prompt. The prompt may include transcripts of interviews, observations, and other details regarding the behavior of the product's users.

To demonstrate this process, Figure 3 shows a sample result from the persona generation agent, representing a user of a knowledge management product designed for higher education faculty. In the figure, it is possible to see that, in addition to a detailed persona profile, a representative image of the ideal user is also generated.

The implementation of this agent is based on the GPT's ability to process and generate personalized content from specific prompts. This allows personas to be created efficiently and tailored to the specific needs of a given product or service. The methodology used for persona generation involves the collection of demographic, behavioral, and social data, which are essential for creating realistic and relevant user profiles. This information is entered via prompt and can take the form of simple imperatives or transcripts from conversations, interviews, and observations. These inputs are then processed by the GPT to generate personas that reflect the characteristics, goals, and challenges of the target users.

The inclusion of elements such as name, illustrative photo, and contextual background helps make the personas more tangible and easier to understand for design and development teams. This promotes a deeper understanding of user needs and facilitates more informed decision-making throughout the user experience design process.



Name

Dra. Camila Ribeiro

Data

- **Age:**36 years old
- **Profession:** University Professor of Mathematics
- **Training**PhD in Applied Mathematics from the State University of Campinas

Personality

Camila is analytical,

Context

Camila teaches at a university

Wishes

It seeks to make mathematics teaching more accessible.

Figure 3: Persona Generation Agent Result

As can be observed, the output generated by the persona agent delivers a detailed and realistic profile that encompasses the essential characteristics of the target user, based on the agent's programmed pattern even from a simple prompt. The persona generated by the GPT agent not only provides general and illustrative data but also delves into personality traits, life context, desires, needs, and motivations, as well as common pains and frustrations of the intended user group. This depth of information enables design and development teams to better understand who their users are and how they interact with the product or service.

The results show that integrating generative AI techniques into the five stages of Design Thinking can contribute to the automation of critical tasks in knowledge engineering projects: in addition to accelerating persona generation and observation analysis (confirming findings by Walch & Karagiannis, 2020), the model addressed gaps identified by Allen et al. (2024) by demonstrating agents for ideation (hypotheses and idea prioritization) and prototyping (wireframes and layout optimization), which reduce iteration cycles, in line with the projected benefits noted by Jansen et al. (2021) and Takaffoli et al. (2024).

However, based on the results, it was observed that, so far, validation is limited to a single instantiation of the proposed model, restricting the current evaluation to only one agent (persona generation). The study still lacks quantitative performance gain metrics and an exploratory and experimental investigation to validate the proof of concept using infrastructures from other providers analogous to OpenAI.

7. Conclusions

The practical instantiation of the model through the development of agents based on customized GPTs demonstrated how traditionally manual and time-consuming processes, such as persona creation, can be transformed into faster, more systematic tasks that are deeply connected to users real needs. The customization of agents, combined with the flexibility of data input via prompts, enables their application across diverse contexts while respecting the specificities of each knowledge domain.

In addition to contributing to the theoretical advancement at the intersection of Design Thinking and Knowledge Engineering, this work also offers a practical contribution by demonstrating how Generative AI tools can be integrated into project teams workflows, even in resource-constrained environments. The

proposal aims not only to increase productivity but also to maintain user centrality throughout all stages, enhancing teams' ability to deliver more relevant, empathetic, and effective solutions.

As future work, there is a need for empirical validation of the model in different application contexts, through case studies and experiments with real users. It is expected that, with the advancement of AI technologies and the growing accessibility of such tools, the integration proposed here will become a common practice in Knowledge Engineering projects and related fields. Thus, the model can continue to evolve, incorporating new techniques, tools, and practical insights that will feed back into its cycle of continuous improvement.

Ethics Declaration: For the development of this paper and for all reviews and research involved in this work, no ethical authorization was required.

AI Declaration: No artificial intelligence tools were used to prepare this paper. However, AI tools were used to translate and review some specific terms that involved different languages in the writing of the paper.

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Valorising Academic Knowledge: A Framework for Research-to-Market Pathways

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Abstract: The present study investigates how entrepreneurial universities can systematically exploit diverse knowledge assets for societal and economic impact. Despite growing emphasis on research valorisation, literature lacks clarity on managing varied research types, such as fundamental or domain-specific, and aligning them with exploitation goals. Universities often struggle to deliver their wealth of research assets to the market. Through an ethnographic case study of a technical university, this research examines three exploitation pathways. By analysing research assets through a framework that classifies knowledge based on its Research Focus and Exploitation Scope, the study unveils the internal and external conditions that enable research exploitation. These results advance knowledge management theory by integrating creation-to-application dynamics and refine the well-known Triple Helix model with operational insights. From a practice perspective, the framework provides a strategic tool for university researchers and administrators to map assets, assess exploitation states, and guide transitions, enhancing governance and partnerships.

Keywords: Knowledge management, Research valorisation, Ethnographic case study

1. Introduction

Universities are increasingly recognised not only as institutions of higher learning and fundamental research but also as pivotal engines for innovation, economic growth, and societal problem-solving. This evolving role has given rise to the concept of the 'entrepreneurial university', an institution actively engaged in translating its intellectual assets into tangible societal and economic impact (Etzkowitz, 2003; Guerrero & Urbano, 2012). A central challenge within this paradigm lies in the effective management and valorisation of the diverse knowledge generated within academic settings. Bridging the gap between theoretical academic discovery and practical market application requires a deeper understanding of research knowledge types, dedicated strategies, and increasingly, specialised organisational structures.

Despite clear expectations for universities to demonstrate impact, the literature reveals uncertainty about the mechanisms and processes for achieving this across different types of research knowledge and exploitation goals. Studies on knowledge management (KM) highlight the tension between tacit and explicit knowledge (Nonaka, 1994), while the Triple Helix model underscores university-industry-government interactions (Etzkowitz & Leydesdorff, 2000). Research also explores technology transfer offices, spin-offs, and valorisation pathways (Siegel et al., 2003; Molas-Gallart & Castro-Martínez, 2007). However, existing work often lacks clarity on how the nature of knowledge, whether fundamental and broadly applicable or specialised and domain-specific, shapes exploitation strategies. Similarly, the processes for transitioning research to targeted solutions for the market or scalable ventures remain poorly understood, leaving a gap in systematic approaches to valorisation. To address these uncertainties, this study asks: *How can universities effectively map their knowledge assets to understand and facilitate appropriate exploitation strategies?*

This paper tackles this research gap through an in-depth case study of a technical university pursuing an entrepreneurial research-to-market approach. In this context, 'market' encompasses both private and public organisations seeking research-based solutions and funding bodies supporting impactful research projects. Using an ethnographic methodology with participant observation, the study examines multiple cases of research exploitation, offering insights into strategies, challenges, and enabling conditions in valorising diverse knowledge assets.

The study introduces a novel knowledge management framework to classify knowledge and valorisation initiatives. This framework integrates two critical dimensions. The first dimension, Research Focus, distinguishes between basic research, broadly applicable, and vertical research, focused on specialised knowledge within specific business domains. The second dimension, Exploitation Scope, differentiates problem-solving activities such as consultancy and targeted solutions from scaling efforts including intellectual

property exploitation and spin-offs. By applying this framework to fieldwork observations, the paper shows the operational dynamics of knowledge valorisation in an entrepreneurial university context and provides a practical tool for mapping knowledge assets to appropriate exploitation pathways. The study results contribute to knowledge management research by providing an empirically grounded analysis of knowledge valorisation structures and processes. The findings offer valuable implications for university administrators, policymakers, researchers, and practitioners designing organisational structures to maximise the societal and economic returns of academic research.

2. Literature Review

2.1 Evolution of Knowledge Management Theories

Knowledge management has evolved from a focus on information systems to a broader understanding of knowledge as a dynamic process involving tacit and explicit forms (Nonaka, 1994). In academic settings, this distinction is critical. While explicit knowledge, codified in experimental data, publications, and patents, is easily stored and shared, tacit knowledge, such as researchers' uncodified expertise, is harder to formalise and often transferred through personal interactions (Nonaka, 1994; Tian et al., 2009). Universities, as knowledge-intensive organizations, excel at producing explicit knowledge but struggle to capture tacit knowledge, a challenge central to research valorisation (Tian et al., 2009).

Universities engage in three KM processes: creation through research, transfer via teaching and outreach, and application to societal problems (Rowley, 2000). However, these processes are often disjointed. Research thrives in creation, yet transfer and application lag, particularly in translating findings into practical outcomes (Ramachandran et al., 2009). The rise of the "third mission" amplifies this, pushing universities to exploit knowledge economically and socially, beyond traditional teaching and research roles (Etzkowitz & Leydesdorff, 2000).

Academic KM faces unique challenges. Disciplinary silos hinder knowledge sharing, reward systems prioritise individual publication over collaboration, and tensions between academic freedom and strategic management resist formalised KM efforts (Fullwood et al., 2013; Bhusry et al., 2011). Open science, which promotes transparent sharing of research outputs to advance collective knowledge, often conflicts with intellectual property protection, complicating valorisation as universities balance societal contributions with revenue generation (Siegel et al., 2003).

2.2 The Entrepreneurial University and Knowledge Valorisation

The concept of the entrepreneurial university arose as universities responded to decreasing public funding and increasing economic demands. This shift marked a departure from the traditional focus on teaching and research, leading to what is termed a "second academic revolution" that incorporates a third mission centred on societal impact (Etzkowitz, 2003; Clark, 1998). This historical change highlights the evolving roles of universities in knowledge-based economies, with a focus on diversifying resources and exploiting knowledge (Slaughter & Leslie, 1997).

The Triple Helix model and the third mission frame universities as entrepreneurial nodes driving innovation through university-industry-government interactions and diverse valorisation activities (Etzkowitz & Leydesdorff, 2000; Molas-Gallart & Castro-Martínez, 2007). Value creation from academic knowledge occurs through mechanisms like direct commercialisation (e.g., spin-offs), collaborative consultancy, policy advice, and public engagement. These pathways transform both explicit and tacit knowledge into economic and social benefits, extending beyond traditional technology transfer to include non-commercial impacts (European Commission, 2020). From an organizational perspective, universities support knowledge exploitation through structures such as technology transfer offices (TTOs) and incubators (Siegel et al., 2003). TTOs manage intellectual property and commercialisation, while incubators foster spin-offs, though informal networks (Tuunainen, 2005). Clark (1998) emphasises that integrating these structures into a cohesive culture aligned with academic strengths can strenghten research valorization, yet effectiveness varies by context (Sánchez-Barrioluengo, 2014). This diversity in research exploitation mechanisms and structures demands tools and frameworks that capture varied valorisation strategies, aligning with universities' multifaceted roles.

2.3 Challenges in Valorising Academic Research

Despite advances in KM and entrepreneurial models, valorising academic research faces persistent gaps. Literature identifies a disconnect between knowledge creation and application, with universities excelling at the former but lagging in systematic transfer and exploitation (Ramachandran et al., 2009). Disciplinary silos

and decentralised governance hinder cross-unit collaboration, while reward systems favoring publication over practical impact discourage valorisation efforts (Fullwood et al., 2013).

The tension between open knowledge sharing and intellectual property protection complicates exploitation, as does the "valley of death" between research and market-ready solutions, requiring resources often beyond academic capacity (Siegel & Wright, 2015). Tacit knowledge uncodified nature further hinders formal exploitation, as existing tools like Nonaka's SECI model (Nonaka, 1994) focus on creation, not application (Nonaka, 1994). The Triple Helix model, while insightful, lacks practical guidance for operationalising interactions (Tuunainen, 2005).

These gaps—fragmented processes, misaligned incentives, and limited methodologies—highlight the need for systematic approaches to exploit diverse research assets. The methodological approaches to studying knowledge valorisation in universities have primarily relied on quantitative metrics (such as patent counts, licensing revenues, and spin-off numbers) or survey-based assessments of technology transfer activities (Perkmann et al., 2013; D'Este & Patel, 2007). While these approaches provide valuable macro-level insights, they often fail to capture the nuanced dynamics and contextual factors influencing knowledge exploitation pathways. This methodological gap limits our understanding of how universities operationalise valorisation strategies across different knowledge types and exploitation goals, further supporting the need for in-depth qualitative approaches as employed in this study.

3. Methodology

3.1 Introduction to the Methodology

This study employs a qualitative ethnographic case study approach to investigate how a technical university exploits its research assets for societal and economic impact. The primary aim is to understand the dynamic processes and conditions shaping knowledge valorisation, a phenomenon best explored through immersive observation of daily practices and stakeholder interactions. Ethnography is well-suited to this research question, as it captures the contextual richness of knowledge management and project-based exploitation strategies within a real-world setting (Myers, 1999). By focusing on a single case, the study achieves depth over breadth, offering revelatory insights into a complex, understudied process (Yin, 2014).

The case study centres on a technical university offering training on disciplines such as engineering, architecture, and design, recognised for its robust research output, support for startup creation, and connections with market actors. Observed phenomena include the generation of research findings across disciplines (e.g., physics, IT, design, business and management), their application through collaborative projects, applied research, and transformation of research results into entrepreneurial ventures. Fieldwork spanned 42 months between July 2021 and December 2024, conducted within the university's ecosystem, including research laboratories, administrative units, and external partner interactions. Research methods comprised semi-structured interviews, field observations, and document analysis, providing a multi-faceted view of knowledge exploitation. This approach enables the study to map research assets to their research focus and to exploitation strategy, while identifying internal and external conditions driving knowledge valorisation. By integrating ethnographic insights with project management perspectives, the methodology unveils strategic pathways for maximising research impact in entrepreneurial universities.

3.2 Interviews to Stakeholders

Semi-structured interviews with key stakeholders provided critical insights into the strategies and conditions underpinning knowledge exploitation in the case university. Two primary groups were interviewed: university researchers involved in exploitation projects and representatives from collaborating stakeholders. 12 interviews were conducted, with participants purposively selected based on their direct involvement in research valorisation efforts, such as project leaders and industry and health organizations partners engaged in technology development or consultancy. Interviews, lasting 45-60 minutes each, were conducted in person or virtually, ensuring a longitudinal perspective on evolving practices.

The interview protocol explored topics such as research output, project goals, collaboration dynamics, exploitation challenges, and perceived outcomes. Questions were tailored to each group: researchers were asked about internal capabilities (e.g., expertise development), while stakeholders' representatives provided external perspectives (e.g., market needs, partnership structures). This dual approach aligns with the objective of capturing the conditions enabling knowledge valorisation, as well as collecting the university stakeholders' network and environmental influences. Interviews were recorded where possible, transcribed verbatim, and

supplemented with researcher notes to contextualise responses. This method enriched the study by revealing stakeholder motivations and tensions, such as aligning academic goals with industry timelines.

3.3 Field Observation

Field observations over three years provided a rich, contextual understanding of knowledge exploitation processes at the case university. Data was collected from multiple settings, including formal events like project meetings, industry collaboration workshops, and startup pitch sessions, as well as informal discussions among researchers, administrators, and external partners. Additional sources included presentations delivered at university events and participation in conferences where exploitation outcomes were showcased. Approximately 50 observation instances were documented, ranging from brief interactions to multi-hour sessions.

Field notes, recorded contemporaneously and later expanded, captured detailed accounts of activities, dialogues, and organizational dynamics. These observations highlighted how research assets, such as novel technologies or methodologies, were applied in projects linked to market needs or transitioned to startups. For example, meetings revealed decision-making on project funding, while events highlighted shifts from a problem-solving approach (e.g., addressing specific industry challenges) to scaling (e.g., commercial prototypes). This method complemented interviews by grounding stakeholder narratives in observable practices, aligning with the ethnographic principle of immersion (Myers, 1999). The longitudinal scope ensured a comprehensive view of trajectory shifts, such as from fundamental research to vertical applications, providing empirical depth to the study.

3.4 Data Analysis

Data analysis followed ethnographic guidelines, emphasising iterative, thematic exploration to derive a knowledge exploitation framework. The initial step involved data organization, or indexing: interview transcripts, field notes, and supplementary documents (e.g., project reports, presentation slides) were catalogued, transcribed where applicable, and sorted chronologically. This corpus was reviewed multiple times to identify recurring patterns and variations. The data was then coded using an in vivo and emergent approach, generating initial themes such as “specialised expertise,” “market demand,” and “collaborative structures” (Braun & Clarke, 2006).

Themes were organised into abstract domains aligning with the research objectives and exploitation strategies, and categorised by internal (e.g., team capabilities) and external (e.g., funding support) conditions. Focused coding refined data to identify specific exploitation objectives (e.g., problem-solving to scaling), mapping how research assets evolved. This process balanced inductive insights from the data with deductive links to KM literature, ensuring theoretical grounding (O’Reilly, 2008). The goal was not statistical representativeness but meaningful interpretation of exploitation dynamics (Emerson et al., 1995). Descriptions of project contexts and stakeholder interactions enriched the study. This analysis informed a framework for classifying exploitation strategies, detailed in the findings.

4. Findings

4.1 A Framework for Analysing Research Asset Exploitation

Based on a critical review of knowledge management literature, combined with an empirical investigation of three cases of research asset exploitation within a university context, we propose a novel framework to understand how academic research can be valorised (Figure 1). The framework is structured along two key dimensions: Research Focus and Exploitation Scope. The Research Focus dimension distinguishes between basic/horizontal research, which encompasses fundamental, principle-driven knowledge applicable across multiple domains - aligning with what Gibbons et al. (1994) term "Mode 1" knowledge production - and vertical research, which is specialised and tailored to a specific industry or application area and recalls "Mode 2" knowledge production (Gibbons et al., 1994). The Exploitation Scope dimension differentiates between problem-solving, where research is applied to address a specific, often stakeholder-defined challenge, and scaling, where research is transformed into a broader, typically commercial, venture with growth potential. Together, these dimensions form a 2x2 matrix yielding four quadrants: Basic + Problem-Solving, Basic + Scaling, Vertical + Problem-Solving, and Vertical + Scaling. This structure emerged from observing how research assets in the four cases varied in their disciplinary scope and exploitation intent, revealing distinct patterns of valorisation.

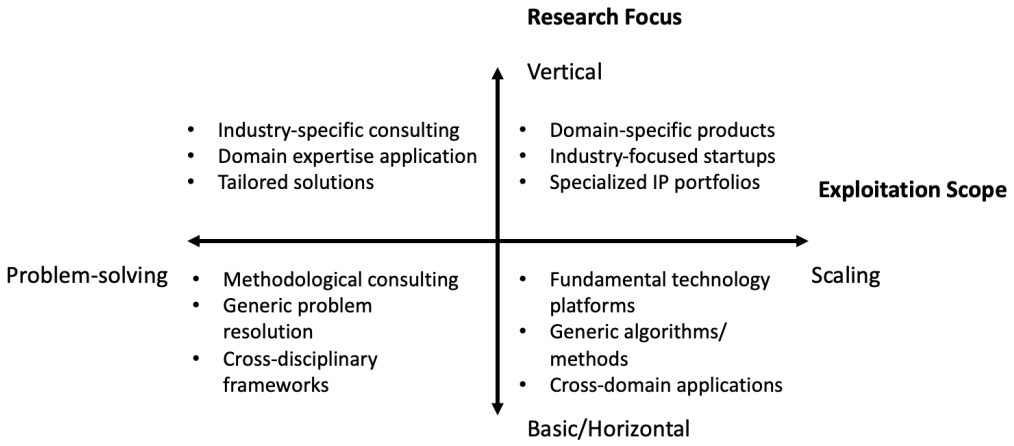


Figure 1: Framework of the study.

4.2 Conditions Influencing Exploitability Across Dimensions

Analysis of the three cases revealed that the exploitability of research assets, classified according to their research focus and exploitation scope, depends on specific conditions, categorised as internal (controlled by the research team) and external (driven by the environment). For the Research Focus dimension, internal conditions for basic/horizontal research include a broad theoretical base and flexibility for adaptation, enabling wide applicability, while external conditions involve an exploratory academic culture and institutional support for fundamental inquiry. For vertical research, internal conditions encompass specialised expertise and targeted development within a domain, whereas external conditions include domain-driven demand and industry/end-user collaboration. For the Exploitation Scope dimension, problem-solving is facilitated by internal conditions such as general applicability and the ability to produce practical deliverables, alongside external conditions like identified stakeholder needs and collaborative bridges to external partners. Conversely, scaling relies on internal conditions like market readiness and commercial viability, paired with external conditions such as platform potential and collaborative networks of stakeholders (e.g., investors, industry partners). These conditions, derived from the interplay of theoretical insights and empirical observations, highlight how exploitability emerges from a synergy of the research team-driven capabilities and environmental opportunities, providing a structured approach to assess and guide research valorisation strategies.

The following sections present three case studies of research asset exploitation, each positioned within the framework to illustrate its analytical potential. Table 1 provides an overview of these cases, summarising their research assets, focus, scope, and exploitation strategies.

Table 1: Overview of three research asset cases, positioning and exploitation strategies

Description of the Research Asset	Positioning in Research Focus	Positioning in Exploitation Scope	Exploitation Strategy
Competence in advanced optical microscopy using coherent Raman scattering, enabling label-free, high-resolution imaging of biological samples, initially developed in a physics laboratory.	Basic/Horizontal: Broad, principle-driven knowledge applicable across domains, later specialised for healthcare.	Problem-solving: Addressed specific imaging challenges, with prototypes and a startup for spectroscopy/ photonics solutions funded by local authorities.	Applied in a health-focused research project to develop a bio-photonics device, followed by commercialisation through a startup offering high-tech imaging solutions.
Expertise in IT technologies, business requirements analysis, and business-IT alignment frameworks, developed through application design and market trend monitoring, applicable across industries.	Basic/Horizontal: Cross-disciplinary, industry-agnostic skills not tied to a specific sector, later focused on digital innovation.	Problem-solving: Delivered consultancy projects (e.g., process mapping, system assessments).	Provided consultancy for diverse sectors (retail, manufacturing, public bodies), then scaled via standardised IT assessment services and a spin-off offering data-driven digital solutions.

Description of the Research Asset	Positioning in Research Focus	Positioning in Exploitation Scope	Exploitation Strategy
Knowledge in digital technologies for healthcare, developed through hospital applications, IoT solutions, and electronic medical record systems, tailored to healthcare unique data and regulatory needs.	Vertical: Specialised expertise at the intersection of digital innovation and healthcare, focused on medical settings.	Vertical: Supported healthcare institutions via different digital-enabled projects (e.g., big data platforms, traceability systems).	Implemented project-based solutions for hospitals and health authorities, followed by a scalable service model for big data and patient care support across healthcare organizations.

4.3 Case 1: Optical Microscopy Competence in a Health Research Project

The first case pertains to a research asset focused on advanced optical microscopy, developed by a physics research group. This capability utilises Coherent Raman Scattering (CRS), a technique that enhances conventional microscopy by facilitating label-free, non-invasive imaging of biological samples with high resolution. In contrast to fluorescence microscopy, which requires staining that may alter biological functionality, CRS employs intrinsic vibrational frequencies for contrast, offering considerable potential for the investigation of cellular structures. Initially developed within an academic laboratory, this asset represented a broad, principle-driven capability in physics, with applications not yet linked to a specific domain.

In its initial state, the research asset aligned with the *Basic/Horizontal* + *Problem-Solving* quadrant of the framework. Internal conditions supporting this classification included its general applicability, as the CRS technique can address a wide range of imaging challenges, and the research team's ability to produce practical deliverables for academic experimentation. Externally, short-term funding from national basic research grants facilitated problem-solving applications within the physics domain, while the academic orientation of the laboratory environment reinforced its exploratory emphasis. The asset exploitation was limited by the absence of identified stakeholder needs beyond the research domain and a lack of collaborative connections to external partners which limited a broader impact.

The trajectory of the asset exploitation shifted when the research team engaged specialised expertise by collaborating with medical doctors and biologists focused on the study of cells and tissues, transitioning it to the Vertical + Problem-Solving quadrant. This transition was facilitated by internal conditions, such as the targeted development of CRS for health-related applications, and external conditions, including domain-driven demand from cancer research and collaboration with hospitals treating cancer patients. A key external factor was the applied funding from the European Commission through a project aimed at developing a next-generation bio-photonics imaging device for cellular disease analysis. This funding, linked to a specific healthcare challenge, reinforced the asset vertical focus and problem-solving scope, leading to the creation of a functional prototype for tissue imaging.

Following the European Commission funding, the subsequent exploitation trajectory indicates a movement towards the *Vertical* + *Scaling* quadrant. The team's development of laser microscope prototypes for tissue analysis, combined with internal market readiness stemming from a proven application, creates the conditions for commercialisation. Externally, the launch of a startup focused on high-tech solutions in spectroscopy and photonics reflects the emergence of collaborative networks with industry partners and potential investment support. This transition hinges on achieving commercial viability (internal) and leveraging platform potential (external) to expand the technology's market reach.

4.4 Case 2: Aligning Business and IT in Organizations

The second case involves a research asset comprising expertise in digital technologies, business requirements analysis, and frameworks for business-IT alignment, developed by a multidisciplinary research group. Knowledge of IT stemmed from designing and developing applications, such as enterprise applications integration, public service systems, and supply chain solutions. Competence in business requirements was developed through participation in market analysis projects, including a university-led initiative to monitor digital technology trends across industries, equipping researchers with insights into business needs. Theoretical and practical frameworks, such as enterprise architecture, business requirements modelling, and alignment methodologies, enabled the connection of IT capabilities with market demands. This broad, cross-disciplinary skill set was not confined to a specific industry, reflecting a versatile foundation for addressing diverse challenges.

Initially, this asset was positioned in the *Basic/Horizontal* + *Problem-Solving* quadrant. Internal conditions supporting this placement included general applicability, as the expertise could be adapted to various organizational contexts, and the ability to produce practical deliverables, such as process maps or system assessments. Externally, identified stakeholder needs from organizations seeking digital solutions and short-term funding through applied research grants or consultancy contracts facilitated problem-solving exploitation. The team engaged in projects like business process mapping for retailers, application portfolio assessments for manufacturers, and information system redesigns across sectors, including services and public bodies. However, exploitation was limited by missing conditions: a lack of market readiness and collaborative networks limited the potential for broader, scalable impact beyond individual projects.

The asset exploitation evolved toward the *Basic/Horizontal* + *Scaling* quadrant when the team identified a high-value, industry-agnostic service: IT assessment and software selection. This shift was driven by internal conditions, including targeted development to formalise frameworks and methodological tools for standardised assessments, and commercial viability, as the service was refined to meet diverse client needs efficiently. Externally, platform potential emerged as the service's broad applicability attracted interest across sectors, while collaborative bridges with companies seeking digital transformation supported its adoption.

The asset trajectory moved toward the *Vertical* + *Scaling* quadrant, driven by the creation of a spin-off company focused on digital consultancy, particularly data-driven solutions. Internal conditions enabling this shift include specialised expertise in data governance, cloud transformation, and AI technologies, developed through ongoing research, and market readiness from validated methodologies. Externally, collaboration with industry partners and investment support from a university incubator and external funding bodies supported this move. The spin-off offers services like IT strategy formulation, cloud transformation, and data governance, targeting specific digital innovation needs. This trajectory was underpinned by entrepreneurial commitment (internal) and domain-driven demand (external).

4.5 Case 3: Digital Innovation Competence in Healthcare

The third case centres on a research asset comprising deep knowledge at the intersection of digital technologies and healthcare, developed through collaboration between heterogenous university research groups and various healthcare institutions. This competence emerged from projects including hospital application development, IoT solutions for tracing surgical devices and blood bags, electronic medical record (EMR) systems, and support for regional authorities in shaping EMR policies. These initiatives equipped the team with expertise in addressing the unique needs of healthcare organizations, such as complex data requirements, stringent regulatory compliance, and public procurement processes, while leveraging technologies like RFID and big data analytics. This specialised skill set was inherently tied to the healthcare domain, reflecting a focused capability to enhance organizational and digital evolution in medical settings.

The asset was initially positioned in the *Vertical* + *Problem-Solving* quadrant. Internal conditions included expertise in healthcare-specific digital solutions and practical deliverables, such as tailored applications and traceability systems for hospitals. Externally, domain-driven demand from healthcare institutions and applied funding from local authorities supported problem-solving exploitation. The asset was utilised in projects such as transfusion process tracking and the design of a big data platform for integrating health data from different domains (e.g., cardiology, oncology, neurology) to advance clinical research and patient care. However, exploitation was limited by a lack of market readiness and collaborative networks for broader dissemination.

The asset's exploitation evolved toward the *Vertical* + *Scaling* quadrant as the team identified a standardised, high-value service offering: support for healthcare organizations in data integration, big data exploitation for patient care, and EMR development. This shift was enabled by internal conditions, including targeted development of formalised methodologies to address common healthcare needs and commercial viability, ensuring services were efficient and replicable. Externally, platform potential arose from the widespread demand for digital transformation across healthcare systems, while industry/end-user collaboration with multiple hospitals validated and expanded the service model.

At the time of the analysis, the evolution trajectory was withing the *Vertical* + *Scaling* quadrant, with potential for further expansion. The team's ongoing work to replicate and refine these services, integrating data, enhancing patient care, and supporting EMR systems deployment, relies on internal conditions like specialised expertise in navigating healthcare's complexities and market readiness from proven methodologies. Externally, collaborative networks with regional health authorities and institutions, coupled with investment support from

public funding tied to national health priorities, drive this scaling effort. The asset's ability to address universal healthcare challenges, such as data governance and regulatory compliance, positions it for broader adoption.

5. Discussion

This study aimed to investigate how a technical university exploits its research assets to generate societal and economic value, addressing a gap in systematic approaches to knowledge valorisation. Through an ethnographic case study, we explored the processes, conditions, and strategies shaping research exploitation within the three cases in a technical university. The findings informed a novel framework classifying research assets by Research Focus (basic/horizontal vs. vertical) and Exploitation Scope (problem-solving vs. scaling), supported by internal and external conditions. This framework maps exploitation dynamics and trajectories, offering a structured lens to understand and enhance valorisation strategies in entrepreneurial universities.

5.1 Contributions to Theory

This study advances theoretical understanding of knowledge management and valorisation in academic contexts through three key contributions. First, it enriches knowledge management literature by integrating Nonaka's (1994) tacit-explicit dichotomy with exploitation dynamics. While prior work focuses on knowledge creation and transfer (Rowley, 2000), our framework extends this to application and scaling, addressing Ramachandran et al.'s (2009) noted disconnect between creation and practical use. By classifying research assets into basic/horizontal and vertical focuses, it reveals how knowledge type influences exploitation potential, adding granularity to KM theory.

Second, our study refines the Triple Helix model (Etzkowitz & Leydesdorff, 2000) by operationalising university-industry-government interactions into actionable categories. Unlike the model broad emphasis on institutional roles, our study specifies conditions (e.g., collaborative networks, market readiness) and trajectories (e.g., problem-solving to scaling), offering a practical bridge between theoretical interactions and empirical outcomes. This addresses Tuunainen's (2005) critique of the model's lack of operational detail, enhancing its utility for analysing entrepreneurial universities' innovation roles.

Third, results contribute to entrepreneurial university scholarship by systematising valorisation processes beyond commercialisation (Siegel & Wright, 2015). The framework dual dimensions and conditions highlight diverse pathways—consultancy, standardised services, startups—expanding Clark's (1998) entrepreneurial pathways with a structured approach. This broadens the universities' third mission discourse (Molas-Gallart & Castro-Martínez, 2007), showing how they can strategically align research with societal and economic goals, adding a dynamic, process-oriented perspective to the literature.

5.2 Contributions to Practice

The study offers two practical contributions for university researchers, administrators, and industry partners engaged in knowledge valorisation. First, the framework provides a diagnostic and planning tool for managing research exploitation projects. By mapping assets to quadrants and identifying enabling conditions (e.g., internal expertise, external funding), universities can assess current exploitation states and strategise transitions, such as shifting from problem-solving consultancy to scalable ventures. This also enhances universities governance by clarifying resource needs and stakeholder roles.

Second, our results offer actionable guidance for enhancing university-industry collaboration. The identified conditions (e.g., collaborative bridges for problem-solving, investment support for scaling) enable university administrators to prioritise partnerships and infrastructure, such as technology transfer offices or incubators, to maximise impact. For instance, researchers can leverage external demand to secure funding, while administrators can foster entrepreneurial ecosystems to scale innovations, as seen in the study's startup cases. This practical insight bridges academic knowledge to market outcomes, empowering universities to fulfil their third mission effectively and respond to societal needs, such as healthcare innovation or digital transformation.

5.3 Limitations and Directions for Future Research

While this study provides valuable insights into knowledge exploitation within a university context, it is subject to limitations that limit the generalisability of its findings. First, the reliance on a single case study, a technical university with strong market connections, and the analysis of three exploitation pathways restricts the framework applicability across diverse contexts. Although the selected cases offer a rich interpretation of how research assets can be modelled and exploited, their specificity to a technically oriented institution with

established industry ties may not fully reflect the dynamics of universities with different disciplinary focuses (e.g., humanities) or weaker market linkages. To validate and refine the framework, future research could apply it to a broader range of universities, including non-technical institutions and those in varying innovation ecosystems, testing its robustness across multiple exploitation pathways and organizational settings.

A second limitation lies in the ethnographic approach's emphasis on depth over breadth, which, while yielding detailed qualitative insights, limits the study's ability to quantify exploitation conditions and success or compare them statistically across cases. This qualitative focus may overlook broader patterns or measurable factors (e.g., funding scale, collaboration frequency) that influence valorisation success. Future studies could complement this work with mixed-methods approaches, integrating quantitative metrics such as project budgets, patent outputs, or startup survival rates to assess the framework's efficacy more systematically. Additionally, longitudinal studies tracking exploitation trajectories over extended periods could reveal how conditions evolve, enhancing the framework's predictive power. Finally, an investigation over a prolonged period could also explore the sustainability of the exploitation trajectories described in the present study.

Ethical declaration: Ethical clearance was not required for the research presented in this study.

AI declaration: AI was not used for the creation of the present paper, EditGPT was used for text proofreading.

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Bibliometric Analysis Method of Examining the Concept of Green Knowledge Management and Sustainability: A Test for Web of Science Application

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Abstract: The concept of sustainability and organizational green policies is very important from environmental studies perspectives nowadays. Green practices are evaluated in many different aspects, such as environmental, technological, and economic, in organizations. The green and environmental adaptation of all aspects of knowledge management is defined as "green knowledge management," as well as is being examined by scientists in various aspects, following the organizational structure in the study. The development of green knowledge management, its applications, analyzing it geographically, evaluating its academic performance, and evaluating the existing intellectual accumulation on the subject is possible with bibliometric analysis. Bibliometric analysis methods are used in both academic and administrative studies, as well as to quantitatively analyze scientific publications produced by scientists and academic institutions. It plays an active role in the decision-making process, especially in the measurement of academic performance, in the evaluation of a particular subject, publication, institution, and in the collection development policy practices of libraries. In this study, in addition to the distribution of articles on green knowledge management indexed in the Web of Science (WoS) database according to years, countries, and institutions, keywords and institutions are also used to explain the relationship between the concepts related to green knowledge management and sustainability concepts.

Keywords: Green knowledge management, Sustainability, Bibliometrics, Bibliometric analysis

1. Introduction

Knowledge is defined as a justified belief that influences human actions (Nonaka, 1994), a fluid blend of experience, values, contextual information, and expert opinion that forms a basis for evaluating and incorporating new experiences and knowledge. It arises and is applied in the minds of those who know. Knowledge, which is a strategic resource for the organization (Yu et al., 2022), is not only recorded in documents or stored in repositories but also embedded in organizational routines, processes, practices, and norms (Davenport and Purusak, 1998; Alavi and Leidner, 2001). To do this, individuals gain practical knowledge when they can apply their own experiences and contextual understanding to interpret the details and implications of action. Organizations need the ability to create or adopt new knowledge to shape the strategic directions of the organization and compete with other organizations. Routines, values, norms, and practices reflect the organizational culture. Managers achieve knowledge management (KM) goals by characterizing the connections between culture and knowledge (De Long and Fahey, 2000). The processes of managing knowledge in companies are actions related to acquiring, storing, using, applying, and creating knowledge to increase the effectiveness and competitiveness of an organization (Abbas and Khan, 2023). KM aims to increase organizational performance by explicitly designing and implementing tools, processes, systems, structures, and cultures to improve the creation, sharing, and use of knowledge that is critical for decision making (De Long and Fahey, 2000). Institutions are taking green approach initiatives from KM practices to increase organizational performance and benefit from competitive advantages such as customer satisfaction and profitability (Abbas and Sağsan, 2019).

Integrating KM with all its dimensions, including green and environmental, is defined as GKM. The important criterion for GKM applications is how these applications affect corporate green performance and how such applications can benefit the environment. Since GKM is a new phenomenon, there is no study in the literature that covers all aspects of the natural environment and the postulates of KM (Yu et al., 2022). In the literature, there are studies on GKM in organizations such as economic, social, and environmental (Al-Faouri, 2023), playing a mediating role between technological sustainability (Riaz et al., 2024), utilizing GKM to develop artificial intelligence capabilities and green technology innovation (Kumar et al., 2025), the relationship between GKM and intellectual capital (Khan, Mehmood, and Kwan, 2024), and associating it with digital technologies such as blockchain, big data and social media (Phung et al., 2024).

Scientific research shows that GKM has been the subject of many different studies. For this reason, this study will conduct a bibliometric analysis to examine the intellectual accumulation on the subject in terms of year, institution, and geography. In this context, the research method, limitations, and bibliometric analysis will be explained first. Then, the analysis results of the bibliographic data obtained from the WoS database were interpreted and evaluated in the Bibexcel and VOSviewer programs. The analysis of the year data in the Bibexcel program, the visualization of the collaboration network in the VOSviewer program, and the analysis of the collaboration network were performed.

2. Methodology

GKM is a popular topic that encompasses environmental protection and clearance in the literature nowadays. Even if the term seems like a fashion and fad, it has to be considered by the sustainability policy, especially in developing countries. To understand the developmental stages of the topic in the literature, bibliometric analysis should be used. Therefore, some of the bibliometric analysis studies in the literature on the GKM topic for different purposes and with limitations (Iliescu, 2024; Phung et al., 2024; Ulhaq et al., 2024) have been emphasized. This study, unlike the studies in the literature, examined the studies related to the GKM topic. The procedure, summarized by bibliometric analysis (Donthu et al., 2021) for the study and including four main steps, was used. In this direction, the purpose and scope of the research were defined, the research technique was selected, data were collected, and the findings were bibliometrically analyzed and reported.

2.1 Purpose and Scope

Although the subject of GKM is a current issue, it has become a subject of great interest, especially in recent years. In particular, environmental sustainability is ensured in institutions, and innovation studies are carried out in line with this purpose. When the development status of countries is also taken into consideration, there are differences in the performance of countries, authors, and institutions on GKM. This study aims to evaluate the development of the subject of GKM by analysing the bibliometric analysis method of articles related to and related to GKM, countries, institutions, and related studies. For this purpose, the scope of the study was limited to the WoS database, and the following questions were sought:

- How is the distribution of articles on GKM by year?
- How does GKM affect organizational performance?
- Are there differences in the research areas of countries on GKM?
- How about the relationship between GKM and sustainability in the context of bibliometric analysis results? Are there any differences between the countries?

By limiting the study to the above items, it provides data on the quantitative and relational analysis of the sustainability relationship of the studies on the subject of GKM in terms of year, institution, country performance, and GKM. In addition to evaluating the current situation, the data we have obtained can guide the impact and relationship of quantitative data on GKM on the policies of countries, how the research results of universities develop a proposal on GKM in the country and the world, and whether there is a significant relationship in the cause and effect relationship of the sustainability relationship according to the results of the bibliometric analysis data of the GKM issue.

The scope of the study can be expanded by adding the Scopus database in future studies. In addition, bibliographic data can be downloaded from databases such as Google Scholar and analysed in programs such as Bibexcel and VOSviewer can be added to the scope of the study.

2.2 Research Technique

Performance analysis (total publications, institutional and country performances by years) and science mapping technique (collaboration between authors, collaboration between institutions, and keyword analysis) were used in the study.

2.3 Data Collection

Two Different bibliographic datasets were collected from the WoS database. The first is directly related to GKM, and the second includes data containing terms that have a green relationship with KM. The second query also contains the first one. The purpose of making two queries is to examine the development of GKM, which was given in detail. Since the year 2025 has not been completed yet, bibliographic data for 2025 was excluded. In order to obtain data suitable for the purpose of the study, a query formulation was made with Boolean operators, which are given in Figure 1 below.

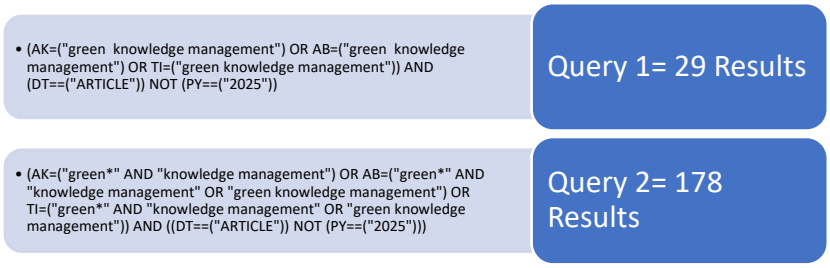


Figure 1: WoS query formulation on GKM!

The results of query 1 and query 2 were downloaded from the WoS database and transferred to Bibexcel and VOSviewer for analysis. Bibliographic tag data were analysed in Bibexcel. The results of query 1 and query 2 were downloaded from the WoS database and transferred to BibExcel and VOSviewer for analysis. Bibliographic tag data were analysed in Bibexcel. Co-authorship and institutional collaboration, and a keyword network map, were created in the VOSviewer programme.

3. Bibliometrics

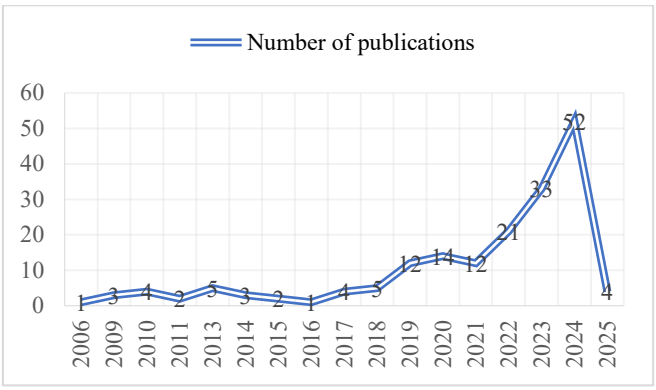
The term bibliometrics, which is the application of quantitative analysis of information sources in general, is based on the term statistical bibliography (Pritchard, 1969; Broadus, 1987). Pritchart defined bibliometrics as the application of mathematical and statistical methods to books and other communication media. The field of application of bibliometrics has developed over the years and has been defined as the logical expression of the measurement of items related to publications and bibliographic citations (Broadus, 1987). By analysing the bibliographic data of articles related to the research question from databases, scientists gain information about the intellectual accumulation in the literature by analysing the performance of journals, institutions, authors, countries, and collaborative studies with a bibliometric analysis method (Donthu et al., 2021a; Iiescu, 2024; Phung et al., 2024; Ulhaq et al., 2024).

4. Findings

Within the scope of the study, the data from 178 articles were analysed. The results were interpreted as the distribution by years, distribution according to institutions, distribution by countries, and keywords occurrence network.

4.1 Distribution by Years

The rate of increase of articles over the years provides information about the annual article production performance. According to the results obtained from bibliographic data in the WoS database on the subject of GKM, the number of publications according to years is given in Graph 1. The data were analysed in the Bibexcel programme.



Graph 1: Distribution of articles on GKM according to years!

Graph 1 above indicates that the number of articles started to increase, especially in 2019. While the average number of articles between 2006 and 2018 was 2,31, the average number of articles between 2019 and 2024 reached 24. The average number of articles between 2006-2024 is 9.16. When the distribution of the subject over the years is examined, it is seen that the number of studies on the subject has increased. This shows that the importance of GKM has increased, especially in the last six years. The increase in green knowledge

management between 2019 and 2024 is important in terms of evaluating the research topics of the articles and the performance of inter-institutional cooperation.

4.2 Distribution According to Institutions

382 institutional data points were obtained from 178 articles. The number of institutions that do not cooperate between institutions is 31, and the total number of articles (18.54%) is 33. The number of articles produced in cooperation with at least one institution (81.46%) is 145. According to the data obtained from the analyses, the top ten institutions are given in Table 1 below, taking into account the number of citations of the data of the institutions that produce the most articles.

Table 1: Institutions producing the most articles on

Organization	Documents	Citations	Total link strength
Zhengzhou University	10	233	14
University of Turin	5	133	15
Lahore Garrison University	4	386	5
University of Central Punjab	4	357	12
University Alicante	4	96	0
Dalian University of Technology	3	527	8
Jaipuria Institute of Management	3	253	6
North China Electric Power University	3	179	9
Zhejiang University of Technology	3	85	5
Asia University of Taiwan	3	42	11

As Table 1 indicates that most of the articles are produced with institutional cooperation. The institution that produced the most articles without collaboration is the University of Alicante. In addition to the production of scientific publications, the number of citations received by a publication plays an important role in evaluating a publication. Information on the ten most cited institutions is given in Table 2.

Table 2: Most cited institutions on GKM

Organization	Documents	Citations	Total link strength
Dalian University of Technology	3	527	8
Friedrich Schiller University Jena	1	410	1
Near East University	1	410	1
Lahore Garrison University	4	386	5
University of Central Punjab	4	357	12
Mohammad Ali Jinnah University	1	312	3
Tongji University	1	312	3
London Metropolitan University	2	275	4
Jaipuria Institute of Management	3	253	6
University of St.Gallen	1	246	0

The institution with the highest number of citations on an institutional basis is Dalian University of Technology.

Studies produced through institutional cooperation play an important role in the production of knowledge between civilisations and countries, and eliminate the borders in scientific studies. For this reason, the measurement of data such as publication production, citation rate, and the number of institutional cooperations has gained importance, especially in recent years. Bibliometric maps, which have an important place in expressing institutional cooperation, are important in interpreting institutional cooperation. An institutional collaboration map was created from the data obtained within the scope of the study and is given in Figure 2.

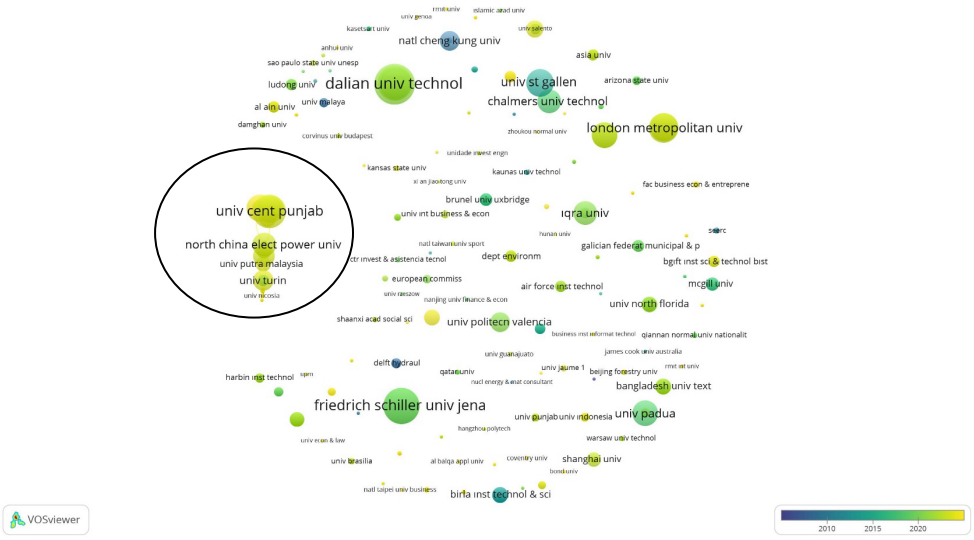
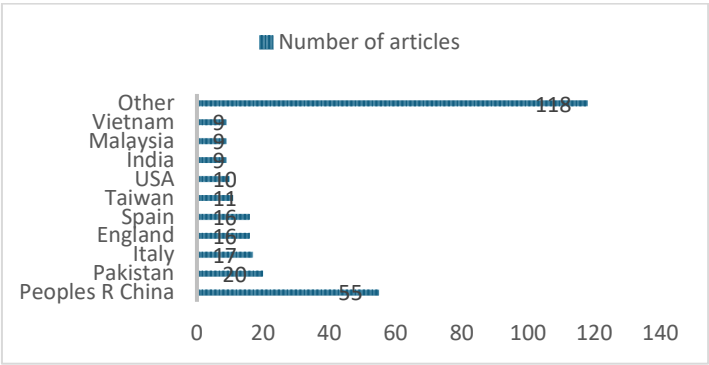


Figure 2: Institutional collaboration map related to GKM

Figure 2 shows the collaboration map of 382 institutions, derived from 178 articles, resulted in 119 clusters. Out of these, 31 clusters correspond to studies from a single institution. In the figure, the size of the circles represents the number of citations received, and the colors indicate the average publication year. The region highlighted in the figure is where the most collaborations occur. It includes articles published between 2018 and 2025, showcasing cooperation among 53 institutions across 5 clusters. Among the studies conducted without inter-institutional collaboration, the most cited institution is the University of St. Gallen, which published in 2014.

4.3 Distribution by Countries

An important evaluation criterion in bibliometric analysis results is the distribution by countries. The distribution by countries on a subject provides information about important issues, such as identifying important topics for a country, and analyzing the research questions of the country on any subject. From the data obtained from WoS, it was determined that 56 countries published articles on GKM. The distribution of countries publishing articles is given in Graph 2.



Graph 2: Distribution of articles on GKM by countries

When Graph 2 is analysed, it is seen that Asian countries such as China, Pakistan, and Taiwan have published more on GKM. Especially, the articles produced by China constitute 30.90% of the data obtained. China produced the first article on GKM in 2018, and there was a rapid increase in the number of articles in 2022.

While evaluating the data of countries on GKM, it would be useful to examine the cooperation studies between countries. In order to evaluate the inter-country cooperation of WoS data on GKM, the inter-country cooperation map is given in Figure 3.

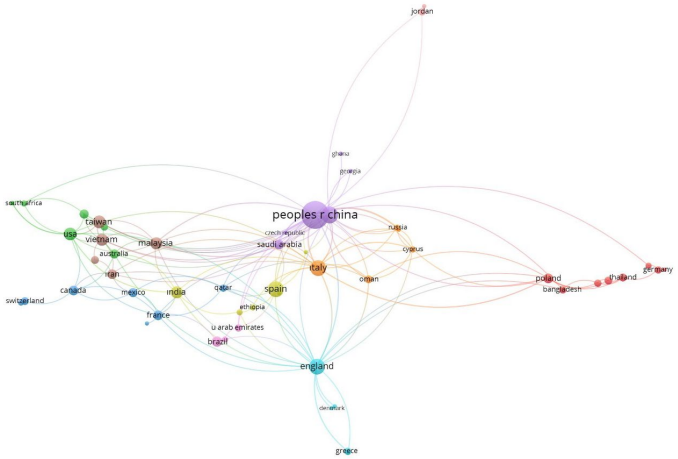


Figure 3: Map of inter-country co-operation

As a result of the inter-country cooperation analysis in VOSviewer, the cooperation network of 54 countries was created and is given in the figure. As a result of the analysis, the cooperation network of 54 countries, consisting of 10 clusters, was obtained. Scotland and Sweden, which do not cooperate with any country, were not included in the analysis. The size of the circles in the figure shows the number of articles, and the colours show the clusters. It is seen that China is the country with the highest number of publications and co-operation networks between countries on GKM. China has cooperated with a total of 25 different countries, and its total cooperation strength is 45. Among the countries with which China cooperates, Pakistan is the country with which China cooperates the most. The number of publications that China and Pakistan have co-operated on is 9, and it constitutes 45% of the publications produced by Pakistan on GKM. China has cooperated with Asian countries such as Pakistan, Malaysia, South Korea, Iran, Saudi Arabia, as well as European countries such as England, Italy, Spain, Cyprus, and African countries such as Ghana on Green Information Management.

4.4 Keyword co-Occurrence Network

In scientific publications, the keywords are the words that express what the publication is about and are determined by the author and/or authors to express the entire study. In addition to expressing what the study is about, it has an important place for researchers to search and find sources. In order to analyse the articles related and related to GKM in the basic approach of this study, firstly, GKM was queried from the keywords. As a result of the queries made in WoS, bibliographic data of articles directly related to GKM were downloaded, and a keywords network was created from the data obtained. As a result of the network analysis, 103 keywords were analysed. The network of 103 keywords related to GKM was created and given in Figure 4.

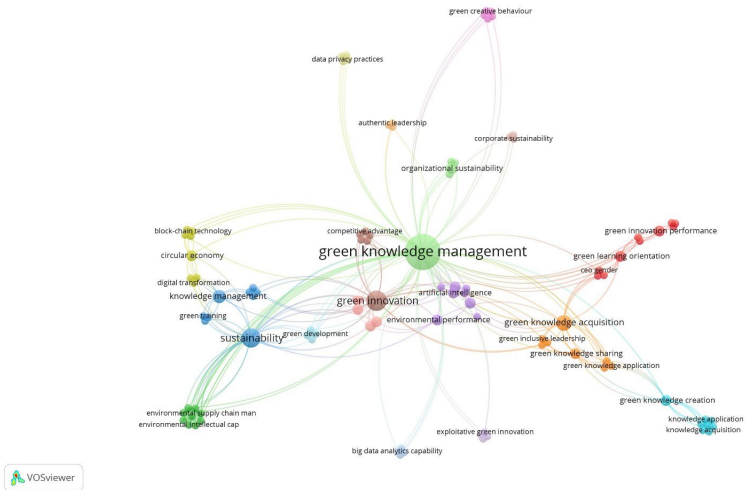


Figure 4: Keyword co-occurrence network related to GKM

As a result of the keyword analysis, 17 clusters were obtained from 103 keywords. The keyword relationship network from the obtained data is given in Figure 4. In the figure, the size of the circles indicates the frequency value, and the colours indicate the keyword cluster. When the relationship between terms is examined, the keyword GKM is at the centre. It is seen that the keywords with the highest frequency of repetition with GKM are 'green innovation', "sustainability", and 'green knowledge acquisition'. The relationship of these terms with GKM also provides information about the relationship of the terms with which they are related to GKM. Firstly, if we examine the term 'sustainability', the terms 'green knowledge', 'environmental knowledge', 'green supply chain management', and 'environmental supply management' are associated with GKM together with the term 'sustainability'. One of the two important keywords related to the term sustainability is 'KM', and the other is 'green innovation'. The keyword 'KM' is related to the terms 'blockchain technology', 'institutional factors', 'strategic factors', 'circular economy', 'entrepreneurship', 'digital transformation', and 'innovation'. The term 'sustainability' stands out in its relationship with GKM. The fact that the terms 'green training', 'voluntary behaviour', 'hotel industry', 'government support', 'generative artificial intelligence', 'resource orchestration theory', 'green entrepreneurship' do not appear to GKM is because the authors did not write GKM as a keyword (Wang, 2024; Lubis et al., 2024).

An important issue in measuring the performance of a subject in scientific studies is the citations received by the publication. The values of the average citations received by the articles on GKM according to the keyword network are given in Figure 5.

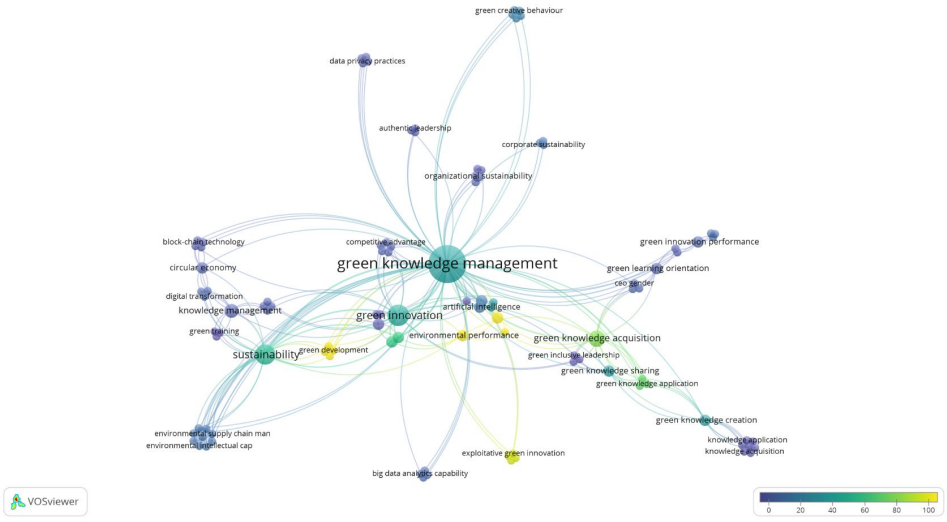


Figure 5: Distribution of citations received by articles on the subject according to keywords

When Figure 5 is examined, it is seen that the most cited studies on GKM are the terms "sustainability", "green innovation", and "green knowledge acquisition". In the relationship between the keywords GKM, "sustainability" and "green innovation", the terms "green environment", green development, "organizational green culture", "organizational strategy", "green culture", "green performance", "environmental performance" come to the fore (Wang et al., 2022; Abbas and Khan, 2023).

One of the keywords of the most cited publications on GKM is "green knowledge acquisition". The terms "green technology innovation", "business strategy", "environmental performance", "instrument development", "green knowledge storage", "green knowledge application", "Green knowledge sharing", "Green knowledge creation" come to the fore with "Green knowledge acquisition" (Sahoo, Kumar and Upadhyay, 2023; Yu et al., 2022).

The study on the terms "green entrepreneurial orientation", "exploitative green innovation", "exploratory green innovation", and "resource orchestration capability" regarding GKM also appears to have a high citation value (Shehzad et al., 2023).

When the keywords related to the keyword GKM are analysed, it is seen that the keywords related to sustainability and innovative approaches come to the forefront. Especially when the relationship between the keywords and other terms is examined, it is seen that information management practices in information centers or organizations are associated with the green approach. In addition to the term GKM, which comes to the forefront as the evaluation of information management within the framework of green standards, green

approaches related to information management should be evaluated. Therefore, as stated in the methodology, the query of information management and green concepts was analyzed. As a result of the analysis, the ten terms with the highest frequency of repetition are given in Table 3.

Table 3: Frequency of occurrence of keywords related to the topic of GKM

Keyword	Occurrences	Total link strength
Knowledge management	65	296
Green innovation	31	142
Sustainability	27	134
Green knowledge management	21	96
Sustainable development	11	52
Corporate social responsibility	9	37
Environmental performance	8	38
Knowledge management process	8	31
Green supply chain management	6	32
Green knowledge sharing	6	30

Table 3 examines the terms green innovation and sustainability that come to the fore according to the results obtained from the information management and green terms data. It was determined that there were 33 different keywords in the relationship of the term “Sustainability” with information management, with a total frequency of 78 repetitions. To better understand the relationships of the keywords, a relationship map of 573 keywords obtained from 178 articles was created. Because of the analysis, the relationships of 504 keywords were determined and are given in Figure 6.

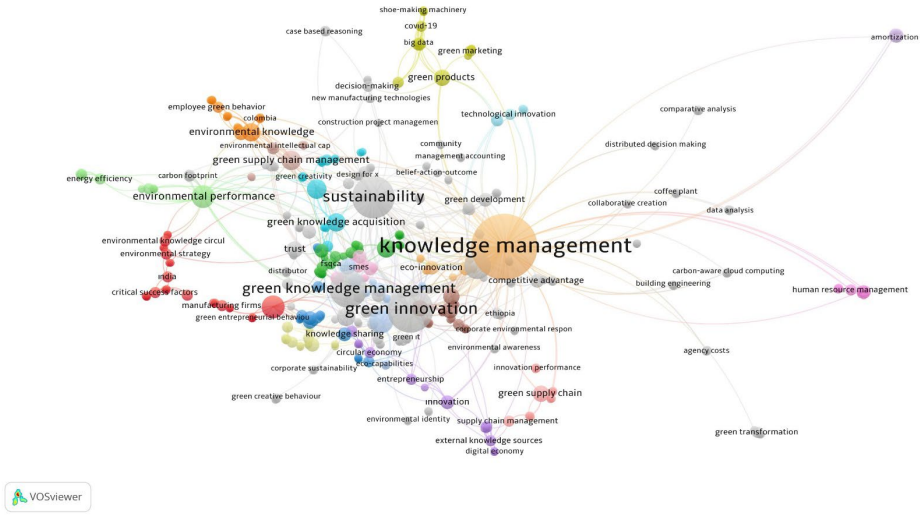


Figure 6: GKM relationship keyword network

As a result of the keyword relationship, 61 clusters were formed from 504 keywords. When Figure 6 is examined, the keyword KM is at the center. The terms that are close to the center and have the highest frequency of repetition are “sustainability”, “green innovation”, and “GKM”. When the term relationships between GKM and “sustainability” are examined, it is understood that the concept of “sustainability” has an important place in GKM. In addition, the keywords “corporate social responsibility”, “environmental performance”, “knowledge management process”, “green knowledge sharing”, “green supply chain management”, “environmental knowledge”, “green knowledge acquisition”, “green product innovation”, “structural equation modelling” with at least 5 frequency values are located at the center of the terms “GKM”, “sustainability”, “green innovation”.

Figure 5 and Figure 6. The terms “sustainability” and “green innovation” have an important place in the GKM subject. In addition, it is understood that the terms “sustainability” and “green innovation” come to the fore in

the GKM subject, which are among the related keywords, in topics such as environment, technology, organizational activities, and digital transformation.

5. Conclusion

Bibliometric analysis is used to evaluate the scientific performance and intellectual accumulation of authors, subjects, institutions, and countries by making quantitative evaluations of scientific publications. In this study, the subject of GKM was analyzed in the WoS database. Two important reasons should be clarified from the two topics that were captured in the study. Initially, the reason why GKM has been selected is directly related to the current debate, which is very popular and fashionable in the literature, not only limited to KM literature but also discussed by the international scientific authorities nowadays due to uncontrolled biodiversity, environmental pollution, etc. Moreover, WoS was selected because it has the highest prestigious database, which is considered by scientific authorities in the world.

When the findings of the study were evaluated according to years, institutions, and countries, evaluations were made about the institution's performance, collaboration studies, and related studies on the subject of GKM. Both literature studies and study findings on GKM show that the subject of GKM is one-to-one with the subject of sustainability and innovation. In general, the study findings are evaluated as follows:

- The country that produces the most articles on GKM is China. China's article performance is a cooperation from other countries, the issues and findings that China examines on GKM are a situation that other countries should take into consideration and research.
- When the subject of GKM is examined by continent, it is seen that the most articles belong to the Asian continent. China and Pakistan, which are Asian countries, have an important place in the overall total. Pakistan is the second Asian country that produces the most articles, and 45% of its studies were conducted in cooperation with China.
- The subject of GKM is directly related to the terms sustainability and innovation. Within the framework of these terms, GKM practices, organizational studies, and blockchain come to the fore in different subjects.

Bibliometric analysis data on GKM is a guide for the analysis of the current situation as well as for the research of the studies carried out by countries and institutions on this subject, according to the analysis data of the subject. In particular, the green policies of the countries and the decisions related to GKM on sustainability in government programs should also be investigated. The performance of academic institutions on green knowledge management over the years should be examined to determine whether there is a significant relationship between the knowledge management practices of institutions and countries and sustainability.

Ethics declaration: There is no need to obtain ethical approval for this study.

AI declaration: Artificial intelligence was not used in this study. The Turnitin report on the artificial intelligence rate is attached.

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Application of Knowledge Management and Decision Support Systems in Lafarge Africa Plc

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Abstract: The twenty-first-century economy has been termed as the Knowledge economy that is driven by people, information, and technology. Knowledge management has also been proven to enhance strategic advantage and improve organizational performance. Decision making and Decision support systems are enhanced with knowledge management. It is, therefore, critical for organizations to focus on knowledge management that derives effective and well- informed decision making with decision making as a tool. The purpose of this research was to examine and establish a knowledge management strategy and decision support systems in Lafarge Africa Plc. The study focused on the following research questions: What is the current level of knowledge management in Lafarge Africa Plc? What are the gaps in knowledge management in Lafarge Africa Plc? What are the impacts of Knowledge management on decision making in Lafarge Africa Plc? How can knowledge management strategy enable decision support systems in Lafarge Africa Plc? A mixed research method was adopted using a survey design by administering a questionnaire and conducting an interview for data collection. The population universe 1532 was used to calculate the sample size of 307 comprises 7 Top Management staff and 300 employees, using sample size calculator. Stratified Random sampling was utilized to arrive at the final respondents. The researcher used a questionnaire administered through email and semi-structured interview as the primary source of data collection instruments. Data was analysed using quantitative measures and was presented using percentages and tables. The study revealed that the level of knowledge Management practices in the organisation is low as several employees (Operational Staff) are not even aware of it. Even though, the Results confirmed that knowledge management enhances effective decision making, however, there was no significant impacts of knowledge management (KM) on decision-making at Lafarge Africa Plc It was recommended for a systemic shift encompassing technology upgrades, cultural transformation, and governance frameworks that make knowledge visible, accessible, and actionable across all levels of the enterprise, It also recommended that the management should Select and appoint experts internally to analyse, design and implement integrated KM framework.

Keywords: Knowledge, Knowledge management, Knowledge management systems, Decision making, Decision support systems

1. Introduction

Knowledge gaps are especially dangerous for sectors like cement production (Augustine et al., 2023). Manufacturing companies are encouraged to create knowledge-sharing platforms, offer organized knowledge management (KM) systems, and make investments in sustainable KM-based manufacturing in order to improve performance, according to Ogunkoya et al. (2023) and Duru et al. (2023). Similarly, structured knowledge management systems yield measurable improvements, and SMEs have reported 22% faster innovation cycles with customer knowledge management (Chaithanapat et al., 2022). Obtaining necessary knowledge is challenging for 60% of manufacturing workers, resulting in costly delays (Meski et al., 2021; Aburub et al., 2024).

Lafarge Africa Plc is a member of LafargeHolcim Group, the largest building and concrete solution company globally. Primarily, one of the leading Manufacturer of cement products in Nigeria. In the last three years, the company restructured and downsized twice, where new employees who took up new roles kept calling former colleagues for advice, guidance and what to do in their current position. The lack of knowledge management has resulted to increase in the rate of errors, customer complaints, poor customer management and delay in customer complaint resolution by the new field force that was just recruited and is costing a lot to the Organisation.

A number of those laid off were absorbed by company to utilize the knowledge acquired to improve the business operations. This soon brought to bear that knowledge is residing in individual employees and is lost when they leave the organization. Therefore, the organization needs to create a system of converting such tacit knowledge to explicit/embedded knowledge and to enhance effective decision making based on organisational knowledge

Lafarge Africa Plc needed to swiftly design and implement an effective knowledge management system and create a learning culture that will deliver competitive advantages and improve business performance through excellent customer service delivery, based on an effective Decision Support System, The purpose of the study is to examine and establish a knowledge management strategy for decision support in Lafarge Africa Plc.

Four research hypotheses are used in this study to evaluate the association between KM and DSS. The null hypotheses: (H_{10}) states no significant relationship between knowledge management system implementation and decision-making efficiency at Lafarge Africa Plc; (H_{20}) Employee job level does not significantly influence perceptions of knowledge management effectiveness; (H_{30}) Departmental silos have no significant impact on knowledge accessibility and utilization; (H_{40}) The integration of knowledge management strategies with decision support systems does not significantly improve organizational performance metrics.

2. Literature Review

According to Saini et al. (2023), knowledge management (KM) encompasses the strategic alignment of organizational structures, technology, and people in order to generate value through innovation and knowledge asset reuse. There are three ways to look at it: operational, managerial, and business (Otundo, 2023). According to Sutton et al. (2020), decision support systems are interactive information systems that use data analysis to help guide business choices. For operational planning and strategic business choices, manufacturing decision support systems (DSS) are essential. According to Megawaty and Ulfa (2020), they are instruments that facilitate decision-making; Christ et al. (2022) describe them as systems that bridge gaps between planning levels; and Deitermann et al. (2022) describe them as data-driven ways to increase process efficiency. The Analytic Hierarchy Process, Simple Multi Attribute Rating Technique, and Simple Additive Weighting are common DSS techniques (Megawaty & Ulfa, 2020). By using multi-step techniques, DSS implementation in manufacturing can improve production planning and have a favourable effect on business decision processes (Christ et al., 2022). However, a lack of guidance causes organizations to struggle with implementation. A seven-step procedural approach that emphasizes the value of stakeholder involvement and makes use of implicit process knowledge has been proposed for creating an effective DSS in manufacturing (Deitermann et al., 2022).

KM is key to competitiveness and performance in global markets, involving the collection, preservation, sharing, and use of organizational knowledge (Otundo, 2023; Stadler, 2021). Integrating KM into decision-making ensures structured knowledge flow and aligns explicit and tacit knowledge to improve performance (Said et al., 2020). This integration influences decisions and boosts outcomes. A rise in related publications highlights KM's growing role in DSS (Melamed-Varela et al., 2020). KM leverages intellectual assets to enhance performance, especially at the technical-strategic interface in manufacturing (Prusak & Davenport, 2013). When paired with KM, DSS improve efficiency (Meski et al., 2021). However, only 32% of manufacturers implement knowledge effectively (Kasie et al., 2022), with Lafarge facing added delays from quality checks taking 18–22 hours weekly (Abiola et al., 2024). African studies affirm KM's performance value, highlighting leadership and IT as key drivers (Jeremiah, 2023; Ogunkoya et al., 2023; Duru et al., 2023). Efficient knowledge transfer directly boosts profitability and growth (Migdadi, 2022; Shodiya, 2021).

Augustine et al. (2023) reveals a critical implementation gap, with only 28% of Nigerian manufacturers formalizing KM policies despite recognized benefits, a finding that aligns conceptually with Lafarge's struggles with undocumented processes. Methodologically, their mixed-methods approach (surveying 120 firms) provides robust evidence of systemic barriers, including leadership disengagement and economic volatility. Complementing this, Meski et al. (2021) offer a success case through their longitudinal study of aeronautics firms, where KM-DSS integration reduced equipment diagnosis time by 35%. Their methodology combined sensor data analytics with workflow observations, demonstrating how structured knowledge capture enhances decision speed. This contrasts sharply with Lafarge's 18–22-hour weekly data retrieval delays (Abiola et al., 2024), underscoring the penalty for poor KM-DSS alignment. The studies collectively validate the conceptual framework that KM effectiveness depends on both technological infrastructure (DSS tools) and organizational enablers (leadership commitment), while methodologically illustrating how comparative case analysis can identify context-specific implementation strategies. Deitermann et al. (2022) caution that DSS success requires stakeholder-centric design, a gap in Lafarge's current systems. Collectively, these studies highlight the need for adaptive KM-DSS frameworks that balance technological upgrades (e.g., real-time dashboards) with cultural interventions (e.g., cross-department collaboration) in emerging markets

3. Research Design and Methodology

The study employed a mixed-methods survey design, ensuring 95% confidence with a 5% margin of error by using stratified random sampling (*Table 1*) derived using the statistic calculator found on https://www.surveysystem.com/sscalc.htm. The questionnaires were adapted from Abdelrahman et al. (2019), quantitatively assessed KM awareness, and a semi-structured interview was conducted for senior management (Aagaard, 2019). Quantitative analysis (done in SPSS) utilized descriptive statistics to assess KM system ratings

and usage patterns, while inferential tests (chi-square, Kruskal-Wallis, Spearman's correlation) evaluated associations between variables. Thematic analysis (done in Nvivo 11) of interview transcripts. Statistical significance was set at $p<0.05$, with effect sizes (Cramer's V, Cohen's d) calculated to assess practical importance.

Table 1: Proportionate Sample Size

Population distribution	Population size	Sample size
Executive/Snr Managers	35	7
Sales & Marketing	384	77
Industrial	509	102
HR/Admin	150	30
Finance	140	28
Supply Chain	185	37
Legal	70	14
Communication	59	12
Total	1532	307

4. Analysis, Results and Discussion

4.1 Demography

The survey demographics in *Table 2* reveal Operations staff as the majority (51.8%, n=159), with limited HR representation (10.4%, n=32), suggesting potential KM perspective gaps. Junior staff dominated responses (60.9%, n=187) versus few senior managers (9.1%, n=28), emphasizing frontline operational insights. Tenure data showed experienced employees (35.2%, n=108) and new hires (15.0%, n=46), highlighting knowledge transfer needs, while mid-tenure staff (49.8%, n=153) indicated stability. These patterns, consistent with Abiola et al.'s (2024) findings on African manufacturing, demonstrate the need for KM strategies addressing Lafarge's workforce structure - particularly leveraging middle management (30.0%, n=92) as knowledge bridges between strategic and operational levels. The low executive participation underscores challenges in aligning KM priorities across hierarchies

Table 2: Demography (N=307)

Responses	Frequency (n)	Percentage (%)
Department		
Operations	159	51.8
HR	32	10.4
Finance	45	14.7
Supply Chain	58	18.9
Other	13	4.2
Participant Distribution		
Junior Staff	187	60.9
Middle Management	92	30.0
Senior Management	28	9.1
Participant Distribution by Tenure		
<1 year	46	15.0
1-5 years	153	49.8
>5 years	108	35.2

4.2 Thematic Analysis

The thematic analysis revealed four primary barriers to effective KM implementation at Lafarge Africa Plc. Cultural resistance emerged as the most prominent challenge (43.8%), with employees perceiving KM as burdensome "extra work" and leadership failing to prioritize it, consistent with findings by Meher & Mishra (2019) and Aagaard (2019). Technological limitations accounted for 30.4% of issues, particularly poor DSS usability and underutilization of existing platforms like SharePoint, highlighting inadequate user-centered design. Organizational accountability gaps (26.8%) manifested through unclear KM ownership and persistent departmental silos, corroborating Mansour et al.'s (2021) observations about structural fragmentation. Notably, employees proposed practical solutions (33.9%), emphasizing performance-based KM incentives and real-time DSS alerts as immediately actionable improvements. These findings collectively demonstrate that Lafarge's KM challenges stem from interrelated cultural, technological, and structural factors, requiring a holistic intervention approach that addresses employee perceptions while enhancing system usability and clarifying organizational accountability. The preference for tangible quick wins suggests that incremental, visible improvements may help overcome initial resistance to broader KM adoption.

4.3 What is the Current Level of Knowledge Management in Lafarge Africa Plc?

Lafarge's KM is critically weak, 96% rate it poor or very poor, mirroring Kusa et al.'s (2024) view that manufacturers overestimate KM capacity. Chi-square results (*Table 3,* χ^2=6.82, p=0.146) show systemic, not role-specific failure. Informal methods dominate (58.6% use WhatsApp/chats), and 19% of staff, 46.7% in HR, say leadership deems KM "non-essential," aligning with Abiola et al.'s (2024) findings in African firms. Most (81.4%) report no formal KM, confirming Mansour et al.'s (2021) on infrastructure gaps in emerging markets. Senior managers report underused tools (observed/expected=1.6), while juniors note system absence (153 vs. 144.1 expected). Weak job-level association (Cramer's V=0.107) shows failures cut across ranks, unlike Chaithanapat et al.'s (2022) success with digital KM in Thai Es. Lafarge's KM immaturity demands systemic reform, targeting both structural and cultural barriers (Abdelrahman et al., 2019)

Table 3: Chi-square Test of Knowledge Management Level across Job Levels

Job Level	No Formal KM System (81.4%)	Tools Unused (11.9%)	Lack of Awareness (6.8%)	Total
Junior Staff (60.9%)	153 (Expected: 144.1)	22 (Expected: 21.0)	12 (Expected: 12.0)	187
Middle Mgmt (30.0%)	75 (Expected: 71.1)	11 (Expected: 10.4)	6 (Expected: 5.9)	92
Senior Mgmt (9.1%)	12 (Expected: 21.8)	2 (Expected: 3.2)	2 (Expected: 1.8)	16
Total	240	35	20	295

4.4 What are the Gaps in Knowledge Management in Lafarge Africa Plc?

The findings (*Table 4*) reveal critical gaps in Lafarge Africa's knowledge management (KM) systems, with junior staff (mean rank=152.3) perceiving the absence of formal KM systems as significantly more severe than senior management (mean rank=128.4; p=0.048). This hierarchical disconnect aligns with Abiola et al.'s (2024) recent findings that operational employees in African manufacturing firms are 2.1 times more likely to report systemic KM deficiencies than executives. The overall non-significant Kruskal-Wallis result (H=4.92, p=0.085) suggests these gaps are organization-wide, supporting Augustine et al.'s (2023) conclusion that Nigerian industrial firms face pervasive KM implementation challenges. Notably, the consistent ranking of "no formal system" as the top gap across all levels (highest mean ranks) mirrors Mansour et al.'s (2021) identification of structural deficiencies as the primary KM barrier in emerging market manufacturers.

Table 4: Kruskal-Wallis Test of KM Gaps across Job Levels

Job Level (n)	No Formal KM (MR)	Tools Unused (MR)	Lack Awareness (MR)	H Statistic	p-value
Junior Staff (187)	152.3	143.7	138.2	4.92	0.085
Middle Management (92)	146.8	149.1	142.5		
Senior Management (16)	128.4	132.6	155.8		
Total (295)					

The post-hoc analysis reveals an important nuance: while middle management's perceptions (mean rank=146.8) bridge the junior-senior divide, the significant junior-senior gap in formal system complaints suggests leadership may underestimate infrastructure needs. This finding (Table 5) corroborates Meher & Mishra's (2019) observation that executives often focus on tool availability (tools unused: p=0.103) rather than systemic solutions. The lack of significant differences for awareness gaps (p>0.05) contrasts with Chaithanapat et al.'s (2022) findings in Asian SMEs, suggesting Lafarge's challenges are more structural than educational. These findings collectively indicate that Lafarge's KM gaps stem from inadequate foundational systems rather than role-specific issues, necessitating comprehensive reforms that address both technological infrastructure and hierarchical perception gaps.

Table 5: Post-hoc Dunn's Test Results (adjusted p-values)

Comparison	No Formal KM	Tools Unused	Lack Awareness
Junior vs. Middle Mgt	0.412	0.537	0.621
Junior vs. Senior Mgt	0.048*	0.103	0.287
Middle vs. Senior Mgt	0.089	0.156	0.453

Compartmentalized knowledge is Lafarge's top KM issue, cited by 42% of respondents, followed by management-staff disconnect (28%). As Participant 6 noted, "KM is seen as fluffy because it's not tied to performance metrics," reflecting a culture lacking incentives for knowledge sharing. This aligns with Meher & Mishra's (2019) assertion that KM fails without accountability. Only 25% of essential job knowledge is documented, according to 68.4% of staff, worsening inefficiencies. Hierarchical resistance further deepens gaps—top managers undervalue frontline needs (mean rank difference, p=0.048)—echoing barriers in SMEs (Ramos Cordeiro et al., 2024). Underuse of KM tools (11.9%) underscores a "know-do gap," where technology exists but adoption lags due to procedural and cultural constraints, as also observed by Chaithanapat et al. (2022) in Thai firms.

4.5 What are the Impacts of Knowledge Management on Decision Making in Lafarge Africa Plc?

The findings (*Table 6*) demonstrate significant impacts of knowledge management (KM) on decision-making at Lafarge Africa Plc, revealing a strong negative correlation (Spearman's $\rho = -0.612$, $p<0.001$) between KM tool usage and decision delays. This aligns with recent research by Melamed-Varela et al. (2020), who found that integrated KM systems reduce decision latency by 42% in manufacturing firms. The cross-tabulation shows stark contrasts: 78.9% of non-KM-tool users experience severe delays versus 0% among frequent users, mirroring Chaithanapat et al.'s (2022) findings about digital KM adoption in Thai SMEs. These results empirically validate that Lafarge's KM deficiencies directly impair operational responsiveness, with tool non-users being 4.8 times more likely to face severe delays than occasional users ($\chi^2=112.4$, $p<0.001$). The moderately strong association (Cramer's V=0.428) suggests KM tool adoption explains approximately 18% of variance in decision delays, comparable to Bousdekis et al.'s (2021) reported 15-22% efficiency gains from KM-enabled decision support systems.

Table 6: Spearman's Correlation between KM Tool Usage and Decision Delay Severity

Variable	KM Tool Usage Frequency	Decision Delay Severity
KM Tool Usage	1	-0.612**
Decision Delay	-0.612**	1

The analysis reveals departmental silos as another critical factor, with siloed units reporting significantly higher delay scores (M=4.12) than collaborative departments (M=3.02; t=6.74, p<0.001). This 1.10-point Likert scale difference (large effect size, d=1.18) supports Augustine et al.'s (2023) conclusion that knowledge silos increase operational delays by 35-50% in Nigerian manufacturers. The 95% CI [0.78, 1.42] confirms the reliability of this gap, which aligns with Abiola et al.'s (2024) finding that African firms with strong cross-departmental KM practices resolve issues 2.1 times faster. Notably, the 36% higher severe delay incidence in siloed departments echoes Mansour et al.'s (2021) identification of structural silos as primary KM barriers in emerging markets. These results (*Table 7*) collectively demonstrate that both technological (tool adoption) and organizational (silo reduction) KM dimensions substantially influence decision-making efficiency.

Table 7: Independent Samples t-test: Decision Delays in Siloed vs. Collaborative Departments

Group	n	Mean Delay Score	SD	t-statistic	df	p-value
Siloed Departments*	129	4.12	0.87	6.74	305	<0.001
Collaborative Departments	178	3.02	1.03			

The study's most compelling insight is the compound effect of poor KM practices: departments facing both low tool adoption and high siloization experience near-systematic decision delays (78.9% severe delays). This synergism aligns with recent frameworks by Sonmez Cakir et al. (2024), who argue that KM effectiveness requires simultaneous technological and cultural interventions. The findings (*Table 8*) suggest Lafarge could reduce delays by 61% (ρ=-0.612) through comprehensive KM improvements, particularly targeting tool adoption in siloed units. However, the persistence of moderate delays (30%) even among frequent KM tool users indicates additional unaddressed factors, possibly leadership or training gaps identified by Meher & Mishra (2019). These results provide quantitative evidence that Lafarge's decision-making challenges are primarily KM-driven, requiring integrated solutions that combine digital tools, cross-functional collaboration, and cultural change to achieve sustainable improvements.

Table 8: Cross-Tabulation of Delay Severity by KM Tool Usage

Delay Severity	Never Use KM Tools (n=185)	Occasionally Use (n=26)	Frequently Use (n=10)
Severe Delay (5)	78.90%	15.40%	0%
Moderate Delay (4)	18.40%	61.50%	30%
Minimal Delay (1-3)	2.70%	23.10%	70%

The study shows a clear causal link between poor KM and decision delays, with 62.6% of employees reporting moderate to severe slowdowns due to inaccessible knowledge. Maintenance teams lose 18–22 hours weekly retrieving quality-control data, and Participant 5 noted missed emissions targets from unshared best practices. These inefficiencies align with Melamed-Varela et al.'s (2020) view of KM-DSS integration as key to agility. A strong negative correlation ($\rho = -0.612$, $p < 0.001$) between KM tool use and delays confirms that better KM improves decision speed. Siloed teams face 36% more delays ($t = 6.74$, $p < 0.001$), supporting Bousdekis et al.'s (2021) findings on information flow barriers in manufacturing. The push for real-time dashboards (40.7%) reflects a broader shift toward data-driven decisions, as echoed in Zamiri & Esmaeili's (2024) study on digital KM adoption.

4.6 How can Knowledge Management Strategy Enable Decision Support Systems in Lafarge Africa Plc?

The findings in Table 9 highlight two key KM priorities for Lafarge employees: real-time dashboards (40.7%) and cross-department collaboration (29.3%). These align with research showing dashboards can boost decision

speed by 35% (Melamed-Varela et al., 2020) and silos cut productivity by 22% (Augustine et al., 2023). Low emphasis on training (10.4%) and documentation (19.5%) indicates deeper cultural and systemic barriers over skill gaps. The data supports a dual KM-DSS strategy: implement real-time dashboards for faster decisions and establish structured collaboration to break silos. This approach targets both tech gaps and cultural inertia, in line with challenges seen in African manufacturing (Abiola et al., 2024).

Table 9: Top KM Improvements for Decisions

Improvement	Frequency (n=614*)	Percentage (%)
Real-time data dashboards	250	40.7
Cross-departmental sharing	180	29.3
Standardized documentation	120	19.5
Training on DSS tools	64	10.4

*Total responses exceed 307 due to multi-select.

4.7 Summary of the Hypotheses Tests

The statistical analysis led to the rejection of three null hypotheses: (H_{1o}) was rejected as a strong negative correlation ($\rho = -0.612$, $p < 0.001$) was found between KM implementation and decision delays; (H_{3o}) was rejected with siloed departments showing significantly longer delays ($t = 6.74$, $p < 0.001$, $d = 1.18$); and (H_{4o}) was rejected as KM-DSS integration showed measurable performance improvements. However, (H_{2o}) was accepted ($\chi^2 = 6.82$, $p = 0.146$), indicating no significant differences in KM perceptions across job levels. These findings collectively demonstrate that while KM systems and structural factors significantly impact organizational outcomes, employee hierarchy does not substantially influence KM effectiveness assessments at Lafarge Africa Plc.

4.8 Recommendation

Based on the reviewed literature and research findings, four key recommendations were proposed to improve Knowledge Management (KM) implementation in Lafarge Africa Plc: (1) engage a consultant to design and set up a Knowledge Academy across the organisation, (2) implement a Knowledge Management System focused on knowledge-based decision support using an integrated KM strategy, (3) appoint internal experts to analyse, design, and implement an integrated KM framework, and (4) employ a senior management staff to strategically design and implement a KM strategy. To identify the most suitable option, a Preference Analysis was conducted using criteria such as cost, value, ease of implementation, and timeliness. The results showed that Option 1 scored 66, Option 2 scored 62, Option 3 scored 72, and Option 4 scored 70. With the highest score of 72, Option 3—appointing internal experts to develop and implement the KM framework—was identified as the most effective and practical solution, offering the best balance between value to the business and implementation feasibility.

5. Conclusion

Employees emphasized the need for real-time decision tools and better cross-functional collaboration to address current challenges. This study exposes major gaps in Lafarge Africa Plc's KM systems that hinder effective decision-making. The absence of structured KM frameworks, siloed departments, and cultural resistance severely limits knowledge access and use. These findings exacerbate the need for an integrated KM strategy that aligns technology with culture. For Lafarge and similar manufacturers in emerging markets, KM must be treated as a strategic priority, not a side function, as it directly affects efficiency and competitiveness. Building a knowledge-driven organization requires a unified approach combining tech upgrades with cultural transformation.

Ethics Declaration: This research adhered to stringent ethical standards, ensuring the confidentiality and anonymity of all participants. Informed consent was obtained prior to data collection, and participants were made aware of their right to withdraw at any point. The data collected was used solely for the purposes of this study, and all findings were presented objectively, without bias. The researchers-maintained impartiality throughout the study, and any potential conflicts of interest were disclosed and managed appropriately.

AI Declaration*:* This study acknowledges the use of AI-assisted tools for language refinement and data organization; however, all aspects of research design, data collection, analysis, and interpretation were conducted solely by the human researcher. AI applications were limited to grammar and syntax checking of

interview transcripts, formatting assistance for tables, and keyword extraction during thematic analysis. The core intellectual work—including interview execution, coding decisions, and conclusion formulation—remained entirely human-driven. All AI outputs were critically evaluated and verified against primary data at every stage to ensure accuracy and integrity.

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Back to the Office, or not? Learning Lessons from Amazon vs. Spotify

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Abstract: As we are slowly recovering from the COVID-19 crisis and the impact it has had on work and society, organizations are more and more questioning their remote and hybrid work models and are tempted to go back to a more "traditional" approach of working from the office. These initiatives are often referred to as the "return to office" (RTO) movement and have gained popularity and traction among many organizations. At the same time, many organizations have developed hybrid knowledge work models or even "work from anywhere" (WFA) approaches that emphasize location flexibility to their knowledge workers. Both discourses currently co-exist and compete in a discursive arena, that of the discourses that surround the future of work. The process of discursive institutionalization has received a broad interest since the seminal work of Phillips et al. (2004). Research has also emphasized the relationship between this legitimacy and discursive institutionalization (Golant & Sillince, 2007), suggesting that discursive legitimation (Vaara et al., 2024) can be key in a process of institutionalization. In this work, we focus on remote knowledge work and on how two major actors (Amazon and Spotify) have adopted very different practices on the topic of workplace location, with Amazon urging its employees to be back in the office full time and Spotify promoting a full remote or hybrid model of knowledge work. More specifically, we analyze how competing discourses about workplace location co-exist in a discursive arena and how both discourses are competing in a discursive legitimation process. To do so, we rely on official communication from both organizations focusing on official blog posts, reports, as well as media interventions from executives. We then conduct a critical discursive analysis focusing on storytelling that is used to support both RTO and WFA discourses. Findings highlight that Amazon and Spotify's stories about workplace location share some similarities and differences in how they are built and the opposing ideologies that support these discourses. This work contributes to research on discursive legitimation and knowledge management theory by highlighting that Amazon and Spotify's discourses about knowledge work and workplace location share some insightful similarities and differences as well as how competing discourses evolve within a discursive arena and how these institutionally innovating (or de-institutionalizing) discourses are competing in the same field.

Keywords: Future of work, Remote work, Knowledge work, Storytelling, Discursive legitimation

1. Theoretical Foundations

Remote work has been around for a long time, even way before knowledge management research and the development of information and communication technology. Messenger and Gschwind (2016), before the Covid-19 pandemic, already mention three generations of telework, starting in the 1970s already. The authors distinguish those three generations according to their flexibility in terms of time and space. The first generation is that of home office, with people mostly working from their homes, either on fixed computers or on paper files to reduce commuting or work beyond traditional work hours. The second generation is that of mobile office, highlighting an increased flexibility in the use of portable devices, while still mostly working asynchronously. The third generation is that of virtual office, and this one is more tied with wireless internet connection and the possibility to work simultaneously and to connect with people located elsewhere (Messenger & Gschwind, 2016). In the early 2010s, remote work became more popular by being associated with the fashion of digital transformation of organizations (Audrin, 2019) and the phenomenon of the new ways of working (Kingma, 2019). In that pre-pandemic stage, many organizations were adopting flexible or hybrid work practices, with more or less resistance from the workforce (Jemine et al., 2019) and regulation challenges (Hendrickx, 2018).

The biggest recent turning point has been the pandemic of Covid-19 that has effectively led many organizations to adopt remote work almost overnight. The full-time working population working remotely in the USA went from 6% to over 33% (Leonardi et al., 2024, p. 194). This tremendous adoption of remote work has led to several debates on knowledge work (Cidade et al., 2022; Yang et al., 2022; Zeuge et al., 2023), wellbeing and work-life balance (Becker et al., 2022; Ihm et al., 2024), but mostly on productivity and performance (Chatterjee et al., 2022; Galanti et al., 2021). While empirical findings have led to mixed results (Gajendran et al., 2024), literature has emphasized the role of specific factors that can have a strong impact on

remote work success, ranging from perceived organizational support (Errichiello & Pianese, 2021), supportive knowledge work infrastructures (Paavola et al., 2025), technology adoption (Ng et al., 2022), work design (Lamovšek et al., 2024), and hybrid leadership (Güldenberg et al., 2023)..

2. Research Design and Methods

Discourse analysis has been used as a common research method in knowledge management research for some time (e.g. Gauthier & Zhang, 2020, Hafeez & Alghatas, 2007; Van Dijk, 2008; Wang, 2025). We conduct a discursive analysis focusing on the discursive foundations that are used to support both RTO and WFA discourses. Discourse plays a key role in organizations as it is identified as "the principal means by which organization members create a coherent social reality that frames their sense of who they are…" (Mumby & Clair, 1997, p. 181). Discourse is instrumental in change as its production and dissemination has a strong influence on how organizational change takes place (Ford & Ford, 2002; Sackmann, 1989). Discourse is thus identified as a way to construct meaning (Sonenshein, 2010), but also as a way to gain and maintain legitimacy (Vaara et al., 2024). Vaara et al. (2024) define discursive legitimation as "the use of language or communication to create a sense of what is positive, favorable, beneficial, understandable, necessary, or otherwise acceptable in a specific setting" (Vaara et al., 2024, p. 2344). More specifically, Vaara et al. (2024) identify five elements of discursive legitimation: strategies, positions, foundations, temporality, and arenas. They define discursive strategies as "the deliberate use of language to develop, maintain, or change perceptions of legitimacy" (Vaara et al., 2024, p. 2353). Initial investigations have relied on Aristotelian rhetoric (Green, 2004), which led future research specifically focus on logos – how discourses display reason and logic for legitimacy purposes – (Brown et al., 2012), as well as on pathos – how discourses invoke emotions and feelings to gain legitimacy – (Roccapriore & Pollock, 2023; Valor et al., 2021; Voronov & Vince, 2012; Zietsma & Toubiana, 2018).

2.1 Data Collection and Sample

Data was collected between December 3rd and 10th, 2024. First, a search using the database EBSCO was led with different search queries per company to identify relevant media articles (Jonsson & Buhr, 2010). In the case of Amazon, the query specified the terms "Return to work" and "Return to office" used for their CEO (Andy Jassy) to discuss the topic. In addition, the names of the Former CEO (Bezos) and CEO of AWS (Garman) were also added to expand the search [(amazon company AND return to work OR return to office) AND (Jassy OR Garman OR Bezos)]. A total of 43 results were found, and after a quick clean, only 34 articles were kept. In the case of Spotify, a first search using the term "Work from Anywhere" which is the term used in their official statements, brought no results. Therefore, a broader search was done, using only the company name and the term "work" [Spotify company AND work]. From 85 articles found, only 10 were selected. In the second stage, a search on each company portal was done. From Amazon, their company news site was searched with the same terms, similarly for Spotify where both their HR blog and company news site were observed. This led to the identification of 8 relevant articles on Amazon's blog (aboutamazon.com), as well as 16 articles on Spotify – 2 on the newsroom (newsroom.spotify.com) and 14 on the HR blog (hrblog.spotify.com). Letters to shareholders as well as sustainability/equity and impact reports from 2020 to 2023 were also collected and analyzed.

2.2 Data Analysis

The analysis focuses on direct communication from both organizations and their executives or spokespeople, as is common in critical discourse analysis (Fairclough, 2013). We follow an inductive approach with constant back and forth over the body of texts, identifying patterns in one organization's discourses and then confronting them with the other organization's discourses, and so on, structured around key questions. The purpose of the analysis is to reveal underlying assumptions and examine relationships between the competing discourses and actors (Fairclough, 2013; Van Dijk, 2013).

3. Findings

We structure our findings in two inter-connected parts: we first present the main answers to key questions around RTO and WFA, highlighting which strategies are used to legitimize RTO or WFA and the logics they support; we then discuss how these logics can be associated with more profound ideologies. We illustrate our findings with quotes from the texts that were analyzed.

3.1 Part #1: Answering key Questions About the Future of Work

In this first part, we present how key questions about the future of work are answered, focusing on the following questions: What supports our vision? Who do we do it for? Why do we do it? What are the key success factors of knowledge work?

3.1.1 What supports our vision?

At a very surface-level, both organizations try to legitimize their decision to adopt a radical vision for the future of work, that of RTO or WFA. It is striking to note that both organizations tend to rely on similar rhetorical strategies to justify their decisions. The analysis helps identify four main types of appeals that are used to answer this question: appeal to logos, appeal to ethos, appeal to authority, and appeal to precedent.

Appeal to logos is widely used by both organizations when they rely on data and evidence to support their policies. The evidence can come in various forms, and different types of numbers or types of evidence coming from the organization itself or from the outside can be relied on. For example, Amazon relies on the partial return to the office to justify the full return to the office: *"If anything, the last 15 months we've been back in the office at least three days a week has strengthened our conviction about the benefits."* (Message from CEO Andy Jassy: Strengthening our culture and teams).

This rhetorical strategy is also used in Spotify's discourse about WFA to detail how WFA supports the growth and hiring of knowledge workers of the organization: *"Roughly half of all new hires in 2021 were hired in a location outside of our main hubs. We wouldn't be able to continue to grow at the pace we are unless we launched WFA allowing us to hire in new markets. In addition we keep exploring entries into new locations."* (The Reality of Working From Anywhere).

Appeal to ethos is also used in some instances by both organizations. Statements tend to refer to a feeling, an observation, or a vision, rather than to rely on solid data to support the implementation of policies. Amazon refers to various beliefs and observations to justify their policy in regard to organizational learning and knowledge sharing: *"When we look back over the last five years, we continue to believe that the advantages of being together in the office are significant. I've previously explained these benefits (February 2023 post), but in summary, we've observed that it's easier for our teammates to learn, model, practice, and strengthen our culture; collaborating, brainstorming, and inventing are simpler and more effective; teaching and learning from one another are more seamless; and, teams tend to be better connected to one another."* (Message from CEO Andy Jassy: Strengthening our culture and teams).

In the same way, Spotify refers to beliefs and things that have been noticed: *"At Spotify, we've noticed that even when DIB is fully integrated into our people strategy and employee behaviors, we can't take our eye away. While it's great being named America's most loved workplace culture by Newsweek, we definitely don't want to get comfortable, we believe that to win the game on talent, this is going to be an important part of our success or failure."* (Community & Belonging In A New Distributed-First Workplace). It is very interesting to note how both organizations refer to an undisclosed "we" in regard to organizational learning, knowledge work and success.

Appeal to authority is used to further justify the policy by relying on specific actors or figures that can help justify – from their legitimate perspectives – the policy. Amazon's discourse mentions consulting employees and talking to other executives: *"S-team listened to employees, watched how our teams performed, talked to leaders at other companies, and got together on several occasions to discuss if and how we should adjust our approach. We spoke to "60 to 80 CEOs of other companies over the last 18 months," and "virtually all of them" preferred in-office work."* (Update from Andy Jassy on return to office plans).

Spotify on their side rather tend to rely on science or academics: *"When building our program we discussed our approach with researchers, read scientific articles as well as met with others who had been on a similar journey to understand what they have learned. We used these insights to make a data-informed decision, meaning we took the learnings and adopted them to our context. We do have many questions though and to help answer them we've turned to Stockholm School of Economics. We'll be conducting a research project with them to further understand the impact of WFA on Energy, Creativity Innovation, Collaboration and Wellbeing."* (The Reality of Working From Anywhere). It is striking to note how both discourses define authority in a different way: whereas Amazon uses managers as a source of authority, Spotify rather uses evidence-based knowledge and research.

Appeal to precedent is also used by both organizations, which both rely on the past to justify the current policy in a form of continuity. Amazon notably emphasizes serendipity in informal meetings and "breakthrough moments" that have happened through the years: *"The energy and riffing on one another's ideas happen more freely, and many of the best Amazon inventions have had their breakthrough moments from people staying behind after a meeting and working through ideas on a whiteboard, or continuing the conversation on the walk back from a meeting, or just popping by a teammate's office later that day with another thought"* (CEO Andy Jassy's 2022 Letter to Shareholders).

Spotify highlights its global nature and how it requires flexibility in terms of workplace location: *"Yet Spotify's leadership team recognized early that in-office work wasn't the only way to achieve company goals. Particularly, the goals of globalization and digitalization necessitated an even more flexible way of working. So becoming "distributed-first," or enabling employees to work from the places that were the most conducive to them, was a logical next step."* (Distributed First Contributes to Spotify's Strength). In both instances, the policy is presented as in line with an organizational vision or strategy, in form of a learning history from the past, with what the organization has been doing or what has made its successes.

3.1.2 Who do we do it for?

Amazon strongly emphasizes their customer-centricity as a supporting logic for RTO. This is identified as some key motive: to serve customers best, and RTO is presented as the way to do it: *"As mentioned earlier, these are unusual times and we're all learning together what we believe is the best way to work together to make customers' lives easier and better every day. And with it being so early in our mission, with lots of invention and change in front of us, you can bet that we will continue to adjust as we keep learning what makes most sense for our customers and teams."* (Amazon offering teams more flexibility as we return to office).

Spotify on its side strongly put the emphasis on knowledge workers, emphasizing how WFA helps attract talent and increase its diversity, but also how it helps retain talent on the longer run by giving more options to employees: *""Our people are our most important asset and it's crucial that we provide the best possible conditions for them to be productive, stay healthy, and feel connected to the company—and, let's not forget—to have fun!" says Mattias. "Our workplace plays an important role in attracting and retaining top-talent to make sure the company continues to develop in a positive way.""* (Distributed First Contributes to Spotify's Strength).

3.1.3 Why do we do it?

Both organizations' discourses on RTO or WFA can be associated with different knowledge work and organizational learning logics. Amazon emphasizes a goal of knowledge work, organizational learning and integration: *"Learning from one another is easier in-person. Being able to walk a few feet to somebody's space and ask them how to do something or how they've handled a particular situation is much easier than Chiming or Slacking them. Even though people can use the instant message function, people just don't do it frequently. This apprenticeship and learning model has been the primary reason a lot of companies who've returned to the office have done so. We have a lot of functions and roles where learning from peers is very useful and critical. And, our newer employees, especially those who have joined us in the past few years, stand to be most disadvantaged by not having the learning and mentorship opportunities from peers that many of us who joined much earlier had."* (Update from Andy Jassy on return to office plans).

Spotify on its side rather emphasizes its objective of knowledge work, talent attraction and retention: *""We believe that work isn't something you come to the office for, it's something you do" is a philosophy long held by Katarina Berg, Spotify's Chief HR Officer. "Giving people freedom to choose where they work will make great people more effective, and this flexibility will better support work-family balance, ultimately helping to attract and retain talent.""* (Distributed First Contributes to Spotify's Strength). The policies are thus framed as a mean to an end, as something that will help the company perform (by achieving innovation or creativity), and create an added value to its knowledge workers. The overall goal is similar, but how this goal should be reached is strongly different.

3.1.4 What are the key success factors of knowledge work?

The discourses also highlight the importance of the knowledge workers in the success of RTO or WFA, but their roles is framed in very different ways. Amazon highlights the need to put knowledge workers in the best environment (through RTO) to make them work better and ultimately make the company more successful:

"We've become convinced that collaborating and inventing is easier and more effective when we're working together and learning from one another in person." (CEO Andy Jassy's 2022 Letter to Shareholders).

Spotify rather puts the emphasis on knowledge workers empowerment (through WFA) and trust-based leadership to make them choose what is right for them and ultimately make the company more successful*: "Moving into a distributed world with flexibility for your people requires a trust-based leadership, vs a control-based leadership. You have to ditch your traditional metrics based on an employee's input, such as when employees arrive or leave the office, the number of hours they spend in the office, the number of sales meetings they attend. Instead, you need to focus wholeheartedly on your employees' output, such as what impact they have on your mission."* (Work From (M)anywhere). Creativity is left out in the hands of knowledge workers who have to put themselves in the best conditions for it to happen. Knowledge workers are thus presented as having a critical role in reaching the end goal of organizational performance, but the policies are based on a whole different premise regarding the knowledge workers contribution and how they are trusted or controlled in the process.

Meetings and technology further crystallize this opposition. Amazon tends to defend a work ethic that relies heavily on meetings and informal communication: *"When you're in-person, people tend to be more engaged, observant, and attuned to what's happening in the meetings and the cultural clues being communicated. For those unsure about why something happened or somebody reacted a certain way, it's easier to ask ad-hoc questions on the way to lunch, in the elevator, or the hallway; whereas when you're at home, you're less likely to do so."* (Update from Andy Jassy on return to office plans).

Spotify rather defends a work ethic that challenges the need for meetings: *"To remain productive and support Spotifers' wellbeing, we need to ensure that meetings help, not hinder productivity. We will be more cognisant about the purpose of meetings and ask ourselves how we can continue to work across distributed time zones without just relying on meetings to move projects forward."* (Our Ways of Working Survey Results: Listening, learning and Leaping Forward).

On the topic of technology, Amazon tends to adopt a somehow critical discourse about technology, framing it as a hindering factor: *"This rapid interjecting happens more often in-person because people feel less inhibited about jumping in or even interrupting sometimes. This interjecting happens less frequently in virtual calls because it blocks out all speakers when it transpires. Also, teams working on new ideas often find that a whiteboard enhances the group understanding and iterating."* (Update from Andy Jassy on return to office plans).

Spotify rather presents technology has a helping factor: *"This is probably one of the most challenging areas for HR teams around the world today, but with the advancement of technologies, we are lucky enough to have an array of tools and supporting systems for all our needs and purposes."* (Creating Connectivity in a Distributed Workforce).

Finally, another key success factor that appears in both discourses is that of knowledge work itself, and how it should be performed. Here again, both organizations' discourses present very different perspectives on the topic of knowledge work. Amazon's discourse presents a vision of knowledge work that is done together and simultaneously: *"It's also easier for leaders to teach when they have more people in a room at one time, can better assess whether the team is digesting the information as intended; and if not, how they need to adjust their communication."* (Update from Andy Jassy on return to office plans). In this perspective, RTO is critical to ensure successful knowledge work.

Spotify discourse rather emphasizes a vision of knowledge work that is distributed and done asynchronously: *"Within that, we defaulted to asynchronous work to reduce the dependency on team members being in the same time zone or physical location. Flexing this async muscle has provided us with valuable insights and experiences. To be specific, asynchronous work is advantageous for numerous reasons: deep focus work, decreased reliance on meetings to get things done, flexibility, to name a few."* (Work From Anywhere: An Evolution). In this perspective, WFA is critical to ensure successful knowledge work.

3.1.5 Part #2: Underlying logics

In this second part, we discuss how the key questions about the future of work presented above might be associated with more profound logics that may clash. More specifically, the analysis highlights three key dilemmas at the root of the RTO versus WFA debate, on the topics of organizational focus, knowledge work transformation, and knowledge management approach.

3.1.6 Organizational focus

Organizational focus has been discussed in the "Who do we do it for?" question, and the opposition between the customer-centric approach of Amazon and the employee-centric approach of Spotify is striking. This dilemma is rooted in two very different logics about the focus of organizations. Amazon's perspective is in line with the logic of "the customer is king", which puts the customer as the main priority (e.g., *"Our thinking is predicated on what we believe will be most beneficial for customers"* – Amazon updates return-to-office guidance) – everything else holding less importance.

Spotify's perspective is in line with the logic of the service-profit chain which puts the employee as the main priority (e.g., *"Our people are our most important asset"* – Distributed First Contributes to Spotify's Strength), as the starting point of the value chain. In that approach, the premise is that satisfied employees will perform better and lead to more satisfied customers.

3.1.7 Knowledge work transformation

Amazon presents Covid as an interruption, a challenge that has disrupted the traditional ways of doing knowledge work before: "During the pandemic, our employees rallied to get work done from home and did everything possible to keep up with the unexpected circumstances that presented themselves. It was impressive and I'm proud of the way our collective team came together to overcome unprecedented challenges for our customers, communities, and business. But, we don't think it's the best long-term approach." (CEO Andy Jassy's 2022 Letter to Shareholders). This seems to rather be rooted in a logic the future is the past, i.e., that things should go back to as they were before Covid.

Spotify tends to present Covid-19 as an opportunity to change things for good and get more radical about their workplace location approach: "The future of how we work has been a popular topic inside the walls of Spotify for a while now. Our leadership team has long championed the idea that digitalization and globalization are massive drivers for a more flexible workplace that better suits both our band and our business. Needless to say, the events of the last year accelerated this thinking—and there's no better time than now to transition into a distributed-first model—a workplace that isn't built on the premise that employees need to gather in an office with traditional desk setups." (Distributed-First Is the Future of Work at Spotify). This seems to rather be rooted in a logic that the future is different, i.e., that companies should embrace distributed knowledge work.

3.1.8 Knowledge management approach

The dilemma on knowledge management approach can be summarized in opposed logics of control versus trust. Amazon discourse highlights some traditional views about knowledge management and how leaders should lead and overview their teams: *"It's also easier for leaders to teach when they have more people in a room at one time, can better assess whether the team is digesting the information as intended; and if not, how they need to adjust their communication."* (Update from Andy Jassy on return to office plans). This can be associated with a logic of control-based traditional knowledge management, in which the organization more directly prescribes what employees should be doing and how, as well as closely monitors their behavior.

Spotify on its side clearly emphasizes the importance of trust: *"Moving into a distributed world with flexibility for your people requires a trust-based leadership, vs a control-based leadership. You have to ditch your traditional metrics based on an employee's input, such as when employees arrive or leave the office, the number of hours they spend in the office, the number of sales meetings they attend. Instead, you need to focus wholeheartedly on your employees' output, such as what impact they have on your mission."* (Work From (M)anywhere). This can be tied with the previous point on knowledge work transformation, in which Spotify's logic of a different future can be associated with a trust-based future.

4. Discussion

This paper aimed to understand how discourses about knowledge management and workplace location may co-exist in a discursive arena and how they may be competing in a discursive legitimation process. The discursive analysis of official communication from Amazon and Spotify highlights some similarities and differences in how the discourses are built and the foundations that support these discourses.

More specifically, it is interesting to note that similar rhetorical strategies are used to legitimize diametrically opposed knowledge management approaches and workplace location policies, both organizations using the same types of appeals. In their discursive legitimation process, both companies thus seem to be relying on the same type of "weapons" to convince their audience of the appropriateness of their change initiatives. In

comparison with previous research on Aristotelian rhetoric, our analysis did not find a strong emphasis on pathos (Roccapriore & Pollock, 2023; Valor et al., 2021; Voronov & Vince, 2012; Zietsma & Toubiana, 2018) but still found both categories of logos and ethos as well represented in both organizations' narratives (Brown et al., 2012; Green, 2004). As with Vaara's work (2014), this research suggests that other strategies (beyond the three classical ones) can be used by organizations.

Although marked by many similarities in the points that they focus on or on the rhetorical strategies that they use, both competing discourses seem to be marked by very distinct logics about knowledge work and its future. The analysis identifies three main logics of organizational focus, work transformation, and knowledge management approach, that are – to an extent – correlated and are suggesting different foundations or ideological assumptions to legitimize RTO or WFA. Previous work has identified different forms of ideologies mobilized to legitimize organizational practices (Vaara et al., 2006; Vaara, 2014). The findings from this work on their hand seem to be more rooted in ideologies about knowledge management, organizational learning, leadership, and on the opposition between control and trust, past and future (REF). The debate on RTO versus WFA seems thus to be more than a discussion about workplace location, but rather competing ideologies about the future of work, looking to innovate institutionally (Deephouse et al., 2017) or to "deinstitutionalize" (Brown et al., 2012; Maguire & Hardy, 2009). As legitimacy depends on the "generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995, p. 574), the final judge of the legitimation attempts of RTO or WFA is likely to bet the relevantaudience (knowledge workers).

5. Conclusion

This work investigates the discursive legitimation of two competing discourses about knowledge work and workplace location, that of RTO mandates by Amazon and WFA initiatives by Spotify. Data consists of media articles and corporate communication coming from both Amazon and Spotify. The critical discursive analysis highlights that Amazon and Spotify's discourses about knowledge work and workplace location share some similarities and differences. This research offers new insights into discursive legitimation by analyzing a specific situation of competing discourses and how they are built and feed off of each other. It also uncovers how some specific points of contention crystalize the discursive legitimation on key topics, and how the way these points of contention are addressed can help uncover different ideologies that can explain why organizations decide to implement one policy or another in the first place.

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Rethinking Strategic Thinking Through the Lens of Strategic Coherence

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Abstract: In light of the rapidly evolving complexities in strategic management and organizational behaviour, the aim of this research is to explore the conceptualization of strategic thinking in the context of innovative developments that have occurred in the research field over the past decades. This study is a follow-up upon the findings of a bibliometric analysis of publications between 1962 and 2024 obtained from the Scopus database and conducted to investigate shifts and trends in the research landscape of strategic thinking. Key conceptual shifts were identified through a co-occurrence analysis with a minimum threshold of 3. The study was also complemented with a qualitative analysis that offered a richer exploration of strategic thinking as a multidimensional construct. The research indicates that strategic thinking is no longer the sole purview of the C-suite but rather is being pushed down throughout the organization. Within this paper, four key dimensions of strategic thinking were identified: (1) analytical reasoning, (2) systems thinking, (3) strategic intuition, and (4) creativity – each critical to decision-making under uncertainty. Beyond mapping these dimensions, we demonstrate how they interact to produce strategic coherence – defined as the mutually compatible configuration of meanings, choices, and resource deployments that shape long-term advantage. The research also explains how digital transformation and AI-based decision augmentation transformed strategic thinking from a rigid, top-down function to a dynamic, distributed, and ecosystem-centric model. An outcome of this is that strategic decision-making has become more dynamic, with employees at all tiers now expected to engage in strategic thinking. Drawing on these insights, along with an analysis of the strategic choices laying ahead, the paper outlines an alternative understanding of strategic thinking that takes into consideration both real-world and technological dimensions of it. This refinement in conceptualization enhances literature in strategic management and organizational psychology by showing that leaders must strengthen their muscle of strategic agility, digital literacy, and navigating uncertainty in pluralistic business ecosystems. The paper closes by outlining leadership-development, strategic-learning, and policy implications that flow from a strategically coherent mindset.

Keywords: Strategic coherence, Strategic learning, Strategic thinking, Leadership, Digital transformation, Strategic learning

1. Introduction

In today's fast-paced business environment – characterized by extensive digital transformation, the widespread adoption of artificial intelligence, and, as a result, the growing complexity of interactions among ecosystem actors (Verhoef et al., 2021; Nambisan et al., 2019; Hess et al., 2016) – the substantive content of the concept of strategic thinking has undergone significant change. Traditionally, strategic thinking was often equated with strategic analysis and planning, assumed to be the exclusive purview of senior management (Mintzberg, 1994; Hambrick & Mason, 1984). However, the rise of the platform economy has challenged this conventional understanding, redirecting researchers' attention to a new set of factors that substantially reshape the field of study and underscore the need for a revised conceptualization of strategic thinking. Moreover, an expanding body of work investigates how variables previously left outside the boundaries of strategic models – such as personality traits – affect strategic choices (e.g., Grüning & Krueger, 2024; Shirokova et al., 2024; Carré et al., 2020).

At present, a paradox has emerged: on the one hand, there is a clear trend toward "fragmenting" strategic thinking into specialized domains (business, politics, ESG strategies, etc.). On the other hand, both scholars and practitioners continue to demand a universal conceptual foundation (Bonn, 2001; Goldman, Scott, & Follman, 2015) that allows for adapting strategic thinking and the approaches to teaching this core 21st-century meta-skill (Liedtka, 1998a) to the realities of a changing environment (Aksiutin et al., 2022; Bagrationi & Thurner, 2023; Bagrationi et al., 2022). This tension mirrors the classic exploration vs. exploitation dilemma and underlines the need for strategic coherence that dynamically balances vertical and horizontal fit (Mielcarek, 2023).

How has the research landscape of strategic thinking evolved over the past decades? Answering this question will bridge certain gaps in the scholarly debate on the essence and boundaries of strategic thinking by reconstructing it as a multi-dimensional, dynamically developing concept that underpins the long-term competitiveness of organizations (Rumelt, 2012; Child, 1997). In this article, the authors aim to address this question by conducting a comprehensive analysis of the body of research devoted to strategic thinking.

2. Methodology

To ensure a thorough exploration of the body of literature on strategic thinking, the study employed both (1) a quantitative assessment of the significance of individual keywords and their interconnections, and (2) an in-depth qualitative analysis of academic publications.

To form the research sample, bibliometric data on the entire corpus of articles indexed in the Scopus database for the period from 1962 to 2024 were retrieved. These articles were published in the categories Business, Management and Accounting, Sociology, and Psychology, and contained the keyword strategic thinking.

As our primary tool, we chose co-occurrence (frequency) analysis, which helps identify relationships among keywords and topics in the scholarly literature. This approach was selected for three main reasons: (1) it offers a promising way to detect both well-established and emerging directions within the field; (2) it ensures objectivity (Mingers & Leydesdorff, 2015); and (3) it can track shifts in the research landscape and highlight new dimensions and trends that may have arisen in recent decades.

The minimum co-occurrence threshold was set at 3, which made it possible to identify even rare but meaningful connections between terms. This decision was driven by the fact that the need to revisit existing paradigms and identify new aspects has been emphasized since the 1990s (e.g., Prahalad & Hamel, 1994). Presumably, the semantic field of strategic thinking has undergone a renaissance in recent decades. This allowed us to reduce the dimensionality significantly, cutting the number of keywords from 6,149 to 633 (see Figure 1.).

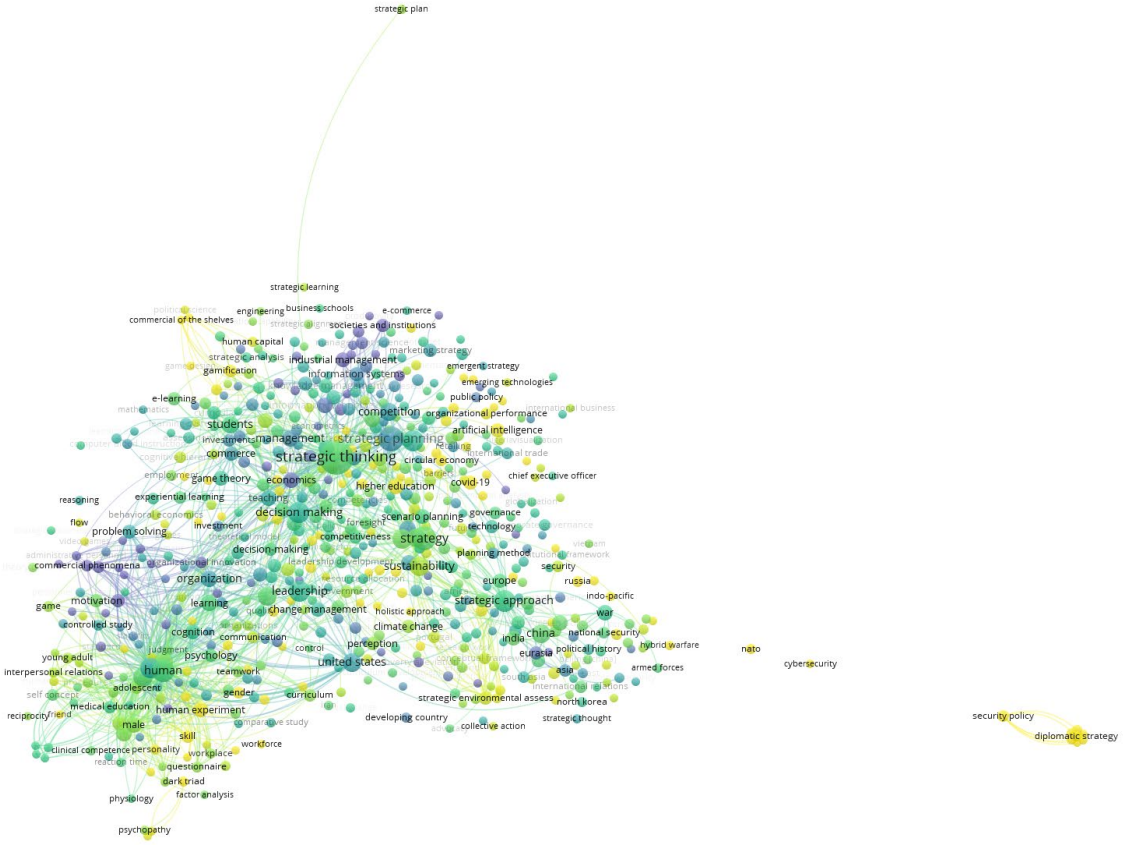


Figure 1: Results of the co-citation analysis, visualized with VosViewer

However, many of the extracted keywords related to strategic thinking still contained a substantial amount of "informational noise." To focus on truly significant aspects of the topic and eliminate noise, we excluded the following categories of keywords:

- non-informative general terms (e.g., human, article) and those too broad or overly generic relative to the studied concept (e.g., business, business strategy);

- geographic references, including city names (Beijing [China]), country names (Finland, Ireland), regions (Indo-Pacific, Europe), as well as political and military alliances (European Union, NATO);
- political and military terminology (democracy, diplomatic tactics, etc.);
- keywords related to the COVID-19 pandemic (covid-19, pandemic, etc.);
- keywords describing the development of specific strategies in various domains (sustainable development goal, supply chain management, etc.).

As a result, the number of keywords was reduced to 367 (see Figure 2.)

Figure 2: The tag cloud was generated using the 367 resulting keywords, sized according to their importance. Terms with higher scores are rendered larger.



The authors acknowledges that certain insights found in publications on military and political topics or sustainability strategies will not be included in this study and considers this to be a limitation of the research. However, this approach was chosen deliberately: the study focuses on universal aspects of strategic thinking in business, the transformation of strategic thinking approaches due to the emergence of new technologies (hence the retention of terms such as artificial intelligence), and the challenges of teaching strategic thinking and other meta-skills (see (Zinchenko et al., 2024) and (Gordienko & Bagrationi, 2024)), rather than industry-specific or military-political strategies. At the same time, studies where keywords directly pertain to the subject of inquiry are still represented in the research field. However, works that do not meet the developed inclusion criteria (e.g., those focusing on military strategy) were excluded from further analysis.

Before calculating the importance of each keyword, all indicators were normalized to account for their values relative to one another. To determine keyword significance, an integral metric was used, taking into account citation frequency, link strength, and citation impact (Ding et al., 2014; van Eck & Waltman, 2010; Newman, 2004). This resulted in a final pool of 367 keywords. To minimise construct-validity threats, we triangulated keyword statistics with qualitative coding of seminal studies on strategic coherence, ambidexterity, and dynamic capabilities (Nath & Sudharshan, 1994; Teece, 2007).

3. Findings and Discussion

In the 21st century, strategic thinking is no longer a linear, hierarchical process but rather a dynamic, integrative capability that combines logical analysis, systemic perspective, intuitive judgment, and creative problem-solving. Organizations that cultivate cognitive diversity and empower employees at all levels to engage in strategic thinking will be better equipped to navigate complexity and achieve sustainable competitive advantage (Rumelt, 2011). We further show that cultivating individual-level strategic thinking is insufficient unless complemented by organisation-level mechanisms (e.g., routines for sensing, seizing, and re-configuring) that generate a specific form of dynamic capabilities – strategic coherence.

3.1 The Changing Role of Strategic Thinking due to Technological and Organizational Shifts

Historically, strategic thinking was considered an exclusive function of senior executives, who formulated long-term plans and cascaded them down the hierarchy (Mintzberg, 1994). However, the increasing complexity of digital ecosystems and market volatility have eroded the effectiveness of centralized strategy-making, giving rise to more decentralized and adaptive approaches (Teece et al., 2016): strategic thinking is no longer confined to top executives. Digital transformation, shifting organizational structures, and the rise of platform economies have fundamentally altered the nature of strategic decision-making (Nambisan et al., 2019; Verhoef et al., 2021). Two key trends stand out: (1) the decentralization of strategic thinking – where employees at all levels are expected to engage in strategic decision-making–and (2) the evolving competencies required of leaders in the face of digital disruption and rapid market shifts. A third, often overlooked, trend is the rise of enabling leadership practices that weave together bottom-up initiatives and top-down intent to sustain coherence (Lusiani & Langley, 2018)

Organizations operating in platform-based business models (e.g., Amazon, Google, Uber) require decentralized strategic decision-making, where employees, partners, and even customers contribute to shaping strategy in real time (Gawer, 2014). Studies on self-organizing teams highlight how distributed strategic thinking fosters agility and responsiveness in uncertain environments (Felin & Powell, 2016). For instance, employees are increasingly empowered to act as internal entrepreneurs, making strategic decisions about product development, market expansion, and operational efficiencies (Kuratko et al., 2021). The use of real-time analytics, AI-driven insights, and decision-support systems allows mid- and lower-level employees to make strategic choices traditionally reserved for senior management (Shrestha et al., 2019). Companies leverage open innovation ecosystems, where external stakeholders – customers, developers, and research institutions – actively contribute to strategic innovation (Chesbrough, 2010). These developments align with complexity theory, which suggests that organizations function as adaptive systems, where decision-making authority needs to be distributed for the system to remain resilient in turbulent environments (Dooley, 1997).

Advancements in AI, big data analytics, and automation have further enabled decentralized strategic thinking (Brynjolfsson & McAfee, 2017). AI-powered decision augmentation tools assist employees by providing predictive insights, scenario simulations, and risk assessments, allowing them to engage in real-time strategy formulation (Davenport & Ronanki, 2018). For example, AI-driven decision-making is transforming marketing strategy, supply chain optimization and strategic HR planning: AI-driven customer segmentation allows frontline marketing teams to adjust branding strategies dynamically, rather than waiting for centralized directives (Wedel & Kannan, 2016), while predictive analytics empower mid-level managers to reconfigure supply chains in response to external shocks such as geopolitical instability or raw material shortages (Ivanov et al., 2019), whereas AI-based workforce analytics help HR teams anticipate skill gaps and workforce trends, aligning recruitment and training initiatives with long-term strategic goals (Chattopadhyay et al., 2023). The implications of these technological advances are profound: decision-making is no longer confined to C-suite executives but is increasingly democratized across all levels of the organization (Nambisan et al., 2019).

3.2 Strategic Coherence as a Future Research Avenue

The bibliometric map (Table 1) reveals that dynamic capabilities and strategic management cluster closely with one another: Over the past three decades, research in strategic management has evolved from static "structure-strategy-performance" models to process-oriented approaches that place dynamic capabilities at the center (Teece, 2007). Building on Teece's (2007) sensing-seizing-reconfiguring framework, scholars should explore how individual-level strategic-thinking skills (e.g., analytical reasoning, systems thinking, intuition, creativity) aggregate into routines that enact vertical and horizontal coherence. Multi-level designs – linking cognitive micro-processes to firm-level outcomes – are particularly fertile. Strategic coherence is not a static end-state but a "dynamic balance" (Mielcarek, 2023) that oscillates as firms pivot between exploration and exploitation. Lusiani and Langley (2018) show that enabling leadership – the practice bundle of fueling, shaping, and entwining – binds top-down intent with bottom-up initiatives. Future work could test how such mechanisms moderate the coherence-performance link in settings characterized by pluralistic logics (e.g., healthcare, platform ecosystems). As AI-driven decision augmentation diffuses, algorithms increasingly participate in strategy formulation. Researchers should examine how human-AI complementarity affects the construction and maintenance of strategic coherence. Coherence may enable, constrain, or coexist with organizational ambidexterity. Future research could uncover boundary conditions under which high coherence supports simultaneous exploration and exploitation.

4. Conclusion

The paper contributes to the growing body of research on strategic thinking by challenging traditional assumptions and proposing a more holistic and adaptive model that reflects the realities of modern, technology-driven organizations. Specifically, we argue that strategic coherence is the missing integrator that links dispersed strategic-thinking capabilities to firm-level performance outcomes. It is built upon the following ideas: (1) strategic thinking is no longer a linear, rational process but an integrative cognitive capability – requiring a balance between analytical rigor, systems thinking, intuitive decision-making, and creativity (Dane & Pratt, 2007; Kahneman, 2011); (2) strategic decision-making is increasingly decentralized – enabled by AI, big data, and open innovation networks, allowing employees at all levels to contribute to strategic processes (Nambisan et al., 2019); (3) leadership competencies are shifting – future-ready leaders must develop strategic agility, digital literacy, and the ability to manage uncertainty in complex ecosystems (Westerman et al., 2014).

Traditionally, upper echelons theory (Hambrick & Mason, 1984) emphasized how top executives' personality traits, motivations, identities, and values set the stage for strategic intent (Zhang & Sternberg, 2005; Armstrong & Hird, 2009). With the emergence of platform economies and digital ecosystems (Verhoef et al., 2021; Nambisan, Wright, & Feldman, 2019), however, strategic thinking is no longer an exclusive leadership skill. Today, every employee can act as an independent agent – a sort of entrepreneur – seeking to maximize personal earnings and professional growth. Hence, each employee is both "gifted" and "limited" by their individual traits in how they develop strategic-thinking capabilities. Yet employees can learn to think strategically, albeit with varying degrees of success.

With the shift to digital ecosystems, strategic thinking becomes integral to the day-to-day responsibilities of everyone in the organization – even temporary contractors such as freelancers – because they, too, must focus on strategic thinking to stay competitive in a world of high uncertainty. Moreover, the integration of AI and analytics platforms has paved the way for human – AI partnerships, wherein AI handles routine tasks and the human counterpart is responsible for strategic interpretation and goal setting (Hess et al., 2016; Nambisan et al., 2019). A key driver of long-term organizational competitiveness in this context – achieved through strategic learning principles – is the company's attention to developing employees' meta-skills, especially strategic thinking (Liedtka, 1998a; Goldman, Scott, & Follman, 2015; Edmondson, 2018; Harvey et al., 2022).

The strategic process is best described as a synthetic form of thinking that integrates its analytical (Mintzberg, 1987), creative (Shalley et al., 2004), systemic (Senge, 1990), and intuitive (Dane & Pratt, 2007) dimensions. As the pace and intensity of change continue to accelerate (Bagrationi, 2023; Bagrationi et al., 2021), intuition and creativity play an increasingly prominent role in strategic decision-making (Khatri & Ng, 2000; Shalley et al., 2004). In practical terms, an analytical approach must be augmented by creative and intuitive elements that make it possible to arrive at nontrivial solutions (Sadler-Smith & Shefy, 2004). Drawing on the key trends that define today's research landscape, we propose the following updated conceptualization: Strategic thinking is a hypothesis-driven, creative, intuitive–analytical process for generating long-term goals and strategic tasks (along with solutions for achieving them). It aims to build a systemic vision of the future and to continually reinterpret (based on new inputs) the goals and tasks that arise from the interplay of internal (psychological) and external (situational) factors that shape an organization or an individual's behaviour.

Providing a conceptual framework that integrates cognitive and technological dimensions of strategic thinking, the analysis shows that the concept of strategic thinking is currently undergoing a paradigm shift. As AI and digital platforms continue to evolve, the question is no longer whether strategic thinking must change – but how organizations can best adapt to this transformation: presumably, organizations that embrace decentralized decision-making will be better positioned to navigate uncertainty, drive innovation, and sustain long-term competitiveness.

The research has several limitations. First, the bibliometric corpus is restricted to Scopus indexing and English-language publications; seminal non-English works may be under-represented. Second, our keyword-filtering rules excluded military, political, and COVID-19-related strategy studies, narrowing external validity. Finally, while we adopt a dynamic-capabilities lens, other theoretical frames were not systematically examined.

Ethical declarations: Ethical clearance was not required for the research

AI declaration: AI (ChatGPT o1) was used to enhance language quality

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A Conceptual Framework for City Learning to Drive City Transformations Utilising Contextual Knowledge Management: Insights from Theory and Practice

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Abstract: Cities of the future have been described as smart, socially innovative, people and community-driven, shaping collaborative ecosystems for learning and innovation. Cities are complex socio-technical ecosystems described as large-scale organisations. A city's or an organisation's knowledge can be transferred through collaborative processes involving relevant actors. City transformations through sustainable, citizen-centric development and innovation of cities require understanding cities as collaborative learning and innovation ecosystems aligned with societal needs that are often supported by technology. It calls for new and innovative ideas in knowledge management to address both organisations and cities. Building on theoretical work that conceptualises cities as learning and innovation ecosystems, this study proposes a conceptual framework for city learning. The framework includes a high-level ecosystem model and maps key elements/processes, illustrating interactions that can drive city learning. Through case studies of two European neighbourhood development projects complemented by an expert interview, we gain insights into utilising contextual knowledge management in city learning through multi-stakeholder interactions. The elements of a city include actors such as government and administrative bodies, citizens, private business institutions, funding bodies, and community groups, alongside the natural, built and technical environments. Elements assuming the role of facilitators emerged as catalysts in fostering collaboration and contextual innovation through knowledge exchange, while limited citizen participation and funding constraints remain challenges. The study reveals that trust among stakeholders and political vision can decisively influence learning outcomes in cities, highlighting the context-dependent nature of learning in cities. This study's main contribution is a framework for city learning to drive sustainable city transformations utilising contextual knowledge management.

Keywords: City learning, City ecosystem, Knowledge creation, Case study, Conceptual framework

1. Introduction

Cities are complex socio-technical ecosystems described as large-scale organisations (Mayangsari and Novani, 2015; Papageorgiou and Demetriou, 2020). City administrations, public organisations, and service providers need to evolve to better meet citizen needs and increase engagement. The need to become more agile and dynamic through constant innovation is increasing. At the same time, the move to become smarter and sustainable in a citizen-centric manner remains of utmost interest. Smart cities aim to achieve sustainability through the use of technology (Ahvenniemi *et al.*, 2017), and associate smartness with the ability to gather and analyse data to provide value-added services to its citizens. Another body of literature that talks about smart cities proposes a people-centric approach in addition to technology and highlights the role of human capital (Giffinger *et al.*, 2007; Ahvenniemi *et al.*, 2017).

Cities have been discussed in the context of the knowledge economy, and the fact that cities need to foster environments where knowledge resources are valued and securely anchored was discussed already in the 1990s (Knight, 1995). Furthermore, a knowledge-based approach to city planning continues to be of interest to many authors, e.g., (Yigitcanlar, 2010). Cities of the future have been described as smart, socially innovative, with innovation driven by people and communities, shaping collaborative urban ecosystems for innovation (Mora *et al.*, 2023; Romanelli, Fierro and Oppedisano, 2024). Cities have also been described as evolving ecosystems, collaborative networks, and as learning and innovation ecosystems (Concilio *et al.*, 2016). City knowledge, like institutional knowledge, can be transferred via collaboration among actors, adapting contextual knowledge from interactions (Nonaka, Takeuchi and Umemoto, 1996). Learning in cities can occur at individual, group, and organisational levels (Petersen, Concilio and Oliveira, 2015).

These emerging trends call for a new understanding of the organisational dynamics of a city as a learning and innovation ecosystem. While cities have been referred to as ecosystems, e.g., (Krueger *et al.*, 2022), there is limited literature describing a city ecosystem. Furthermore, the emerging trends call for new and innovative ideas in knowledge management (KM), to address both organisations and cities. The main research question addressed in this paper is: How can we describe a city as a learning and innovation ecosystem that shares and creates knowledge for city transformations? This study provides a conceptual framework for describing and

understanding city learning, considering a city as an innovation ecosystem, where knowledge sharing and creation are central aspects of the evolution of a city. This conceptual framework is the outcome of a literature review and case studies that complemented and validated the theoretical insights with practical insights. The main contribution of this work is a city learning framework supporting contextualised learning, knowledge creation/sharing and learning from past experiences in a collaborative manner.

The rest of this paper is organised as follows: Section 2 provides the theoretical background; Section 3 describes the research methodology; Sections 4 and 5 present the case descriptions and results of the case studies, respectively. Sections 6 and 7, respectively, present a conceptual framework for city learning to drive city transformations and a discussion of the results in relation to KM concepts. Section 8 concludes the paper.

2. Theoretical Background

A city as an ecosystem functions as a large organisational entity (Mayangsari and Novani, 2015; Papageorgiou and Demetriou, 2020), where interactions among internal and external elements at individual, group, or organisational levels shape its emergent behaviour. The literature suggests that a city ecosystem consists of both internal and external elements. Internal elements include the human-driven environment, technological systems, and the natural environment, while external elements comprise other city ecosystems or networks. The human-driven environment acts as the driving force of a city ecosystem, responsible for initiating, designing and implementing city transformations. It consists of key stakeholders actively shaping and transforming a city. Technological systems, on the other hand, facilitate communication, enable knowledge transfer within the human-driven environment and support data collection and analysis related to service systems and the natural environment through sensing mechanisms (Bibri, 2018; Bouzguenda, Alalouch and Fava, 2019). Banerjee and Petersen (2023a) on this perspective, with the concept of 'city learning,' wherein a city-ecosystem can learn and adapt through interactions between its internal and external elements for city transformations, ensuring contextually relevant, sustainable, citizen-centric innovations and development. Banerjee and Petersen (2023b) identifies the following core elements and processes that can drive city learning:

- Key city elements: Individuals, Groups of individuals and institutions, Government, institutions, Academic and research institutions, Private organisations and industries, Other cities, Technology, Natural environment.
- Processes crucial for city innovations through learning: Planning innovations with leadership; motivating and involving citizens; ensuring engagement and empowerment; collecting and sharing information; sharing ideas and codesigning; providing feedback; and reflecting on experiences and available contextual information.

A city's human-driven environment involves collaboration and knowledge transfer via interactions between individuals, institutions (academic/business), and government/administration. The processes of collaboration have been highlighted by Preece, (2017), McKenna, (2021) as crucial processes for driving city innovations through learning. These interactions between the elements of the human-driven environment of a city also reflect the social dimension of a city ecosystem. The study by de Oliveira (2016) shows that techno-centric, top-down city innovation approaches miss citizens' contextual opportunities, requirements, and challenges. Ensuring citizen participation, motivation, and engagement have been mandated as essential for empowering citizens and driving citizen-centric transformations through learning from their interactions, ideas, knowledge, experiences and reflective analyses and feedback. Consideration of natural environments has been marked as crucial for the sustainable innovation and development of cities (Spinosa and Costa, 2020). The study has argued that the human-driven environment (society at large) and technological systems influence the natural environment, which evolves reactively and, in turn, impacts them. These impacts lead to contextual opportunities, requirements, and challenges of a city ecosystem shaping innovation pathways. Hence, consideration of these environmental impacts has been put forth as essential for ensuring environmental sustainability while developing cities. Based on the analysis of the literature, three themes central to sustainable citizen-centric city development emerge: collaboration, citizen-centric innovation and sustainability.

3. Research Methodology

A multi-method qualitative research approach was used in this study to obtain insights from both theory and practice. First, a literature review was conducted to obtain an overview of the research that has been conducted in describing cities as learning and innovation ecosystems. This resulted in the identification of a conceptual model of a city ecosystem view and mapping of processes and elements in a city that can drive city learning, described in detail in Banerjee and Petersen (2024). To validate whether this model and the corresponding

interrelationships reflect real-world city or city neighbourhood (hereafter referred to as neighbourhood) perceptions, case studies were conducted. The results from the case studies were further enriched by an expert interview. The analyses of the data that were gathered from these methods are presented as a conceptual framework for understanding the city ecosystem view that can drive city learning for contextual knowledge exchange and creation for city transformations.

Theory-driven case studies (Ridder, 2017) can validate theories (Yin, 2017), enhance literature review findings, and build explanations (Yin, 2014). The case studies of two European neighbourhood development projects aim to answer the following questions: What elements, processes and aspects of learning have been considered essential in the neighbourhood development cases for sustainable citizen-centric transformations?

The overview of the steps followed as per the case study process (Yin, 2017) are shown in Figure 1 as follows: I) designing the study, II) preparing for data collection, III) collecting the data, and IV) analysing the data.

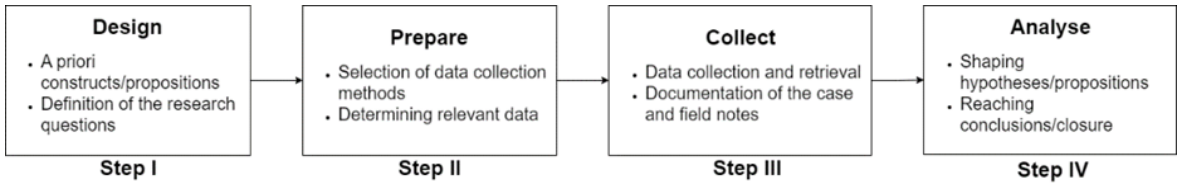


Figure 1: Overview of the case study process

The two cases were selected based on the criteria that they were a city or a neighbourhood development project that highlights a city's underlying elements and processes required for its sustainable citizen-centric development, encompassing the key themes (as described in Section 2) of collaboration, citizen-centric innovation and sustainability. The data was gathered through analysing available documents such as the project's websites, reports and deliverables. Furthermore, a semi-structured interview was conducted with 1-2 people from each project, who had a good overview of their corresponding projects. An expert interview was also conducted to obtain a richer insight into the data obtained from the case studies and to validate whether the findings from the literature were aligned with practice. The expert has experience from several European smart city and neighbourhood innovation and development projects and was selected based on relevant research publications. Qualitative data analysis methods, e.g. thematic analysis (Braun and Clarke, 2006; Wæraas, 2022), were used to analyse the documents and interview data.

4. Case Descriptions

The cases are part of two projects funded by the European Union (EU) and aim to develop climate-positive circular communities and sustainable neighbourhoods. The cases are the neighbourhood development demo case in Gewin Gnice, Salzburg, Austria (hereafter referred to as the Austrian neighbourhood) of the Syn.ikia project (syn.ikia, 2024), and the neighbourhood development demo case Llevant Innovation District, Palma de Mallorca, Spain (hereafter referred to as the Spanish neighbourhood) of the ARV project (ARV, 2024). Both cases focus on transformations in the services providing energy in their respective neighbourhoods. However, their final outcomes are different. The Austrian neighbourhood is about developing a cooperative model involving social housing, along with education, medical care and community space development, whereas the Spanish neighbourhood is a mixed-use development area including residential, tertiary and educational buildings involving both new construction and renovation activities.

The primary objective of this Austrian neighbourhood is to collaboratively create superior outdoor spaces abundant with greenery, energy-efficient buildings with minimal heat requirements, and implement sustainable and high-quality mobility solutions in the neighbourhood. It is a sustainable community development project, which includes the construction of 17 new buildings, to house 251 apartments and other facilities such as a kindergarten, a doctor's office and a charity organisation's office. The project is spearheaded by a non-profit housing association and several associated stakeholders. In addition, a group of senior citizens have established a communal living arrangement in one of the buildings, complete with social activities.

The Spanish neighbourhood has approximately 2500 inhabitants and is a mixed-use development area including residential, tertiary and educational buildings. Both new construction and renovation activities are taking place. A large-scale retrofitting of 250 dwellings is in progress, which includes a new energy-efficient social housing building, two new high-efficiency residential buildings with 202 apartments and energy renovation of a heritage-

protected building. A Citizen Energy Community is being created to facilitate renewable energy deployment. Lastly, a Living Lab is created for collaborative co-creation to collectively achieve the goals of energy transition and social justice. The importance of cultivating trust among tenants and the project administration was emphasised at this Living Lab.

5. Results

This section provides an overview of the results from the document analysis and the interviews conducted as part of the case studies. The results from the document analysis helped to identify the key elements and processes in a city ecosystem, while the interviews provided deeper insights into the roles and dynamics and the practical challenges in city ecosystems.

5.1 Document Analysis

The results from the document analysis were obtained through a thematic analysis (Braun and Clarke, 2006; Wæraas, 2022). An inductive approach was used, and the data were coded based on the three themes that were identified from the literature for sustainable citizen-centric city development: collaboration, citizen-centric innovation and sustainability. An overview of these themes is shown in Figure 2.

Additional elements were identified from the themes identified in the document analysis. Technological systems and the built environment were elements that were central in both cases and are complementary to the elements that have also been identified through the literature review, described in Section 2.

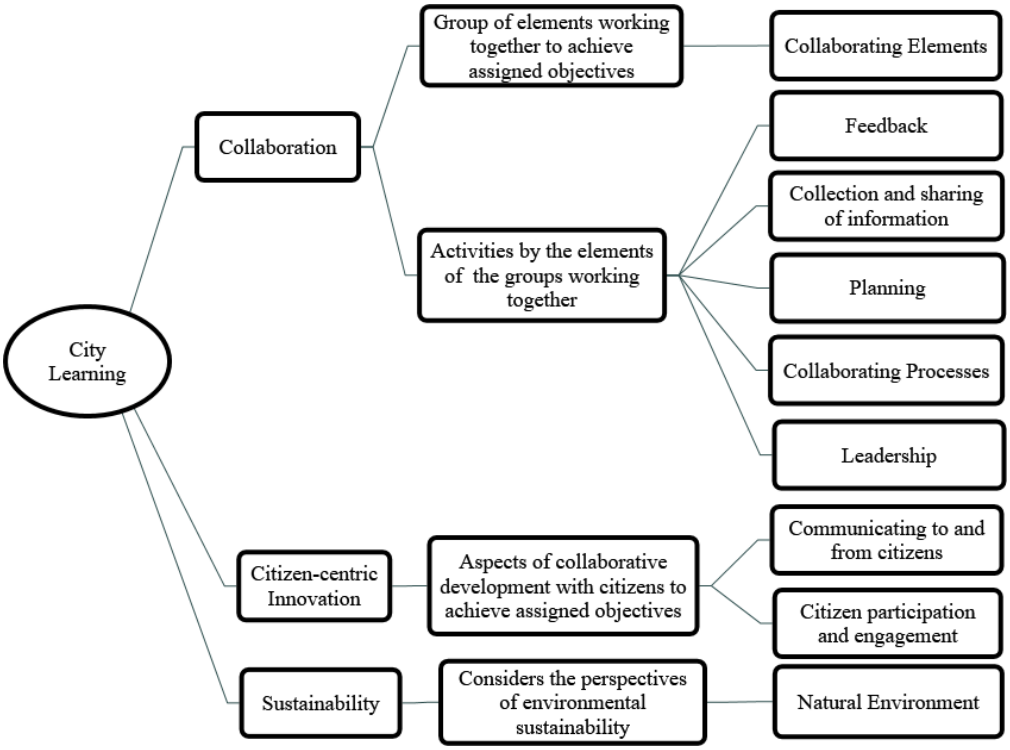


Figure 2: Themes identified in the document analysis of the selected cases

5.2 Interview Analysis

Interviews were conducted with two project personnel from the Austrian neighbourhood and one from the Spanish neighbourhood. Furthermore, an expert was interviewed. All interviews took place online between July and September 2024, with each session lasting between 60 and 70 minutes. Informed consent was obtained from the interviewees before the interviews, and the audio of each session was recorded to ensure precise documentation and analysis afterwards. The main aim of the interviews was to identify the key elements, processes and aspects of neighbourhood development projects, to validate the findings from the literature. Hence, a thematic analysis (Braun and Clarke, 2006; Wæraas, 2022) approach was used to analyse the transcripts from the interviews. An overview of the key elements, processes and aspects that were identified is shown in Table 1.

Table 1: Overview of Interview analysis

Coding themes	Results from the interview analysis
Key elements	• Academic and research institutions, • City administration bodies, • Funding bodies, • Community groups that facilitate citizen participation, • Information and Communication Technology (ICT) tools for visualisation, communication and information analysis, • Private business institutions, • Other city ecosystems, • Built environment.
Key processes	• Planning innovation and development projects with the relevant leadership, • Citizen participation and engagement processes for informing citizens, enabling citizen awareness, and establishing bidirectional communication with citizens, • Collection and sharing of relevant information, knowledge and experiences, • Collaborating processes comprising of formal meetings and informal interactions, • Reflecting on experiences and available contextual information, • Feedback processes for acquiring post-implementation feedback.
Key aspects	• Generally, city administrators assume the leadership role and make the final decisions, • Leadership roles can be taken by specific persons from academia or city administration who have an influential reputation or possess political power, • Elements responsible for funding the development often guide the path of the development, wherein funding constraints often act as limiting factors, • Any of the elements representing the stakeholders can assume the crucial role of a facilitator to offer help in multiple ways, from offering technical to financial insights and fostering collaboration among stakeholders, • Privacy and anonymity are crucial for spontaneous interactions, sharing of ideas and contextual information exchange for relevant knowledge creation, • Trust among stakeholders is essential in facilitating learning and knowledge exchange, • Scaling up projects from a neighbourhood to a city or from city-to-city level remains a challenge, • Citizens should be knowledgeable enough so that the quality of inputs from them can be ensured to help the learning for contextual research and development, • Citizen participation in Living Lab workshops has been very minimal and a challenging issue, • Development context, political environment and project timing are critical factors influencing the success of learning.

All the interviewees emphasised the importance of the government/administrative bodies. The interviewees highlighted that the political will and vision that guide the government/administrative bodies are the key deciding factors in furthering any development project at a city or neighbourhood level. One of the interviewees from the Austrian neighbourhood highlighted that during the design and development phases, the legal experts played a crucial role and were essentially a part of the government bodies. They also acknowledged the essential role of citizens.

Another key element highlighted by all the interviewees was funding bodies, as they are the ones who influence the financing of the development projects based on their vision and feasibility assessment. Scaling up projects from neighbourhoods to a city level or between cities has not been that successful and remains challenging due to funding constraints and *a priori* simplistic scalability assumptions. The interviewee from the Spanish neighbourhood also highlighted that private business institutions were also crucial for the corresponding neighbourhood development projects, and they are quite different from government institutions due to the difference in their objectives, because private business institutions are mostly profit-driven.

The themes of the projects and, thus, the interview discussions were focused on environmental sustainability aspects. It was highlighted that considering the built environment separately from the natural environment would help assess aspects of the development projects more objectively. The role of ICT tools as a key to the efficient design and development of their corresponding development projects was also acknowledged.

The interviewees from the Austrian neighbourhood further identified their research institutions as intermediaries or facilitators whose role was to work independently and bridge the link between the different stakeholders involved in the neighbourhood development. The role of facilitators was identified from the interviews to play a pivotal role in development projects, offering insights ranging from technical and financial dimensions while fostering collaboration among stakeholders. Although technological systems can facilitate and influence city learning for city transformations through sustainable citizen-centric development and innovations,

they are not seen as facilitators because they do not independently engage stakeholders; they are viewed as support. This highlighted the role of humans in the knowledge creation and learning processes. The role of facilitators can be assumed by any stakeholder belonging to the elements of the human environment, while they can simultaneously assume multiple roles which can be classified into three categories: leadership, facilitator and implementer.

Privacy and anonymity concerns were also identified as crucial for enabling spontaneous interactions, idea-sharing and contextual information exchange. Trust among stakeholders has been highlighted as essential for effective knowledge exchange. Minimal citizen participation has been a challenging issue, and moreover, citizen input is valuable only when they are well-informed, as poor-quality input from insufficiently informed citizens can hinder research and development. Ultimately, the development context, political environment and project timing have been identified as critical factors determining the success of learning and development initiatives for developing sustainable citizen-centric cities.

6. Conceptual Framework for City Ecosystems

Based on the literature review and the case studies, we were able to identify the elements that are relevant for a city ecosystem, for a city to innovate and learn. Furthermore, the main processes necessary for this learning were identified, some of which focus on experience sharing, knowledge sharing and exchange. The conceptual framework for city learning comprises a conceptual model, which highlights the main elements within a city ecosystem, and a mapping of key processes to these elements, illustrating the interactions and relations among them that can drive city learning. As the literature suggested, a city ecosystem consists of both internal and external elements. From the case studies, we identified a fourth internal element, the built environment, together with the human-driven environment, technological systems and the natural environment.

The conceptual model in Figure 3 presents the high-level view of a city as an ecosystem, as a large organisational entity, where its emergent behaviour is shaped by interactions among various internal and external elements at individual, group and organisational levels. The model represents the drivers of city learning for innovation through two interconnected ellipses: one encompassing internal elements of a city ecosystem and another representing other city ecosystems as external elements. Within the ellipse for internal elements, four interconnected smaller ellipses are illustrated: the human-driven environment, technological systems, the natural environment and the built environment. Findings from the case study and the expert interview highlight the significance of private business institutions, funding bodies, NGOs/community groups and the built environment in driving city learning.

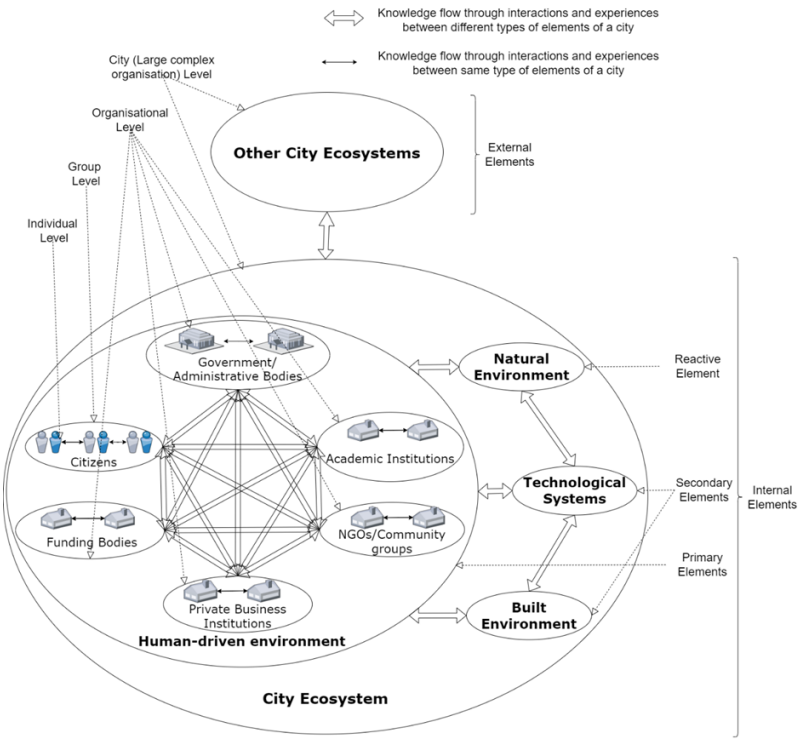


Figure 3: A conceptual model illustrating the elements of a city and its ecosystem view for city learning

The human-driven environment includes proactive actors initiating, designing, and implementing city innovation and development, making it a primary element. This human-driven environment plays a crucial role in shaping a city ecosystem through innovation, driven by continuous learning and interactions. The built environment, in turn, supports the human-driven environment and directly influences decision-making. While private business institutions, funding bodies and NGOs/community groups are a part of the human-driven environment, the built environment, similar to technological systems, is designed, developed, operated and utilised by human-driven actors. Consequently, the built environment, like technological systems, is a secondary element influencing a city ecosystem. The natural environment is classified as a reactive element, as it evolves in response to societal and technological influences, shaping innovation pathways while simultaneously being impacted by other ecosystem components.

Knowledge sharing, co-designing, collaboration and feedback were identified as central processes in a city's innovation and learning processes, and the interactions among the elements of a city, as shown in Figure 3, relate to these processes. Table 2 shows an overview of the interactions between the different elements of a city by presenting the mapping of the processes between all the elements and the primary elements of a city ecosystem that can drive city learning.

Table 2: Mapping of the processes between the elements of a city ecosystem that can drive city learning

		Elements of a City Ecosystem					
		Internal Elements					**External Elements**
		Primary Elements		**Secondary Elements**		**Reactive Element**	**Other City Ecosystems**
		Citizens	**Academic Institutions, Private Business Institutions, Funding Bodies, NGOs/ Community Groups, Government/ Administrative Bodies**	**Technological Systems**	**Built Environment**	**Natural Environment**	
Primary Elements of a City Ecosystem	**Citizens**	• Sharing of ideas, experiences and knowledge • Codesigning innovations	• Sharing of ideas, experiences and knowledge • Codesigning innovations • Providing feedback	Utilising as a medium and support to carry out the processes involved with other elements	Reflecting on experiences and available contextual information		
	Academic Institutions, Private Business Institutions, Funding Bodies, NGOs/ Community Groups, Government/ Administrative Bodies	• Codesigning innovations • Collection and sharing of information, knowledge and experience.	• Sharing of ideas, experiences and knowledge • Planning innovations for city development • Codesigning innovations • Collection and sharing of information, knowledge and experience.	Utilising as a medium and support to carry out the processes involved with other elements	• Collection of information • Reflecting on experiences and available contextual information		

7. Discussion

The motivation for this work has been the emerging needs of cities for frequent collaborative innovation and agility. This requires a newer understanding of them as ecosystems. Hence, the research question addressed in this paper is: how can we describe a city as a learning and innovation ecosystem that shares and creates

knowledge? Sharing of ideas, experience and knowledge appears to be a central collaborative process within a city ecosystem, which aligns well with the core idea of KM (Ting, 2023). Such processes enhance the knowledge and facilitate innovation through contextualisation and adaptation of knowledge, and lead to new knowledge. At the same time, it helps to learn from past failures and avoid pitfalls. The results of this study can contribute to a holistic understanding of a city as an ecosystem, leading to a knowledge-sharing culture, which can drive effective city learning for city transformations.

This study extends KM principles beyond traditional organisations to complex, multi-stakeholder city ecosystems. The proposed conceptual framework highlights that creation, sharing and utilisation of knowledge in cities are not merely techno-centric processes but are deeply embedded in social interactions, collaborative activities and the interplay between diverse city elements such as citizens, government bodies, academic institutions and private businesses. This insight aligns with KM theories emphasising communities of practice (Crane, 2013) and social learning (Ting, 2023) while scaling these concepts to an urban context and revealing a city as a dynamic knowledge-creating entity.

This study offers practical KM insights for city ecosystems by identifying critical drivers within city ecosystems. The role of 'facilitators' emerges as crucial catalysts for bridging stakeholder groups and fostering knowledge exchange, underscoring the importance of dedicated roles in managing knowledge flows within complex networks. However, challenges such as building trust among diverse stakeholders, ensuring meaningful citizen participation, addressing funding constraints, aligning with political will, the timing and context of innovation, and overcoming difficulties in scaling up successful initiatives represent significant KM hurdles in such complex socio-technical ecosystems.

8. Conclusion

This study provided a framework for understanding cities as learning and innovation ecosystems where knowledge sharing/creation is central to their sustainable evolution. This conceptual framework is the outcome of a literature review, case studies and an expert interview. An initial overview of the elements and processes that are central to learning and innovation in a city ecosystem was identified through literature. These were then both validated and enriched through case studies of two European neighbourhood development projects and an expert interview. The case studies and the expert interview complemented the theoretical insights with practical insights. The case studies also provided insights about facilitators acting as catalysts in fostering collaboration and contextual innovations through knowledge exchange within city learning ecosystems and about practical challenges that could hinder the scalability of city learning initiatives, such as limited citizen participation and funding constraints. Insights about the context-dependent nature of city learning show how factors such as political vision and timing of development can significantly influence learning outcomes in urban environments.

This study has identified that knowledge exchange and collaboration among the elements of a city ecosystem are essential processes for learning and innovation in cities. Details of how and the types of knowledge that should be considered have not been addressed. This could be a part of our future work. The main challenge is operationalising the framework's knowledge to benefit cities and similar large organisations/ecosystems. For exploring options to address this challenge and strengthen our validation, we are designing a board game based on the conceptual model that could promote collaboration, knowledge sharing and creation among the stakeholders of a city ecosystem.

Ethics declaration: Informed consent for the interviews mentioned in the study has been obtained as part of the ethical clearance for this study and approved by Sikt – Norwegian Agency for Shared Services in Education and Research.

AI declaration: AI tools have not been used in the creation of this paper.

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Challenges and Practices for Knowledge Transfer in Global Software Development: An Updated Literature Review

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Abstract: In recent years, the evolution of technology and the increasing globalization of work have significantly transformed the software development industry. Global Software Development (GSD) has become a prevalent practice, enabling companies to reduce costs, leverage time zone differences for continuous development, and access diverse talent pools worldwide. However, knowledge transfer among distributed teams remains a significant challenge, often resulting in inefficiencies, project delays, and decreased software quality. As organizations increasingly rely on geographically dispersed teams, understanding the barriers to effective knowledge transfer in GSD is essential. This study is motivated by the need to reassess knowledge transfer in GSD, especially considering recent advancements in communication tools, collaboration platforms, and the widespread shift to remote work. While previous studies, such as those conducted by Zahedi et al. (2016), have examined knowledge transfer challenges and practices in GSD, the rapid technological and organizational shifts over the past decade necessitate an updated literature review. This work aims to provide a comprehensive overview of distributed teams' challenges in knowledge transfer and the emerging practices to address these issues. A systematic literature review was conducted, building on the work of Zahedi et al. (2016) by analyzing research published between 2014 and 2024. The study followed a rigorous research protocol, utilizing the Scopus database to identify relevant papers and extract key insights. The findings highlight persistent challenges, including communication barriers, cultural differences, time zone constraints, and difficulties managing knowledge within distributed teams. Social and organizational factors hinder effective knowledge transfer, such as a lack of trust and inadequate coordination. The literature points to several best practices for facilitating knowledge transfer, including on-site visits for remote employees, synchronous and asynchronous communication tools, structured documentation, training programs, and establishing communities of practice. This study contributes to the field by offering an updated perspective on knowledge transfer in GSD, providing valuable insights for organizations aiming to optimize their global collaboration strategies. Future work should compare these findings with previous studies to track the evolution of knowledge transfer practices over time and explore new organizational approaches that have emerged in response to the changing dynamics of distributed software development.

Keywords: Global software development, Knowledge management, Communication barriers, Distributed teams, Collaboration practices, Systematic literature review

1. Introduction

Global Software Development (GSD) refers to building software products using development teams distributed across different world regions (Niazi et al., 2016). This approach is often chosen for its potential to reduce production costs, leverage different time zones to accelerate development, and access the diverse skillsets of professionals worldwide (Conchúir et al., 2009; Damian & Moitra, 2006; Niazi et al., 2016). However, effective knowledge transfer between teams remains a significant challenge in distributed development (Niazi et al., 2016; Parviainen & Tihinen, 2014), and if not properly managed, may undermine these benefits by resulting in low-quality software products (Niazi et al., 2016).

Studies by Damian and Moitra (2006) and Lanubile et al. (2003) show that GSD has been practiced and studied since the early 21st century. Since then, technological advancements have led to the development of tools that facilitate communication among geographically distributed individuals via the web. With greater access to high-speed internet, tele/videoconferencing applications and instant messaging tools have become widely used. Furthermore, documentation and collaborative sharing platforms have enabled the construction and exchange of knowledge in various formats. More recently, in the early 2020s, significant changes have reshaped how

teams operate, particularly due to the widespread shift of organizational human capital toward remote work starting in 2020.

Given these changes, it is necessary to assess the current state of knowledge management in GSD. Zahedi et al. (2016) conducted a literature review on the subject, covering the period from 2000 to 2014. The present study aims to update that review by offering an overview of the practices and challenges of knowledge transfer in GSD from 2014 to 2024.

2. Methodology

This study presents an updated version of the review conducted by Zahedi et al. (2016), extending it to the present day and following the original research methods, with some modifications. This section introduces a framework for validating the updated review, followed by the research protocol and the results of its implementation.

2.1 Validation of the Update

This subsection documents the application of the framework proposed by Garner et al. (2016) to assess the need to update the literature review conducted initially by Zahedi et al. (2016). The results of this validation were positive, supporting the relevance and timeliness of conducting a new review. The analysis followed the three-stage process outlined in the framework.

In the first stage, the original review was evaluated based on its current relevance, impact, and methodological rigor. The topic remains pertinent, especially considering the global shift to remote work in 2020, which further consolidated distributed work practices and spurred the development of improved tools and new communication methods enabled by technological advances. The original review has also demonstrated considerable impact, with 156 citations indexed in Scopus and 571 readers registered on Mendeley, indicating sustained academic interest. Methodologically, the study was well-structured, with a clearly defined protocol that included research objectives, guiding questions, a selection of Scopus as the primary data source (justified by its role as an indexing aggregator for multiple relevant databases), filtering criteria, a data extraction form, and a synthesis approach. The documentation of results was also satisfactory, offering both demographic and thematic analyses.

Given the positive evaluation across all criteria in the first stage, the second stage involved verifying the existence of new studies or emerging information since the publication of the original review. A preliminary search in Scopus covering the period from 2014 to May 2024 identified 771 new studies, confirming the presence of significant additional material.

In the third stage, the potential impact of these new studies on the findings, conclusions, or credibility of the original review was assessed. Although definitive conclusions require further analysis, the substantial changes in the global landscape of remote work in recent years suggest that knowledge management practices in GSD have evolved, potentially altering previous insights. Given these findings, the decision to proceed with an updated review is justified and aligned with the framework's recommendations.

2.2 Research Protocol

This study aims to provide an updated overview of the practices and challenges of knowledge transfer in current GSD. The research questions of this review remain the same as those proposed by Zahedi et al. (2016) and are as follows:

- **RQ1**: What are the knowledge-sharing challenges in GSD?
- **RQ2**: What are the knowledge-sharing practices in GSD?
- **RQ3**: In which contextual configurations (i.e., research methodology and organizational context) are these challenges and practices reported?

To ensure consistency with the original review, Scopus was selected as the sole database for article retrieval, both to maintain methodological alignment and due to its widespread use in this type of research (Zhu & Liu, 2020). Only articles published from 2014 onwards, up to the search date, were considered. Eligible works had to belong to one of the following subject areas: *Computer Science*, *Business, Management and Accounting*, *Decision Sciences*, or *Economics, Econometrics, and Finance*. Table 1 presents the original search string.

Table 1: The search string

Search String
TITLE-ABS-KEY ((“global software development” OR “collaborative software development” OR “global software engineering” OR “distributed software development” OR “distributed software engineering” OR “offshore software development” OR “offshore software engineering” OR “geographically distributed software development” OR offshor* OR “software outsourcing” OR “software outsource” OR “globally distributed software development” OR “offshore outsourcing” OR “Dispersed teams” OR “distributed teams” OR “virtual teams” OR “globally distributed work” OR “global software teams” OR outsour*) AND (“knowledge transfer” OR “knowledge shift” OR “knowledge exchange” OR “knowledge distribution” OR “tacit knowledge” OR “explicit knowledge” OR “knowledge transfer process” OR “knowledge flow” OR “organizational knowledge” OR “knowledge acquisition” OR “knowledge management” OR “knowledge creation” OR “knowledge sharing” OR “knowledge retention” OR “knowledge valuation” OR “knowledge use” OR “knowledge application” OR “knowledge discovery” OR “knowledge integration” OR “knowledge theory” OR “knowledge engineering” OR “experience transfer” OR “technology transfer”) AND (risk* OR challenge* OR tool* OR method* OR problem* OR challeng* OR barrier* OR “best practices” OR model* OR techniq* OR strateg* OR approach* OR process* OR solution* OR obstacle* OR “risk analysis” OR effect* OR “risk factors” OR selection* OR mechanism* OR assessment* OR “evaluation process” OR practice* OR mitigate*))

For each selected article, the following data were extracted to support the creation of visual elements aimed at answering RQ3: **Author(s), Year of Publication, Title, Venue, Citation Count (Scopus), Research Method, Data Collection Method(s), Data Analysis, Units of Analysis, Study Context, Site Locations, Collaboration Model(s), Organization Size, and Media/Tools Used.**

To answer Research Questions 1 and 2, the articles underwent **thematic analysis** (Braun & Clarke, 2006) to identify challenges and practices related to knowledge transfer in GSD. The analysis followed these steps:

- Reading of the article;
- Annotation of potential codes;
- Grouping of codes and identification of themes;
- Segmentation of articles by identified themes; and
- Reporting of results.

2.3 Protocol Execution

The search in the Scopus database was conducted in May 2024. Filters were applied in the tool to limit the results by publication year, language, and subject areas. A total of 771 results were returned. Figure 1 presents details of the article selection process. Table 2 provides the list of selected articles along with their associated identifiers. After selection, the articles were organized in a spreadsheet, where their metadata was extracted. The thematic analysis was conducted by directly annotating the article files. Grouping and reporting of themes were performed using a text editor.

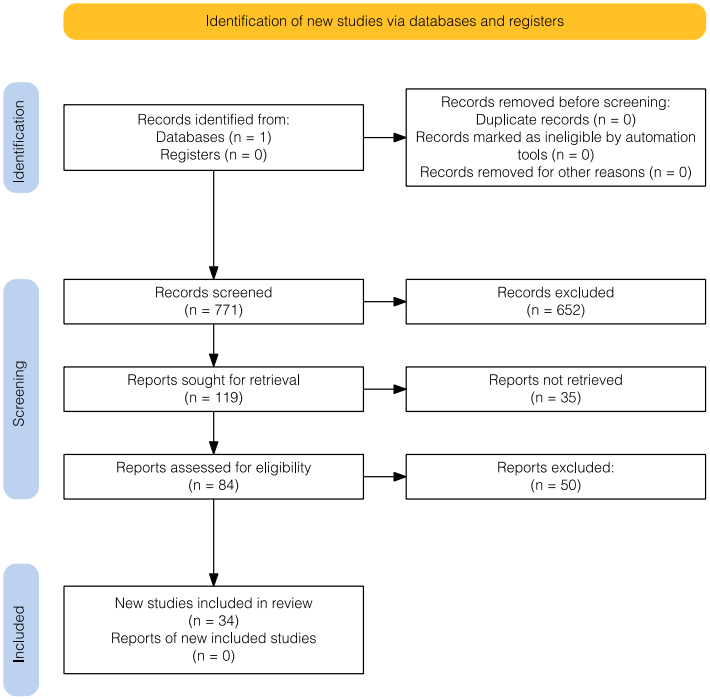


Figure 1: Article selection flow

Table 2: Selected studies after applying inclusion and exclusion criteria

ID	Year	Truncated Title	Reference
A1	2014	Navigating the mutual knowledge problem: a comparative…	(Koppman & Gupta, 2014)
A2	2014	Towards an understanding of enabling process knowing in…	(Zahedi & Babar, 2014b)
A3	2014	Knowledge transfer in IT offshoring relationships: the roles…	(Zimmermann & Ravishankar, 2014)
A4	2014	The four' W's of face-to-face: suggesting an enriched…	(Stetten et al., 2014)
A5	2014	Knowledge transfer in offshore outsourcing software…	(Betz et al., 2014)
A6	2014	Integration by communication: knowledge exchange in…	(Kristjánsson et al., 2014)
A7	2014	The Knowledge-Bridging Process in Software Offshoring…	(Nguyen et al., 2014)
A8	2014	Knowledge sharing for common understanding of technical…	(Zahedi & Babar, 2014a)
A9	2014	Knowledge-related challenges and solutions in GSD	(Parviainen & Tihinen, 2014)
A10	2014	From offshore outsourcing to insourcing and partnerships…	(Moe et al., 2014)
A11	2014	Vendors' team performance in software outsourcing projects	(Qu et al., 2014)
A12	2015	Riding for a Fall in Outsourced ISD	(Alanne & Pekkola, 2015)
A13	2014	Networking in a large-scale distributed agile project	(Moe et al., 2014)
A14	2015	An Empirical Study of Offshore Software Development	(Consoli et al., 2015)
A15	2015	Knowledge Management in Distributed Agile Software…	(Razzak et al., 2015)
A16	2015	Communication and personality profiles of global software…	(Licorish & MacDonell, 2015)
A17	2015	Knowledge Management in Globally Distributed Agile…	(Razzak & Mite, 2015)
A18	2015	You Feel The Threat From Asia	(Blomqvist et al., 2015)
A19	2017	Tool-supported continuous business process innovation	(Heredia et al., 2017)
A20	2017	Knowledge sharing for agile distributed teams	(Gervigny & Nagowah, 2017)
A21	2016	Why does site visit matter in global software development	(Zahedi & Babar, 2016)
A22	2019	Investigation of Knowledge Sharing Behavior in Global…	(Anwar et al., 2019)
A23	2018	Prioritizing challenges of agile process in distributed…	(Shameem et al., 2018)

ID	Year	Truncated Title	Reference
A24	2019	A Survey on Agile Practices and Challenges of a Global…	(Lautert et al., 2019)
A25	2018	Knowledge transfer in IS offshoring	(Strasser et al., 2018)
A26	2019	Improving Knowledge Sharing in Distributed Software…	(Waheed et al., 2019)
A27	2021	Knowledge management, sharing, and transfer in…	(Patel et al., 2021)
A28	2021	Determinants of trust in computer-mediated offshore…	(Cheng et al., 2021)
A29	2021	An Empirical Investigation of Pull Requests	(Stray et al., 2021)
A30	2020	Asynchronous Collaboration	(Sangwan et al., 2020)
A31	2021	Understanding the relation between repeat developer…	(Datta et al., 2021)
A32	2023	The Role of Responsiveness to Change in Large…	(Smite & Moe, 2023)
A33	2023	Determinants of success and failure of knowledge transfer	(Strasser et al., 2023)
A34	2023	Developing a knowledge-based perspective of coordination	(Mishra, 2023)

3. Descriptive Insights into GSD Literature

This section offers a descriptive overview of the selected studies to characterize the general research landscape on GSD. It examines the temporal distribution of publications, the tools and media adopted for knowledge sharing, and the contextual settings in which GSD initiatives occur. These insights help contextualize the reviewed literature's empirical and methodological foundations.

3.1 Demographic Attributes

The distribution of publications by year shows a declining trend in the number of studies on the topic, with a peak in 2014—the first year included in this review—and no publications recorded in 2022 or from January to May 2024. Publications from the 2010s represent 76.5% of the total, while those from the 2020s account for 23.5%, indicating a decrease in research output in recent years.

The distribution of tools and media mentioned in the selected studies that support knowledge sharing in GSD was grouped into three categories based on their primary function: coordination, organizational memory, and project management. Each tool was considered only once per article, regardless of whether multiple case studies were included. Coordination tools were the most frequently mentioned, reflecting an apparent concern with enabling effective communication in distributed settings to support knowledge sharing.

Email was the most cited tool in the coordination tools, serving as a common channel for asynchronous communication. However, when grouped, real-time communication tools—such as videoconferencing, Skype, telephone, chat, and teleconferencing—appear more frequently than email alone. This finding suggests a growing emphasis on synchronous communication, likely influenced by advances in web-based data transmission technologies and the demands of distributed work environments.

Regarding organizational memory, Wiki and SharePoint were the most frequently used platforms, highlighting the importance of maintaining shared documentation for effective knowledge management. Tools such as JIRA, digital boards, Redmine, and Confluence were the most cited for project management, underscoring the significance of tracking task execution in distributed teams. Additionally, Git was referenced in four studies, indicating its relevance for code versioning and the maintenance of updated development artifacts.

3.2 Contextual Configurations

The collaboration models identified in each case study were offshore, nearshore, and insourcing. In this context, *offshore* refers to development in a different country; *insourcing* denotes a situation where a single organization conducts development activities in another location; and *outsourcing* involves delegating tasks from one organization to another (Zahedi et al., 2016). Additionally, this study adopts the definition of *nearshore* proposed by Carmel and Abbot (2007), which refers to development conducted in countries geographically closer to the headquarters, typically sharing cultural similarities despite being distinct nations.

The most frequently adopted model was offshore outsourcing, cited in 47 case studies. The nearshore-outsourcing model was only considered when the studies explicitly mentioned using characteristics specific to this modality, making it the second most cited collaboration model.

In most cases, the size of the studied organization was not explicitly stated in terms of organizational size. However, when available, there was a notable focus on large organizations, which accounted for 25.8% of the cases, followed by medium-sized companies. The classification of organizational size followed the descriptions provided in the studies; when only the number of employees was indicated, the OECD (Organisation for Economic Co-operation and Development) classification was applied.

Table 3 details the geographical distribution of participating entities—clients and providers—in GSD cases. India was the most prominent country, involved in 18 studies, followed by Germany and Sweden, each in 13 cases. European countries were represented in 55 studies, while Asian countries participated in 26, highlighting the global nature of the software development landscape and the concentration of activity in specific regions.

Table 3: Geographical distribution of participating entities in GSD case studies.

Count	Countries
18	India
13	Germany, Sweden
7	United States
6	Ukraine, Bangladesh
5	Norway, China
3	Russia, Denmark, Pakistan, Serbia, Netherlands
2	Belarus, Switzerland, Latvia, Brazil, Poland
1	Finland, Japan, Philippines, Italy, South Korea, Australia, Ireland, Canada, Croatia, Vietnam

4. Knowledge Sharing in GSD: Challenges and Practices

Building on the publication trends and tool-usage patterns observed in Section 3.1 and the collaboration models mapped in Section 3.2, we now examine how these descriptive foundations inform the core challenges and practices in global software development. This section presents the results of a thematic analysis focused on knowledge sharing in GSD. It explores the challenges reported in the literature and the practices adopted to overcome them. By organizing the findings into recurring themes, this section highlights how knowledge is managed across distributed environments and identifies patterns that inform future research and practice.

4.1 Challenges in Knowledge Sharing in GSD

One of the most frequently cited challenges is the lack of effective communication. As observed in Section 3.1, real-time communication tools outnumber email in frequency, yet many projects continue to rely heavily on asynchronous channels such as email. Several studies highlight coordination problems stemming from misunderstandings in communication (ID 01) and reluctance to engage in electronic interactions (IDs 01, 09, 33). Language barriers are commonly mentioned (IDs 03, 04, 05, 07, 12, 13, 15, 18, 20, 22, 33), with issues such as accents and region-specific comprehension affecting clarity. The absence of adequate feedback (ID 23) and difficulties articulating and understanding priorities across different sites (ID 09) further hinder communication. In addition, the lack of face-to-face interaction (IDs 01, 02, 05, 22, 24) and the limitations of electronic communication (IDs 01, 02, 08, 09, 11, 12, 15, 23, 24, 25, 33) are reported as significant obstacles to smooth collaboration.

Cultural differences also emerge as a critical issue in GSD (IDs 03, 04, 05, 07, 08, 09, 10, 11, 15, 18, 23, 25, 29, 30). Section 3.2 revealed that 47 out of 67 case studies use offshore outsourcing, where teams are geographically distant and culturally diverse. These differences manifest in varying understandings of career goals, professional backgrounds, and communication styles, for example, the level of detail considered necessary when conveying information. Such disparities influence behavior and attitudes toward tasks, ultimately complicating collaboration and decision-making processes (IDs 03, 08, 10, 25).

Time zone differences and geographical distance present additional challenges. Several studies note the difficulty in scheduling synchronous activities and meetings due to non-overlapping work hours (IDs 01, 05, 10, 13, 20, 22, 24, 30). Teams in different regions are available at different times, reducing real-time interaction windows. Geographic distance further limits face-to-face engagement due to the high cost of travel, reducing informal communication opportunities and hampering relationship-building (IDs 01, 05, 12, 22).

Issues related to knowledge sharing and management are also prominent. The lack of proper documentation and the risk of knowledge loss are mentioned in several studies (IDs 12, 26, 33), often attributed to inadequate tools (e.g., exclusive use of chat applications), absence of knowledge retention plans, or high employee turnover in distributed teams. The difficulty of sharing knowledge across sites is frequently reported (IDs 05, 09, 10, 12, 29, 30, 33), with variability in understanding project architecture, domain knowledge, and even the product itself, often influenced by cultural factors. Furthermore, the lack of awareness regarding the skills of professionals at other sites (IDs 09, 29) is cited as a bottleneck that hinders project progress.

Coordination and project management pose specific challenges in the global context. Given the dominance of large organizations in nearshore-outsourcing cases (Section 3.2), unclear roles and responsibilities (ID 23) and a lack of managerial involvement (IDs 09, 23) become more pronounced, resulting in delayed task interdependencies and monitoring issues. Difficulties in estimating and monitoring project progress (ID 09). Another recurring issue is the failure to identify, consider, and communicate task interdependencies (ID 09), which can significantly delay or disrupt project execution.

Lastly, the lack of social interaction and trust hinders effective knowledge sharing. Several studies emphasize the absence of informal interactions and difficulty building trust (IDs 01, 03, 05, 08, 25, 28, 33). As detailed in Section 3.2, reported trust issues in offshore scenarios are primarily concentrated in Europe and India, underscoring the difficulty of establishing trust in these contexts. Communication insecurity and reluctance to share information openly are noted (IDs 03, 08, 33), as a lack of trust in unfamiliar team members and uncertainty over whether others have correctly understood the requirements. This unfamiliarity often leads collaborators to avoid asking questions or participating actively in online meetings.

4.2 Knowledge-Sharing Practices in GSD

A common and foundational practice involves using general communication tools for knowledge exchange. Emails (IDs 01, 24, 26, 30) are widely used for formal communication, offering traceability and the ability to document short and long discussions. Instant messaging and videoconferencing platforms (IDs 15, 17, 24, 26, 28) are employed for real-time communication, facilitating immediate interaction, along with teleconferencing and phone calls (IDs 03, 24). This shift reflects the tool-usage profile noted in Section 3.1, where synchronous platforms outpace email in the studies we reviewed. Meetings—in-person or virtual (IDs 02, 06, 15, 17, 24, 25, 29)—are used for alignment, progress reviews, and problem-solving. Discussion forums (IDs 01, 13, 15, 17) and microblogs (ID 19) are also cited as hybrid tools that combine communication and documentation functions. Some studies mention the deliberate creation of informal and open communication moments (ID 08) and the assignment of dedicated communication facilitators (ID 12) to support knowledge exchange.

Training and workshops are also important mechanisms for facilitating knowledge sharing. Both in-person and online training sessions (IDs 04, 06, 07, 10, 17, 32, 33) are reported as valuable for equipping employees with business domain knowledge and technical skills. Workshops (IDs 02, 17, 21, 22, 33) are collaborative environments for sharing experiences and discussing complex topics. Introductory training (ID 06) is particularly emphasized for onboarding new employees and integrating distributed teams. Cultural workshops (ID 22) are also noted for easing multicultural integration.

Face-to-face visits and expatriation strategies are frequently mentioned as effective means to strengthen relationships and improve understanding of local work contexts. Site visits (IDs 02, 03, 04, 05, 06, 08, 10, 13, 15, 17, 18, 21, 25, 29, 32, 33) contribute to resolving communication issues and building trust among team members. Expatriation (ID 27), where employees from different locations work together over extended periods, enables deeper knowledge exchange and relationship development. Managerial visits to remote sites (ID 04) and visits to foster personal relationships (ID 10) are also highlighted as valuable practices.

Organizational culture plays a key role in shaping knowledge-sharing behavior. The formation of communities of practice (IDs 02, 13) is used to encourage ongoing learning and exchange among team members. Multicultural integration efforts (ID 14) and socialization through events (IDs 04, 08) support the development of a cohesive work environment. The deliberate formation of multisite teams (IDs 10, 18) aims to promote intercultural interaction and leverage diversity to enhance communication. Fostering direct communication and adapting team and managerial cultural practices enables knowledge exchange.

Lastly, documentation practices and knowledge artifacts are crucial for ensuring that knowledge remains accessible and is preserved over time. Tools such as wikis and other collaborative documentation platforms (IDs 01, 08, 17, 18, 19, 20) help maintain knowledge repositories that can be consulted by team members as needed. The creation and availability of documented knowledge artifacts (IDs 07, 08, 17, 32), including collective

documentation practices (ID 01), are recognized as effective methods for preserving and disseminating knowledge within distributed development environments.

4.3 Comparison with Zahedi et al. (2016)

Our updated review builds upon the thematic framework established by Zahedi et al. (2016), categorizing challenges into management, team structure, work processes, team cognition, social attributes, and technology, and grouping practices around collocation, boundary spanning, communication routines, documentation, cognition-supporting mechanisms, and socio-technical enablers. Whereas Zahedi et al. analyzed 61 studies through September 2014, our review examines 34 studies from 2014 to 2024, reflecting the pandemic's impact on remote work and advances in synchronous collaboration tools. Zahedi et al. reported a steady increase in publications up to 2014; in contrast, we observe a plateau and slight decline after 2017, with no publications in 2022 or early 2024. This pattern signals a shift from methodological standardization and tool experimentation toward a deeper focus on hybrid and post-pandemic collaboration.

Methodologically, we retained Scopus as our primary database but broadened our search terms to include "knowledge management" and "knowledge sharing." This change yielded only 11 overlapping articles with Zahedi et al.'s set and highlighted evolving terminology and new empirical contexts, especially nearshore and hybrid teams in non-Western settings.

Whereas Zahedi et al. observed that technology-related challenges were underreported, we find that modern tool ecosystems—integrated chat-wiki platforms and expertise browsers—now appear prominently as both challenges and practices. Furthermore, whereas the original review called for more research on small and medium-sized enterprises (SMEs), we document a growing number of SME-focused case studies. This comparison confirms continuity in core themes while revealing a shift toward richer, technology-mediated, and context-sensitive knowledge-sharing investigations in global software teams.

5. Conclusion

Although distributed software development and remote work have become ubiquitous, accelerated by the COVID-19 pandemic, our review shows that organizations still grapple with well-known challenges such as communication breakdowns, cultural mismatches, time-zone barriers, and trust deficits. At the same time, face-to-face visits, targeted training, structured documentation, and coordination tools continue evolving, reflecting technological advances and enduring human factors.

Building on Zahedi et al. (2016), this updated systematic literature review covers studies from 2014 through early 2024, following a transparent Scopus-based protocol. We provided a descriptive overview of publication trends, tool usage, and collaboration models, and conducted a thematic analysis of challenges and practices. Notably, coordination tools—and increasingly synchronous media—dominate knowledge-sharing strategies, while offshore outsourcing remains the prevalent collaboration model. Our findings offer continuity with past research and fresh insights into how global teams negotiate distance, culture, and technology.

As a contribution, this work delivers a comprehensive synthesis of the past decade's research on knowledge transfer in global software development. Practitioners will find actionable guidance on selecting and combining tools, structuring interventions (e.g., site visits, workshops), and preparing for context-specific hurdles. For researchers, the review establishes a detailed baseline against which future longitudinal or meta-analytic studies can be compared, particularly as hybrid and post-pandemic work patterns emerge.

By reinforcing this field's theoretical and practical contours, our review maps where we stand today and signals where the next generation of studies should venture—examining underexplored contexts, testing evidence-based solutions, and measuring long-term impacts. Ultimately, this review serves as both a roadmap for practitioners seeking to optimize distributed collaboration and a foundation for scholars aiming to chart the evolution of knowledge transfer in an ever-more-connected world.

Ethics Declaration: Ethical clearance was not required for the development of this research.

AI Declaration: AI tools such as Grammarly and ChatGPT were used solely for language revision. The authors' analysis and interpretations are their own.

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The Contribution of Knowledge Management to the Co-creation of Sustainable Public Value

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Abstract: In recent years, public sector performance assessment has shifted beyond financial metrics to include Environmental, Social, and Governance (ESG) considerations, aligning with the sector's focus on creating public value (PV) rather than maximizing profit and guided by a Knowledge Management approach (KMA). Increasing stakeholder demands for transparency and sustainability have rendered traditional financial indicators inadequate for evaluating public resource use. In this context, Sustainability Accounting and Reporting (SAR) has emerged as a key framework, combining social and environmental accounting with formal reporting to enhance accountability and stakeholder engagement. SAR functions as an integrated mechanism for measuring and communicating progress toward sustainability goals, reinforcing transparency in public organizations through the leverage of KMA. Despite growing interest in both SAR and public value co-creation, which involves active stakeholder participation in shaping public services, their academic development has remained largely separate. This study seeks to bridge that gap by applying Mark Moore's strategic triangle (1995) to SAR in the public sector, aiming to synthesize existing literature, identify research gaps, and examine how SAR supports the co-creation of public value.

Keywords: Sustainable public value, Knowledge management, ESG

1. Introduction

In recent decades, the assessment of organizational performance—particularly within the public sector—has evolved to encompass not only financial outcomes but also environmental, social, and governance (ESG) dimensions. Public sector organizations, oriented toward the creation and co-creation of public value (PV) rather than profit maximization, are increasingly subject to demands for greater sustainability and accountability (Cifolelli et. al, 2025, Cepiku et al., 2022.

Contemporary public sector organizations face increasing expectations to deliver value that is sustainable across economic, social, and environmental dimensions, extending beyond traditional mandates of financial performance. In response to heightened accountability demands from a diverse set of stakeholders, financial data alone is now viewed as insufficient for assessing the legitimacy and effectiveness of public resource use (Ansell et. al, 2022).

In this context, Sustainability Accounting and Reporting (SAR) has emerged as a central framework in academic discourse. SAR integrates various strands of sustainability-related accounting—such as social and environmental accounting—into a comprehensive system for measuring and communicating organizational performance. While Sustainability Accounting focuses on generating information that tracks progress toward sustainability goals, Sustainability Reporting formalizes the disclosure of this information to stakeholders (Bryson et. al, 2022).

Together, these processes constitute a unified accountability mechanism that reinforces organizational transparency and supports informed stakeholder engagement. The convergence of these previously distinct concepts under the SAR umbrella reflects a growing scholarly consensus on the importance of holistic, non-financial performance measurement in the public sector (Talbot, 2011; Papi et. al, 2018).

An emerging yet underexplored dimension of SAR is its role in public value co-creation, which involves the active participation of stakeholders—such as citizens and private entities—in the design, implementation, and evaluation of public policies and services. Despite parallel scholarly interest in SAR and PV co-creation, these two domains have largely developed in isolation.

To bridge this conceptual and empirical divide, the study undertakes a re-frame of Mark Moore strategic triangle (1995) applied on SAR in the public sector to synthesize the current body of knowledge, identify

research gaps, and explore the extent to which SAR contributes to PV co-creation, thereby offering new avenues for integrated future research.

2. Process of Creation and Co-Creation of PV, a Literature Framework

The aim of co-creation in the public sector is the generation of public value (Ansell & Torfing, 2021). To establish a foundation for this concept, the discussion begins with an exploration of public value itself. Since Moore's seminal work in 1995, public value has gained significant traction across multiple disciplines, functioning as a concept, theoretical lens, and analytical framework. It is commonly understood as the production of benefits for the public sphere that are recognized and appreciated by the public (Ansell & Torfing, 2021; Hartley et al., 2017; Benington, 2011; Moore, 1995).

To effectively create public value, practitioners must first identify what different segments of the public value. This process—referred to by Moore (1995) as defining public value—involves engaging with a diverse array of public stakeholders to determine shared or contested priorities. Given the heterogeneity of the public, this process is inherently complex and democratic in nature (Hartley et al., 2017). Nailer et al. (2019) further distinguish between anticipated public value (what is expected or hoped for) and realized public value (what is achieved through action).

Public value outcomes encompass contributions across economic, social, cultural, ecological, and political dimensions (Bovaird & Loeffler, 2012; Benington). These outcomes, although central to public sector missions, are often challenging to quantify (Alford & O'Flynn, 2009). Several of these dimensions align closely with the concept of sustainability. For instance, Benington (2011) equates ecological public value with efforts that promote sustainable development and mitigate environmental harm such as pollution and climate change essentially echoing principles of environmental sustainability.

Similarly, social sustainability is interconnected with the social, cultural, and political dimensions of public value. In the context of urban development, it typically refers to equitable access, safety, social cohesion (social and cultural dimensions), and participatory democracy (political dimension) (e.g., Granath Hansson, 2020; Eizenberg & Jabareen, 2017). Candel (2023) shows that municipalities strive to achieve these varied public value outcomes—ecological, social, cultural, political, and economic—through sustainability-oriented land development projects. However, further research is needed to understand how these outcomes are individually or collectively (co-)created.

Closely related to the idea of public values is the concept of public values, which are normative principles realized through effective governance rather than direct creation (Bryson et al., 2017; de Graaf & Paanakker, 2015; de Bruijn & Dicke, 2006). Public values can be procedural—such as transparency—or performance-based, relating to efficiency and effectiveness in service delivery (de Graaf & Paanakker, 2015; de Bruijn & Dicke, 2006). Core public values identified across countries like the US, UK, and those in Scandinavia include human dignity, sustainability, citizen participation, openness, integrity, compromise, and resilience (Jørgensen & Bozeman, 2007).

Because of value pluralism, tensions often arise when public values conflict, necessitating prioritization (Aschhoff & Vogel, 2018; de Graaf & Paanakker, 2015; van Gestel et al., 2008). This is especially evident in contested land-use decisions, where economic development goals frequently clash with environmental protection, highlighting the need for more participatory and informed decision-making processes (Tudor et al., 2014; Wittmer et al., 2006). In co-creation contexts, the challenge becomes even more complex, as multiple public and private actors may pursue divergent value creation objectives. Thus, a critical issue in these collaborative processes is determining how to uphold and reconcile the array of potentially conflicting public values.

The concept of co-creation originated in marketing, where it referred to the collaborative process in which consumers contribute to value creation alongside service providers or producers (Vargo & Lusch, 2004, 2008). Over time, co-creation has expanded into other domains, particularly public management (e.g., Ansell & Torfing, 2021; Torfing et al., 2019), where it has become increasingly influential. In this context, Torfing et al. (2019) define public sector co-creation as a collaborative process involving multiple public and private actors working together to address shared problems by exchanging knowledge, resources, skills, and ideas to enhance the creation of public value.

Although often used interchangeably, co-creation and co-production are conceptually distinct. Co-production typically emphasizes service delivery with less focus on value creation, whereas co-creation emphasizes both

collaboration and innovation (Torfing et al., 2019; Voorberg et al., 2015). Furthermore, co-creation differs from concepts such as collaborative governance or network governance, which focus more on consensus-building and policymaking. Co-creation, by contrast, explicitly seeks to link collaboration with innovation to address complex public challenges in transformative ways (Ansell & Torfing, 2021).

In the context of urban flagship developments, which often function as testbeds for innovation, public value co-creation is proposed as a particularly suitable conceptual framework. According to Voorberg et al. (2015), co-creation may involve stages such as co-initiation, co-design, and co-implementation. This study focuses on the latter two, as the developments under investigation have already been initiated by municipalities.

Co-design entails collaborative planning processes where public institutions involve other stakeholders in designing public services, including jointly identifying problems, defining desired outcomes, and co-developing solutions. In co-creation literature, the goals that providers intend to deliver are referred to as value propositions, while the benefits that users derive from services are termed value-in-use (Grönroos, 2017; Skålen et al., 2015; Vargo & Lusch, 2008). Co-implementation, on the other hand, refers to the collaborative execution and delivery of public services.

A comprehensive analysis of co-creation must account for several key components: the involved actors, their practices, the institutional arenas where interactions occur, the functional roles of co-creation activities, and the underlying challenges or tensions that shape public value creation (Bryson et al., 2017). The range of actors includes public officials and politicians, as well as private entities such as businesses, non-profits, and citizens (Torfing et al., 2019). Their roles vary depending on their institutional positions and objectives. Practices essential for co-creation include policy analysis, participatory leadership, strategic management, design and evaluation, democratic dialogue, and both formal and informal institutional design (Bryson et al., 2015).

The arenas for co-creation are collaborative spaces where stakeholders engage in dialogue and joint problem-solving. These are understood as generative institutions that facilitate co-creative practices (Ansell & Torfing, 2021). Their continued development is supported by platforms, which provide broader systemic infrastructure for ongoing collaboration through networks, projects, and programs.

The functions of co-creation in these arenas include not only the improvement of outcomes but also the transformation of how problems are understood and addressed (Torfing et al., 2019). A growing body of research explores co-creation, co-production, and co-design within urban planning, highlighting the potential of collaborative approaches to foster innovation and improve outcomes (e.g., Brokking et al., 2021; Bisschops & Beunen, 2019; Puerari et al., 2018; Teder, 2019).

However, much of this literature remains focused on citizen participation, aligning it closely with participatory planning traditions, often neglecting collaboration with other relevant stakeholders. The advantage of employing public value co-creation theory in urban planning lies in its broader scope—it accounts for diverse actor involvement and emphasizes collaborative innovation (Ansell & Torfing, 2021; Torfing et al., 2019).

Moreover, the process of co-creation is strictly engaged with ESG Agenda. As a matter of fact, the integration of Environmental, Social, and Governance (ESG) principles into organizational strategy has become increasingly pivotal in contemporary public administration and corporate governance. ESG frameworks serve as normative guidelines that inform ethical and sustainable decision-making processes across sectors. Concurrently, the concept of public value co-creation, rooted in public value theory (Moore, 1995), emphasizes collaborative engagement among governmental entities, private actors, and civil society to generate outcomes that are valuable to the public sphere. The theoretical correlation between ESG and public value co-creation lies in their mutual commitment to long-term societal well-being, participatory governance, and sustainable development.

ESG can be understood as a mechanism through which organizations internalize externalities and adopt a stakeholder-oriented approach to governance (Rodriguez Muller et al, 2024). This perspective aligns with the co-creation paradigm, which posits that value is not solely produced by the state or market actors but emerges from dynamic interactions among stakeholders (Osborne, 2006; Li et al 2025). The governance dimension of ESG, for instance, resonates with the principles of accountability, transparency, and inclusiveness, which are foundational to co-creation processes. Similarly, the environmental and social components of ESG reflect a commitment to sustainability and equity, core tenets of public value creation.

From a theoretical standpoint, co-creation theory (Ege et. al, 2025) and stakeholder theory provide useful lenses to understand this correlation. ESG-driven organizations, shaped by normative and coercive institutional

pressures, often engage in collaborative arrangements with public and civil society actors to enhance legitimacy and responsiveness. These interactions foster environments conducive to co-creation, wherein the ESG agenda becomes a vehicle for addressing collective challenges such as climate change, social inequality, and systemic governance failures.

In essence, the intersection of ESG and public value co-creation reflects a convergence of normative ideals and practical imperatives. It underscores the evolution of governance models toward more integrative, participatory, and sustainable paradigms, where public value is no longer solely the remit of the state but a shared responsibility among diverse societal actors.

Nonetheless, with the rise of collaborative urban governance and growing private sector influence, concerns have emerged regarding the legitimacy and inclusivity of these processes (Mäntysalo & Bäcklund, 2018). Scholars warn that such collaboration can lead to the dominance of powerful interests, often at the expense of long-term sustainability goals (Fox-Rogers & Murphy, 2015; Palmås & von Busch, 2015; Parker et al., 2015). For example, Solly (2021) found that in Sweden, the shift towards collaborative, market-driven spatial planning has hindered planners' capacity to prioritize sustainable development, instead favoring private developers' short-term interests.

Similarly, Palmås and von Busch (2015) argue that citizen input gathered early in participatory processes is often diluted as projects progress and negotiations evolve. Despite urban planners' generally high aspirations and good intentions (Metzger & Lindblad, 2021), these critiques highlight the need to remain vigilant about potential imbalances and exclusions within co-creation frameworks.

3. The Contribution of KM in Public Value Co Creation

In an increasingly complex and dynamic governance landscape, knowledge management (KM) has emerged as a critical enabling of public value creation. Public sector organizations are facing rising demands for transparency, responsiveness, and innovation from diverse stakeholders. Against this backdrop, KM provides the tools and frameworks necessary for harnessing institutional knowledge, facilitating organizational learning, and enabling collaborative problem-solving. These functions are essential for creating public value, which involves delivering outcomes that are meaningful and beneficial to society, encompassing economic, social, political, and environmental dimensions (Moore, 1995; Benington, 2011).

At its core, knowledge management refers to the systematic process of acquiring, organizing, sharing, and applying knowledge to improve organizational effectiveness (Nonaka & Takeuchi, 1995; Davenport & Prusak, 1998). In the public sector, this translates into improved policy formulation, evidence-based decision-making, and enhanced service delivery. By managing both explicit knowledge (e.g., data, documents, procedures) and tacit knowledge (e.g., expertise, skills, institutional memory), public organizations are better equipped to respond to societal challenges, reduce inefficiencies, and innovate in ways that generate long-term public value. For instance, knowledge repositories and decision support systems allow public managers to draw upon past experiences, reducing redundancy and enabling more strategic resource allocation.

Knowledge management contributes to public value creation by enhancing internal organizational learning and fostering a culture of continuous improvement. This is particularly crucial in the context of adaptive governance, where public institutions must be able to learn from feedback, assess performance outcomes, and adjust their strategies accordingly (Argyris & Schön, 1978). KM systems facilitate this learning loop by capturing and analyzing performance data, enabling public servants to understand what works, under what conditions, and why. This supports more effective program design and implementation, thereby improving the quality and impact of public services. Moreover, the ability to learn and adapt is fundamental to building trust and legitimacy among stakeholders, which are themselves essential components of public value.

Another significant contribution of KM lies in its capacity to support collaborative governance and co-creation processes. Public value is increasingly recognized as the result of joint efforts among public institutions, private sector actors, civil society organizations, and citizens (Bryson et al., 2017; Ansell & Torfing, 2021). In such multi-actor environments, the exchange and integration of diverse forms of knowledge—technical, experiential, contextual—are indispensable for collective problem-solving. KM tools such as knowledge-sharing platforms, digital collaboration spaces, and inter-organizational knowledge networks enable the flow of information and foster mutual understanding among actors with differing goals and perspectives. By breaking down silos and facilitating cross-boundary learning, KM enhances the potential for co-designing and co-implementing policies and services that are more responsive, inclusive, and sustainable.

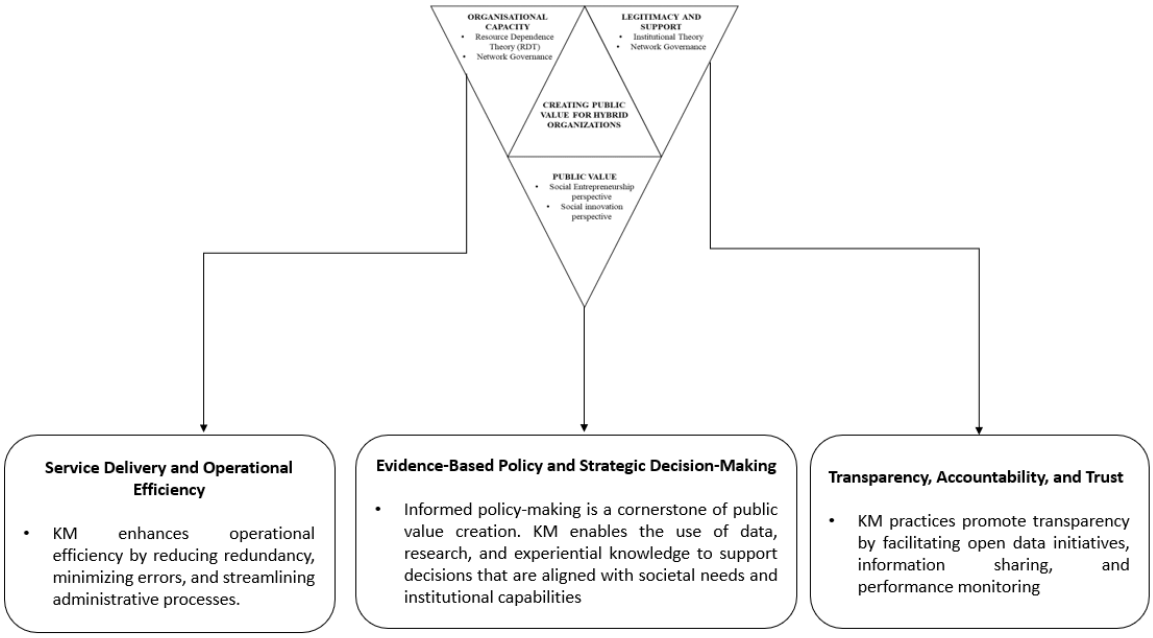
Importantly, KM also contributes to the democratization of knowledge, thereby promoting equity and participation in public decision-making. Access to relevant, timely, and understandable information empowers citizens and stakeholder groups to engage more meaningfully in policy deliberation and service design. This participatory aspect of KM aligns closely with the political dimension of public value, which emphasizes democratic governance, accountability, and civic engagement. Through open data initiatives, knowledge portals, and participatory knowledge platforms, KM helps bridge the gap between institutions and citizens, enabling a more informed and empowered public. Furthermore, by incorporating diverse voices and forms of knowledge into public discourse, KM contributes to the legitimacy and relevance of public policies and services.

Despite its potential, the integration of KM into public sector practices is not without challenges. Organizational resistance to change, lack of technological infrastructure, data silos, and weak knowledge-sharing cultures are among the key barriers. Moreover, the success of KM initiatives depends heavily on leadership commitment, adequate resources, and alignment with strategic goals. Addressing these challenges requires a holistic approach that combines technological solutions with cultural and institutional reforms. Building a knowledge-centric public sector involves fostering an environment that values learning, incentivizes collaboration, and recognizes the strategic role of knowledge in achieving public missions.

Moreover, KM in the public sector encompasses processes that enable the identification, capture, distribution, and application of knowledge to improve public service outcomes. Unlike private organizations that focus primarily on competitive advantage and profitability, public sector entities aim to deliver societal benefits and improve citizens' quality of life (Wiig, 2002). Public institutions rely heavily on knowledge to formulate policy, design services, and engage with stakeholders. Effective KM practices help retain institutional memory, foster innovation, and prevent knowledge silos within government agencies (Cong & Pandya, 2003).

By enabling the systematic reuse of lessons learned and best practices, KM supports adaptive governance and organizational learning (Argote & Ingram, 2000) so public managers can leverage KM systems to align internal processes with strategic goals, improving responsiveness to complex social challenges. Moreover, KM enables cross-agency collaboration and data integration, both of which are critical in addressing interconnected issues such as climate change, public health, and digital transformation.

On this topic academic literature (Cifolelli et. al, 2025; Cepiku, 2022) highlighted that according with Moore (1995) strategic triangle, KM has a leverage effect on the public value creation through several interrelated mechanisms: improved service delivery, evidence-based policymaking, increased transparency, and citizen engagement (Graph. 1)



Graph 1: KM levers in the public value (co)creation process inspired by Ziruolo et al. (2023)

As shown by literature, in terms of service delivery and operational efficiency, KM enhances operational efficiency by reducing redundancy, minimizing errors, and streamlining administrative processes. Public organizations that harness KM tools—such as knowledge repositories, intranet platforms, and decision-support systems—can reduce time spent on repetitive tasks and reallocate resources more effectively (Alavi & Leidner, 2001). For example, municipalities that apply KM to manage service requests and feedback loops have been shown to significantly improve response times and citizen satisfaction (Mas-Machuca & Martínez Costa, 2012). These efficiency gains translate directly into public value by increasing accessibility and reliability of public services.

Considering, "Evidence-Based Policy and Strategic Decision-Making", informed policymaking is a cornerstone of public value creation. KM enables the use of data, research, and experiential knowledge to support decisions that are aligned with societal needs and institutional capabilities. Through knowledge sharing and organizational learning, public agencies can anticipate risks, evaluate policy alternatives, and assess long-term impacts (Heisig, 2009). For instance, during the COVID-19 pandemic, governments that employed robust KM practices—such as real-time data dashboards and inter-agency knowledge exchange—were more effective in implementing timely and coordinated responses (Berardi et al., 2021).

Finally, "Transparency, Accountability, and Trust" shows that public value is closely linked to trust in government and the legitimacy of public institutions. KM practices promote transparency by facilitating open data initiatives, information sharing, and performance monitoring. When knowledge is made accessible to citizens and stakeholders, it enhances accountability and fosters civic participation (Nam, 2012). Knowledge-based governance models also encourage ethical conduct and reduce the risk of corruption by creating traceable and auditable decision-making processes (Weber et al., 2009). These factors contribute to building a resilient social contract between the state and its citizens.

Over this framework, empirical studies provided by literature strong evidence KM's role in improving public sector performance and public value. A study by Lee and Choi (2003) found that knowledge sharing significantly enhances organizational performance in the public sector by fostering innovation and responsiveness. Similarly, research by Mas-Machuca and Martínez Costa (2012) in Spanish local governments revealed that KM practices positively influence both internal efficiency and citizen-centered service outcomes.

The OECD (2021) shows that one prominent example is Estonia's e-Governance model, which has become a global benchmark for digital innovation in the public sector. Through the implementation of interoperable data systems and secure digital platforms, Estonia has institutionalized KM to provide seamless public services, such as e-taxation, e-residency, and e-health (OEC. These KM efforts have not only streamlined administrative processes but also increased citizen trust and satisfaction by ensuring transparency, data security, and participatory governance.

On the other hand, the United Kingdom's National Health Service (NHS) Knowledge and Library Services, developed a comprehensive KM framework to support evidence-based decision-making across the healthcare system. The service provides healthcare professionals with access to clinical evidence, case studies, and digital learning tools. By embedding KM into medical practice, the NHS enhances the quality of care and enables more effective resource allocation—both of which are critical to generating public value (Ward et al., 2014).

Meanwhile In ASIA (Philippines), the "Knowledge Management Portal for Climate Change" was created to centralize information related to climate adaptation and mitigation. This portal, developed by the Climate Change Commission, provides policymakers, researchers, and local governments with data, toolkits, and best practices. By facilitating knowledge sharing among stakeholders, the platform strengthens policy coherence and improves the country's resilience to environmental risks, thereby contributing to public value in the form of environmental security and sustainable development (UNDP, 2016).

Last but not least, during the COVID-19 Emergency OMS used the KM leverage creating an academic repository including all the academic contributions on the topic "Healthcare emergency" including over 1.000.000 scientific contribution from all over the world and different academics disciplines (Medicine, economy, engineering, math, social services, financial distress, enterprises organizations, OMS, 2025).

4. KM as a Leverage to Co-Create Sustainable Public Value

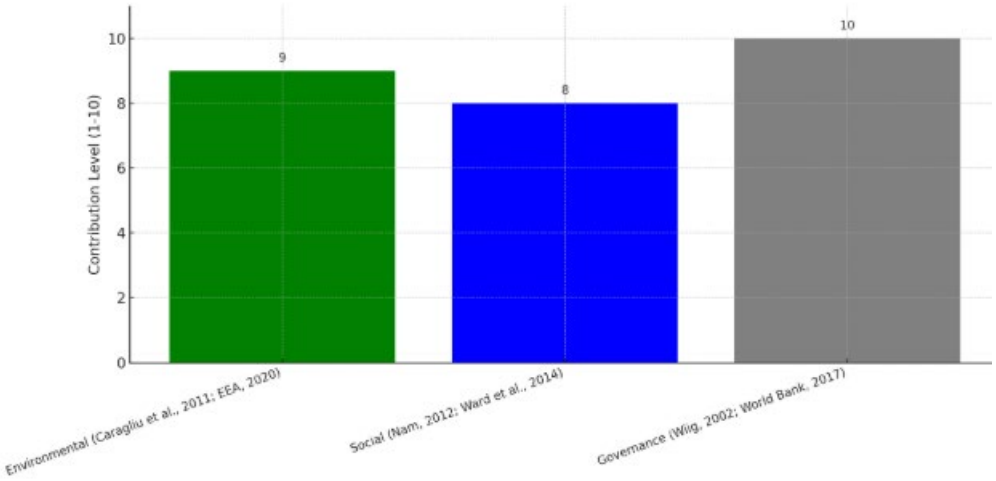
As we know, we are living in an era defined by environmental crises, social inequality, and calls for greater institutional accountability so the public sector faces mounting pressure to deliver value that is not only efficient but also sustainable. In this context, the ESG framework has emerged as a key paradigm guiding both public and private organizations toward long-term responsibility and resilience. In the public sector, the creation of sustainable public value definded as "value that benefits current and future generations" (Moore, 1995) depends heavily on the ability to generate, share, and apply knowledge effectively.

Through this paradigm we can define KM as the systematic process of acquiring, organizing, sharing, and utilizing knowledge to achieve strategic goals (Dalkir, 2017), and as previously shown, plays a critical role in supporting ESG initiatives and embedding sustainability into public governance.

While ESG originated in the corporate world, its principle environmental responsibility, social inclusion, and good governance—are highly applicable to public administration (Bovaird & Loeffler, 2016) so, KM leberages enables public organizations to systematically gather data, apply insights, and disseminate best practices in ways that align operations with ESG goals.

In this sense, literature shows that the integration of KM within sustainability governance structures supports knowledge co-production, cross-sectoral learning, and a long-term strategic orientation (Hartley et al., 2017). In fact, KM supports environmental sustainability by enabling the integration of environmental intelligence into decision-making and policy formulation. Governments and municipalities use KM systems to track climate data, environmental indicators, and ecological risks. For instance, smart city platforms that consolidate sensor data and citizen feedback can guide sustainable urban planning and reduce carbon footprints (Caragliu et al., 2011). In addition, KM facilitates the development and sharing of green innovations across agencies and jurisdictions (Shehzad et al., 2024).

As shown by many international agencies and institutions, Km contributes to ESG agenda building up extensive knowledge repositories and interactive platforms that provide stakeholders with actionable information on biodiversity, air quality, and climate adaptation strategies (EEA, 2020). These tools not only enhance the efficiency of environmental programs but also foster learning and collaboration across borders—key elements of sustainable public value. As argued by Schiuma and Lerro (2008), KM are fundamental to supporting environmental innovation by connecting dispersed knowledge assets in public sector ecosystems (Graph. 2).



Graph 2: The leverage of KM over the contribution of sustainable (co) creation of public value

The social dimension of ESG emphasizes inclusivity, equity, and community well-being. KM contributes to these goals by democratizing access to information and promoting participatory governance. Open data portals, community knowledge networks, and digital literacy initiatives allow marginalized groups to engage in decision-making and benefit from public services (Nam, 2012). Moreover, knowledge-sharing practices within public agencies improve social outcomes by making service delivery more responsive to diverse needs. KM practices such as after-action reviews, knowledge repositories, and community-of-practice models facilitate organizational learning that is critical in addressing inequality and social fragmentation (Choi & Chandler, 2015). For example, KM initiatives in public health—such as knowledge exchanges between local and national

health authorities—have proven vital in addressing health disparities and improving population-level health outcomes (Ward et al., 2014). When public knowledge is shared across institutional and societal boundaries, it helps to build equitable systems and strengthen the social fabric

Good governance, the third pillar of ESG, depends fundamentally on the transparency, accountability, and ethical functioning of public institutions. KM fosters these outcomes by enabling traceable decision-making, performance monitoring, and organizational learning. Through documentation of institutional knowledge, feedback mechanisms, and risk management frameworks, KM ensures that decisions are informed, justified, and aligned with long-term public interest (Wiig, 2002). Knowledge-based systems and performance dashboards also assist in real-time tracking of program outcomes and compliance, promoting adaptive governance (Meijer, 2014). One compelling example is the adoption of knowledge dashboards and performance analytics by public financial management systems. These tools enhance fiscal transparency and allow both officials and citizens to evaluate government spending and policy impact. The World Bank has emphasized the importance of KM in building "learning states"—governments that use evidence and institutional knowledge to continuously adapt and improve governance practices (World Bank, 2017). Furthermore, embedding KM in anti-corruption strategies, as seen in several Latin American public reforms, helps create ethical standards and institutional memory that reinforce public accountability (Perry et al., 2006).

Despite the relevance of the topic, there is still a lack of case studies highlight how KM underpins ESG-aligned public value creation. The Netherlands' National Climate Agreement, for instance, involved extensive knowledge-sharing among stakeholders, including government agencies, researchers, and civil society. KM platforms enabled collaborative policy development and tracking of sustainability goals, resulting in more inclusive and evidence-based climate action (OECD, 2020). Similarly, South Korea's Government 3.0 initiative has demonstrated how KM can enhance transparency and citizen engagement. By integrating big data analytics and knowledge portals across ministries, the initiative improved decision-making, service personalization, and citizen trust—key components of sustainable public value (Lee, 2016). The United Nations Development Programme (UNDP) also supports KM in developing countries through knowledge hubs that focus on sustainable development goals (SDGs). These platforms facilitate south-south knowledge exchange and institutional capacity-building, enabling governments to design and implement more effective ESG-oriented policies (UNDP, 2018).

5. Conclusions

Despite its potential, the contribution of KM leverages in the process of co-creation pf public value faces several challenges. Organizational culture remains a significant barrier, as bureaucratic norms may discourage open communication and knowledge sharing (Cranfield & Taylor, 2008). Additionally, many public organizations lack the technological infrastructure, or the human capital required to maintain dynamic KM systems. Data privacy, security, and the risk of overloading information are also concerns that must be managed carefully.

Moreover, public agents must address the digital divide (Berardi et al, 2021; Lee, 2016) to ensure equitable access to KM-enabled services. This includes providing training, investing in digital literacy, and designing inclusive knowledge systems. Without deliberate attention to these issues, KM may inadvertently exacerbate existing inequalities and limit the generation of public value.

The integration of KM into public governance represents a foundational strategy for advancing sustainability objectives across environmental, social, and governance (ESG) domains. As this paper has demonstrated, KM not only enhances operational efficiency and policy coherence but also enables the dynamic capabilities required to respond to the complex challenges of sustainable development. By boosting evidence-based decision-making, facilitating inter-organizational learning, and enabling participatory governance, KM serves as a catalyst for creating enduring public value.

In the environmental scenario, KM supports sustainability by facilitating the flow of climate intelligence, ecological data, and environmental best practices, which are essential for designing adaptive and resilient policies. Socially, KM promotes inclusivity and equity by expanding access to knowledge, empowering marginalized communities, and enabling more responsive public services. In governance, KM strengthens transparency, accountability, and institutional learning, reinforcing the ethical and strategic foundations necessary for long-term legitimacy and trust.

The literature and case studies reviewed underscore the pivotal role of KM in shaping "learning states" that are not only reactive but proactively aligned with ESG imperatives. However, the effectiveness of KM in public

value creation depends on overcoming key barriers such as institutional silos, cultural inertia, and ethical concerns in data usage. To address these challenges, public institutions must invest in human capital, robust technological infrastructure, and governance frameworks that prioritize knowledge ethics and stakeholder engagement.

Moreover, Knowledge Management is not merely a technical tool but a strategic governance approach that enables the public sector to co-create value with society, deliver sustainable outcomes, and meet the evolving expectations of twenty-first-century governance. As the ESG agenda becomes increasingly central to global and local policymaking, KM will remain indispensable in translating vision into action and fostering resilient, just, and sustainable societies.

Ethics and AI declaration: We authors declare ethical clearance was not required for the research and we used AI Python and ChatGPT to elaborate graph 1 and graph 2.

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Collaborative GenAI: Humanized Interaction Fields for Knowledge Creation

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Abstract: Generative AI (GenAI) is increasingly becoming part of our habits, both in our professional and private lives. The use of this is a way to shape, change and influence knowledge creation and utilisation, and thus a very interesting phenomenon for the field of Knowledge Management (KM). In a previous work, the authors of this paper focused on the bidirectional effects of KM processes due to the interaction between humans and machines using natural language as a medium. The result of this work was the generative and responsive artificial intelligence (GRAI) model, which not only generates content on demand, but also adapts and modifies knowledge-related interactions. This research focusses on the concept of interaction fields and investigates the collaborative nature of those interaction fields to develop the conceptual model even further. This is achieved by relating to the characteristics of collaborative robotics (COBOTs) as an established form of human-machine interaction and the main differences of human-machine interactions to derive the concept of Humanized Interaction Fields (HIF) that describe relevant aspects of interaction in the field of Human-centered AI (HCAI). The research contributes to the understanding for the co-creation of knowledge between human and machine.

Keywords: Generative AI, Collaboration, Knowledge management, Knowledge creation, LLM

1. Introduction

As Artificial Intelligence (AI) and more specifically Generative AI (GenAI) becomes a part of professional and in the private life, it becomes more important to investigate the implications of those uses and study the way we interact with this new technologies. In particular, this technology shapes, changes and strongly influences Knowledge Creation and Knowledge and is already changing our accustomed behaviours. Thus, it is a very interesting phenomenon to study in the realm of Knowledge Management (KM). In previous work the authors focused on the bidirectional impact of Knowledge Management processes due to the interaction of human and machine using natural language as a medium. The model of a Generative and Responsive Artificial Intelligence (GRAI) that does not only generate content upon request but also adapts and changes the knowledge related interactions was developed in this research (Böhm and Durst, 2024).

GRAI introduced the concept of interaction fields and in this research the authors investigate the collaborative nature of those interaction fields to develop the conceptual model even further. An important aspect seems to be that natural language is the carrier for the common collaboration space during knowledge creation and knowledge use. It provides a common ground between men and machine as the language capabilities of the machine have increasingly improved leading to a new level of (implied) trust and (attributed) individualization.

In order to investigate that collaborative nature of human machine interaction a relation is drawn to the field of collaborative robotics (COBOTS). These type of robotic systems differ from the traditional industrial robotics as the collaboration of humans and robots is assumed in the design having direct impact on the robotic machines. In a similar way GenAI that is build to work together with the human in creating new knowledge (as a form of co-creation) is different from the setting that a GenAI just generates the desired output based in an initial stimulus.

This research contributes to understanding the co-creational power of substantial collaboration between men and machine as an emerging pattern. Understanding the mechanics, the advantages and the disadvantages of this pattern is important to develop KM further – in terms of the interaction (pattern) between men and machine.

Specifically the authors derive important properties for such a collaborative interaction field that has human characteristics and build the foundation for systems that proactively use GenAI to build the future KM systems. By doing so, the KM resource based view in which GenAI is understood as just another resource to be used for KM is changing towards a view in which the use of GenAI technologies actually change the way how knowledge is being created and used. It adheres to related fields like the Human Computer Interaction (HCI) and interaction research in general.

The field of HCI has a long tradition (Karat and Karat, 2003) and evolved over the last decades, but the advent of Generative Artificial Intelligence systems changed the human machine interaction significantly. Many studies dealt with the new, often text-based declarative interfaces and the interaction pattern that developed along with those (e.g., so called v"prompting techniques"). Recent research also discovered a changes in the human computer interaction when AI is being used (Xu et al., 2023)

Thus, Human-centered AI (HCAI) is and approach in the development of AI systems that is becoming more important.

An extensive study by Garibay et. al. identified six grand challenges in the domain of HCAI: (1) It is centred in human well-being, (2) is designed responsibly, (3) respects privacy, (4) follows human-centred design principles, (5) is subject to appropriate governance and oversight, and (6) interacts with individuals while respecting human's cognitive capacities. (Ozmen Garibay et al., 2023). Among those challenges the interaction human and AI (or more general the machine) is the most interesting concepts. The authors in the study differentiate several stages as shown in figure 1 below (reproduced from (Ozmen Garibay et al., 2023): The levels of human-AI (H–AI) system interactions are level 1 = working separately or competing; level 2 = supplementing each other work; level 3 = interdependent on each other and finally level 4: full collaboration.

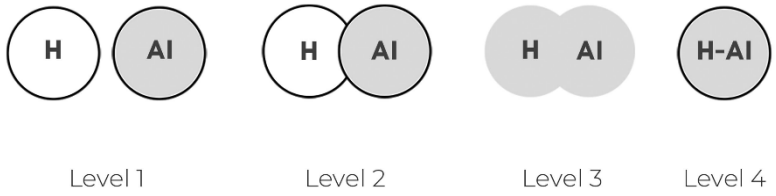


Figure 1: Different Levels of interaction (Source Garibay et. al.)

As the development and deployment of HCAI continues, standards and best practices are evolving. An extensive overview on currently available and evolving standards can be found at (Zhao and Xu, 2025).

The different levels of interaction proposed by Garibay et al. correspond well with GRAI while the focus of the former is on general HCI and the latter focusses on knowledge intensive interactions between human and machine. An interesting aspect of Gribay is the distinction of different levels, which indicate an intensified interaction over time and/or for different application areas.

To develop and verify theory of the GRAI model, different research methods should be applied (Wacker, 1998). This paper uses analytical research as described by Wacker (1998). More precisely, we associated the procedures taken with the analytical conceptual research type that tries to add new insights through the logical connection of past (existing) research. In this context the research is aiming at developing the specific characteristics of the interaction of the human user and the machine (using GenAI technologies) within the domain of knowledge creation and knowledge use.

The remaining paper is structured as follows: In the following section the interaction pattern in the field of collaborative robotics is introduced. Section 3 compares the interaction of human actors with the interaction of human-machine interactions. The following section synthesizes these findings in the novel concept of a humanizes interaction field and derives the main characteristics of such an interaction. The paper concludes with a summary on the results and the next steps in this line of research.

2. Collaborative Interaction in the Field of Robotics

The use of robotic technologies in industrial settings has a long tradition and was a game changer in terms of efficiency and speed of processes on the shop floor. These traditional industrial robots operated in specific work environments to ensure worker safety and need individual programming for every task. Later collaborative robots (COBOTs) appeared that differ from classical industrial robots as they have been designed for the collaboration with the human worker. It is interesting to note, that this main aspect of interaction with a human user (the worker) changed many characteristics of robotic systems. In table 1 below some of the main differences are listed, extensive comparisons can be found in the literature (Faccio, Bottin and Rosati, 2019; Patil, Vasu and Srinadh, 2023). The synthesis of the human actor and the robotic system was already foreseen some time ago (Romero et al., 2016), but took much longer to become slowly a reality are a special type of industrial robot that are particularly designed for direct interaction with humans (Romero et al., 2016), but the advent of humanoid robotic systems changes the level of human-machine interaction even more (Friedman, 2025).

Table 1: Differences of traditional industrial robotic systems and collaborative robotic systems

Feature	Collaborative Robots (Cobots)	Traditional Industrial Robots
Human-robot interaction	Direct and continuous collaboration with humans	No direct human interaction, fenced-off areas
Safety measures	Force-limiting, vision-based safety, no barriers	Requires physical safety barriers and enclosures
Work environment	Open, shared with human workers	Restricted, requires isolation
Speed and force limitations	Low speed and force for safety	High speed and force, unsafe for direct contact
Programming complexity	Intuitive, low-code/no-code, easy to reprogram	Requires specialized coding and expertise
Task flexibility	Versatile, adaptable to different tasks	Optimized for repetitive, predefined tasks
Installation and setup	Quick deployment, minimal infrastructure changes	Requires extensive setup and integration
Space requirements	Compact, does not need safety fences	Large footprint due to protective barriers

For the conceptual development of the human-machine interaction in the field of knowledge creation and knowledge use the developments in robotics are interesting because the aspect of collaboration substantially changes the machines, their functions and their characteristics. In that field collaboration also comes at a cost, e g., less speed, more aspects of safety in order to make the collaboration more human (compatible). This might be also the case in the knowledge management areas: Acting in the same collaborative digital space during knowledge creation would also mean to take the speed of humans into consideration (concerning the individual knowledge absorption, contextual understanding, knowledge levels and so on). The new level of human and machine collaboration using natural language, context and a level of understanding paved the way for a collaborative knowledge creation of human actor and machine in a similar way that it can be observed with COBOTs. In contrast the classical industrial robotics can be seen as a way of automating and optimizing an information process using ICT without or only with oversight of the human user.

3. Interaction Fields in the Knowledge Creation - Human Interaction Properties for the Transfer to the Machine to Human Collaboration

In order to develop a better understanding of the interaction of different actors and thus to come closer to the objective of this paper, it seems useful to show how the interaction between human to human and human to machine differs. Table 2 lists some of these differences and were derived from existing research (Krämer, Von Der Pütten and Eimler, 2012; Walter et al., 2014; Alarcon et al., 2023).

Table 2: Differences between Human-Human Interactions and Human-Machine (Robot) Interactions

Feature	Human-Human Interactions	Human-Machine (Robot) Interactions
Emotional Intelligence	Involves genuine emotions, empathy and the ability to perceive and respond to subtle emotional cues.	Simulated or limited: Machines may mimic emotional responses, but lack genuine feelings.
Communication	Involves verbal, nonverbal, and contextual communication.	Often structured: Relies on programmed language and data interpretation. May lack contextual understanding.
Contextual Understanding	Humans naturally interpret social, cultural, and situational contexts, allowing for flexible and nuanced communication.	Dependent on programming: Machines require explicit programming and data to understand context, and they may

Feature	Human-Human Interactions	Human-Machine (Robot) Interactions
		struggle with ambiguous or novel situations.
Adaptability	Humans can adjust their communication and behavior in response to changing social dynamics and unexpected situations.	Machines' adaptability is limited by their programming, and they may struggle with unpredictable or novel scenarios.
Intuition and Creativity	Humans possess intuition and creativity, allowing for spontaneous problem-solving and the generation of novel ideas.	AI is making strides in creativity, but true intuition remains elusive. Machines primarily rely on algorithms and data patterns.
Trust	Based on shared experiences, emotional connection, and perceived trustworthiness.	Based on perceived reliability and consistent performance.
Ethical considerations	Humans engage in ethical and moral reasoning, considering values, principles, and consequences.	Machines' ethical and moral decision-making is determined by their programming, raising questions of responsibility and accountability.
Spontaneity	Human interactions can be spontaneous, unpredictable, and influenced by a multitude of factors.	Machine interactions are generally predictable and follow programmed patterns.
Subjectivity	Each human has their own unique subjective view of the world, that influences every interaction.	Machines, while they can hold and process data, do not have subjective experiences.
Learning	Humans learn and grow through social interaction, gaining new perspectives and developing their understanding of the world.	Machines learn through data input and programming updates, lacking the organic nature of human learning.

Trust, in general, is a key aspect of any well-functioning interaction (Kaplan, Kessler and Hancock, 2020). The same refers to KM and different KM processes (Holste and Fields, 2010; Rutten, Blaas-Franken and Martin, 2016). Trust has been defined as “the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party (Mayer et al., 1995, p. 712). Existing research suggests that humans evaluate a non-human referent differently from a human counterpart, which means, in turn, that humans have different schemas for machines (robots) and humans (Alarcon et al., 2023). The unique agent hypothesis, for example, argues that people have biases for and against automation referents, which influence how humans interact with and respond to automation. People expect machines to perform perfectly and when they do not, the perceived competence decreases much more in comparison to a human who performed the same task (De Visser et al., 2016).

Against the background of the different strengths or weaknesses of the human and machine actors as highlighted in table 2, it could thus be argued that these actors would be better together. The content of table 2 suggests that there are moments in which the human is clearly ahead of the machine, e.g., when seeing the big picture, but also moments in which the machine is superior to the human, e.g., with repetitive tasks found in the manufacturing process.

However, this would mean that the actors must be on the same page. In order to increase the likelihood of interaction between humans and machines, it seems important that the communicative behaviour and relational abilities of the machine resemble those of humans. Furthermore, humans seem to be more willing to interact with certain machines that promise a higher benefit (Krämer, Von Der Pütten and Eimler, 2012).

In collaborative environments, which is the focus of this paper, humans and machines share a common space. There is no physical separation preventing contacts between these actors, but they work together on a joint

task. This requires in turn that increased safety features need to be in place (Kopp, Baumgartner and Kinkel, 2021).

4. Humanized Interaction Fields (HIF)

Based on the observations of interactions in the robotics domain in section 2 and the general comparison between human-human and human-machine interaction in section 3, this section synthesizes the results from to define the characteristics of interaction fields for knowledge creation and knowledge use in the context of GRAI. As it can be observed with COBOTs the consideration of human aspects (including their limitations) is an important aspect for a successful collaboration. It is therefore paramount, that such a collaboration need to be humanized, which leads to the concept of a Humanized Interaction Field, which is defined as follows:

> *Definition Humanized-Interaction Field (HIF): A HIF is a form of human-machine interaction in the digital domain that embraces in an ongoing collaborative dialogue between human and machine, that takes the individual human capabilities into account. It is driven by the goals of the human user, evolves the generated knowledge over time and creates an integrated User Experience (UX) that amplifies the knowledge absorption capacity in meaningful ways for the human user.*

Currently HIF are targeting the Creation, the Shaping and the use of Knowledge both in an externalized and an internalized form, as the purpose is the application for GRAI (Böhm and Durst, 2024), yet the concept is generally not limited to that. The main intention of HIF is to understand and to describe the main characteristics ("the nature") of an interaction between human and machine with the predetermined intention of collaboratively creating or discovering something new. In the case of KM this relates to the concept of knowledge. The novelty of the created artefact does not to be ultimately new, it can – and in most cases will – just be new to the human user or novel in the context of the situation (e.g., the solution for a given problem), but not new in the sense of an invention.

It is important to understand this humanized aspects to generate meaningful dialogues for the user that are beneficial in terms of reaching the set goal and developing that solution during the dialogue in a way that anticipates the knowledge level of the user. This way the user is able to incorporate the created knowledge assets into her or his existing knowledge and develop it further – also without the help of the GenAI systems. This knowledge creation is the result of a collaborative dialogue and not only the result of a "command-and-deliver" communication pattern that might result in a knowledge asset that works as a solution for the current problem, but cannot be adapted by the user for different but similar contexts. The latter is rather externalized knowledge, while the former includes some form of internalization that happened during the collaborative dialogue already.

Collaborative dialogues between human user and machine will not only help to solve specific problems and generate specific new knowledge assets, but also influence and develop the knowledge creation strategies over time and the reinforcement learning provided to the machine also allows for the adaptation of the GenAI system. As a result, this interaction might lead to a co-evolution of the relation of the human user and he machine (Böhm and Schedlberger, 2023).

Application examples of meaningful collaborative dialogues that should represent an HIF are software development session with AI-coding assistance like Github Copilot or similar solutions. Another scenario might be an GenAI-assisted learning process in a domain relatively new to the human-user using the dialogue pattern with a GenAI. In both scenarios the dialogue and the knowledge creation for the human user go "hand in hand" and creating and using and applying the knowledge become activities that cannot clearly separated from each other. They become entangled in a similar way as it van be observed in a collaborative co-creation process of human actors, where a knowledge asset emerges from the interaction rather than a well planned workflow.

A HIF involves the human user in an inclusive way: it does not overwhelm them and take them along as the knowledge exploration and knowledge creation process unfolds. It explains the content if needed and incorporates ideas and other stimuli of the human user. This is especially important for the learning perspective – providing just enough support ("scaffolding") to enable the learner to take the next step.

On the other side, there is also the phenomenon of too much support – then no more learning takes place. For example, auto-compete in spelling or in programming with IDEs can be seen as examples for "negative scaffolding" – too much support in a knowledge acquisition process might feel like a shortcut as it is solving the current challenge. But it is effectively a barrier for learning, since actual learning did not take place as the learner just applied the proposed solution.

The amplification of knowledge generation using GenAI can also be compared to assisted mechanical systems (e.g., an exoskeleton): They are supportive and are amplifying the capacity of the muscles of our body. But a muscle that is no longer trained, subsequently leads to the loss of muscle mass. Thus, the amplification system has to sides: it is useful in supporting the own muscles or compensating, if not enough muscles exist. On the other side, it might lead to a degradation of muscle mass, if used too long or exclusively. Likewise the use of GenAI in collaborative knowledge creation should be used in a balanced way. A HIF would support this process by supporting the stimulation of our 'cognitive muscles' and amplifying our information processing capacity but also preventing those muscles to degrade.

The synthesis of the characteristics of a HIF based on the observations of the robotics application domain and the distinction between the interaction of human actors and those of a human actor and a machine leads to the three mail characteristics of (1) a joint digital environment, (2) the interaction of to very different actors in this environment and (3) the flexibility of this interaction. In figure 2, below these characteristics are visualized and the influence from the other observation domains is added with a different colour coding.

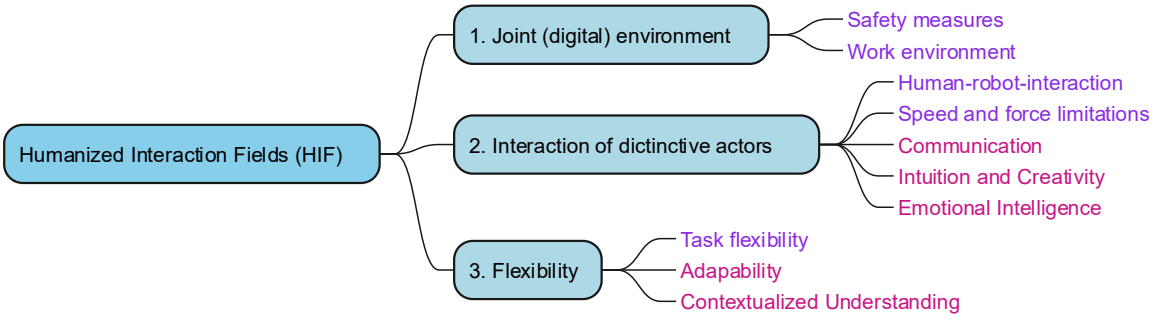


Figure 2: The main characteristics of HIF, influences of other characteristics visualized in violet (COBOTs vs. industrial robots) and red (distinction of human/human vs. human/machine interactions)

The concept of a joint (digital) work environment of two very different agents in a HIF is considered a an important root cause for the development of a successful HCAI as it puts the human agent in the focus and also stresses the agents being "very different by nature". As the COBOTs example demonstrates this aspect implied important design consequences that might also be different from other scenarios in which collaboration is not a central aspect, e.g., the aspect of automating a process by GenAI. Knowledge creation, however is at its core a collaborative and creative process, which makes HIF a good candidate for the interaction fields of GRAI. Likewise, flexibility is often also an important ingredient, when the path for creating new knowledge assets is not clear from the beginning.

When a successful collaboration in the HIF is achieved over several iterations or collaboration events, trust towards the HIF environment is gradually being being build or perceived. Trust is a result of communication and a "perceived (successful) collaboration". The collaboration is (subjectively) perceived from the human user side, because the machine is not having its own goals ans thus follows the stimulation of the human user, leading to a more asynchronous or unbalanced collaboration that is driven by the human-side (opposed to the collaboration of human users where both sides have collaboration goals on their own).

5. Conclusion

In conclusion, this research advances knowledge management by extending the GRAI model—an evolution of Nonaka and Takeuchi's SECI framework—to incorporate GenAI capabilities. This work demonstrates that human-machine interactions are evolving into a pattern, where generative AI complements and augments human knowledge creation and exhibit characteristics that support a successful interaction. The research introduces the concept of the Humanized Interaction Field (HIF), as a novel domain characterized by a joint environment with a flexible interaction of very distinctive actors.

As an analytical conceptual research it lays the groundwork for future empirical studies. To address the limitation of empirical validation, the next steps in are qualitative research, including case studies, interviews, and real-world observations, to validate these interaction fields and offer practical insights into effectively integrating generative AI into knowledge management practices.

The main purpose of this work is to understand the co-creation of knowledge between human and machine from the perspective of the capabilities and limitation of a human user. This understanding is becoming more important as the the collaborative use of GenAI increases across all application domains.

Ultimately, by re-framing generative AI as a collaborative partner rather than a mere tool, this research provides a roadmap for organizations to foster innovation and strategic growth while ensuring that the future of knowledge management remains both technologically advanced and deeply human-centric.

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Types of Knowledge Shared Among Rural Women in the Northern Region of Ghana for Poverty Eradication

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Abstract: This paper explores the types of knowledge shared among rural women in the northern region of Ghana for poverty eradication and make recommendations to enhance knowledge sharing among rural women in the northern region of Ghana. It uses qualitative research approach within an interpretive paradigm, primary data were collected from 111 rural women across the Tintang, Tongnoli, and Nagbali communities through face-to-face interviews, focus-group discussions, and direct observations.The findings reveal that rural women predominantly share indigenous knowledge related to agriculture, traditional crafts, maternal health, societal norms, and various local expertise. However, their access to external formal/technical knowledge is limited, which hinders their ability to enrich their existing knowledge for poverty alleviation. The study recommends expanding access to new types of knowledge through mobile network infrastructure, community radios, and other knowledge-sharing tools. Additionally, providing education and skill development opportunities is essential for fostering innovation and enhancing agricultural productivity. The paper further emphasizes the need to refine and repackage indigenous knowledge in a way that integrates external knowledge while preserving its core value, ensuring that it remains relevant for sustainable development. These findings align with the Sustainable Development Goals (SDGs), specifically Goal 1 (No Poverty) and Goal 5 (Gender Equality). The study was limited to rural women in Tintang, Tongnoli and Nagbali communities in the northern region of Ghana. A further study covering rural communities in other regions in Ghana is recommended.

Keywords: Knowledge sharing, Types of knowledge, Rural women, Northern region, Ghana

1. Introduction

Knowledge sharing empowers rural women and addresses poverty in developing regions (Mchombu & Mchombu 2014:5; Taylor & Ramos 2016). Knowledge itself is a fundamental resource for socio-economic development and poverty eradication (Karlsson & Johansson 2006:3; Romer 1990:71). The ability to make informed decisions about investments in land, labour, technology, and capital hinges on access to relevant knowledge (Fombad 2018:2). It is not just cognitive knowledge (know-what) or technical skills (know-how), but also deeper system understanding and problem-solving abilities (know-why) that enable individuals to address complex challenges and foster growth (Mohajan 2016:10; Quinn, Anderson & Finkelstein 1996). Given that knowledge is power—its absence leaves individuals and communities vulnerable. The lack of access to critical knowledge perpetuates cycles of poverty by limiting opportunities for better decision-making, development and growth (Akhter & Cheng 2020:3; United Nations Women Watch 2012:4).

Rural women in Ghana contribute a significant portion of the agricultural workforce and household leadership (Ghana Statistical Service, 2021). Studies highlight that rural development efforts often emphasize tacit, indigenous, and local knowledge (Burch 2007:5; Cummings et al. 2019:161; FAO 2010:7; Rahman 2000:4). However, technical knowledge, typically acquired through formal education, is also essential for enhancing livelihoods (FAO 2010:7). The distinction between these knowledge types, as well as the challenges in integrating them, stresses the need for structured knowledge-sharing mechanisms (Burch 2007:14). In northern Ghana, poverty rates remain relatively high at 28% (Ghana Living Standards Survey Round 7/GLSS7 2018:17). Literature on rural development and poverty eradication has highlighted tacit knowledge, with most studies focusing on informal, local, traditional, or indigenous knowledge (Burch 2007:5; Cummings et al. 2019:161; FAO 2010:7; Rahman 2000:4; Ugboma 2014). By examining the interplay between indigenous and technical knowledge, the study contributes to ongoing discussions on rural women's empowerment and sustainable poverty eradication aligned with the United Nations Sustainable Development Goals (UN 2017:3-5). In exploring the types of knowledge shared among rural women in the northern region of Ghana, the study was guided by the following research questions:

- What are the types of knowledge shared for poverty eradication among rural women?
- What are the ways by which the types of knowledge shared by rural women in the northern region of Ghana may be enhanced?

2. Literature Review

2.1 Knowledge

Knowledge has been classified into various categories. Zaim, Gürcan, Tarımc, Zaim and Alpkan, (2015:760) categorize knowledge as individual or group, internal or external, hard or soft. Kimble, Hildreth & Wright (2000:3) as practical or theoretical. Fueston (2008:51) identifies revealed, speculative, empirical scientific, and practical empirical knowledge. Bhasin (2019) classify knowledge into thirteen types, including tacit, explicit, empirical, procedural, meta-knowledge, and propositional knowledge. This paper defines knowledge as a flexible, socially driven process where curiosity, conversation, and social ties facilitate learning and the exchange of experiences (Davenport & Prusak 1998:5; Xue 2017:32; Weinberger 2010).

Among all these categories tacit and explicit knowledge are the most common types of knowledge. (Fombad 2018:6; Gamble 2020; Xin 2020:42; Joia & Lemos 2010; Khatun 2018:59). Tacit knowledge exists in the mind as intuition, experience, and know-how (Panahi, Watson & Partridge 2012:648-649). It is personal and based on individual experience (Xue 2017:33), making it the most valuable form of human knowledge (Abidi, Cheah & Curran 2005). For example, an experienced farmer may instinctively treat animal diseases yet struggle to codify his knowledge for a beginner. In rural areas, tacit knowledge is indigenous knowledge, serving as a vital resource for preserving heritage, learning, problem-solving, and innovation (Fombad 2018:6). While FAO (2010:7) advocates for rural women to possess technical knowledge, Bohrer (2012:9) stresses the importance of raising awareness of indigenous knowledge. However, human development is typically measured by formal knowledge, neglecting the capacity of societies to create and exchange knowledge (Cummings et al. 2019:161). The distinction between indigenous and technical knowledge lies in their acquisition—technical knowledge is learned through formal training, while indigenous knowledge is derived from lived experiences (Rahman 2000:4).

2.2 Indigenous Knowledge

Ugboma (2014:60) defines indigenous knowledge as knowledge rooted in a community's tradition or culture, passed down through generations. Often referred to as local, traditional, or ancestral knowledge (Burch 2007:14; Rahman 2000:1), it is inborn and does not stem from formal education. In rural areas, tacit knowledge manifests as indigenous knowledge, evolving within the local community (Tire 2006:63). This knowledge includes not only local wisdom, but also scientific and external knowledge acquired over time (Rahman 2000:3). While it cannot solve all poverty-related issues on its own, it plays a vital role in discussions on poverty eradication in developing countries (Rahman 2000:3). However, gaining the full benefits of indigenous knowledge requires more than simply mobilizing people; it involves initiatives such as shared meetings, radio programs, messages, publications, music, dance, and local knowledge facilitators (Arce & Long 1992:211; Karamagi 2009).

2.3 Formal/Technical Knowledge

Fueston (2008:51) defines formal/technical knowledge as knowledge gained or refined through tools that enhance our physical senses, such as empirical knowledge from qualitative or quantitative observations, experiments, or measurements. Often technology-based and accumulated over time, technical knowledge is challenging to convey through written or spoken forms (Wang, Tseng & Yen 2014:454). To share this knowledge with rural women, particularly those with low literacy, experts or knowledgeable individuals must present it in a more accessible format.

2.4 Acceptable use of Indigenous and Formal Knowledge

The level at which indigenous or formal knowledge is accepted for use by rural communities has become a subject of research (Kolawole 2001:13). It remains unclear how much indigenous knowledge is still relevant, whether certain knowledge systems should be abandoned, and how much external knowledge should be embraced. Kolawole (2001:13) suggests that local communities tend to favor knowledge proven within their own socio-economic, political, and ecological context over foreign ideas. He emphasizes the importance of respecting cultural norms when introducing external knowledge. Addressing the integration of indigenous and formal knowledge, Hess's (2006) argues that successful knowledge-sharing requires mutual respect and trust, a shared language, a common knowledge foundation, and a growth mindset among stakeholders.

3. Research Methodology

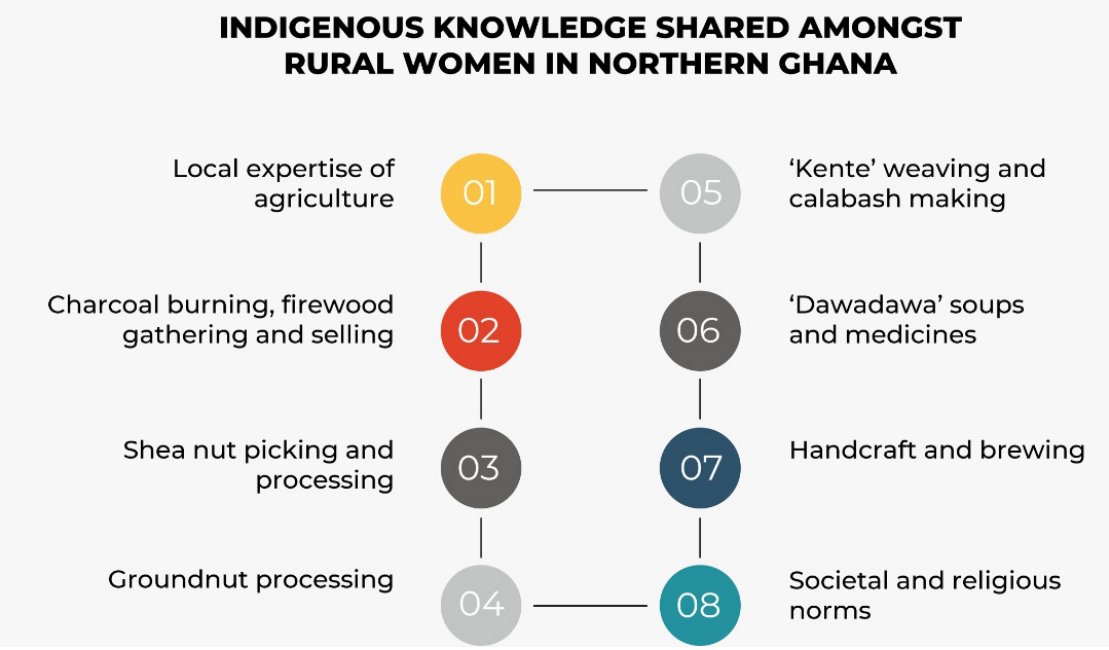
The study adopted a qualitative approach within an interpretive paradigm. The qualitative method allowed for in-depth interaction with rural women, providing insights into their experiences that would not have been possible using a quantitative approach. Primary data was collected from 111 rural participants, with 32

interviewed, 79 involved in focus groups, and 16 observed during various situations. Snowball sampling was employed to recruit interview participants, starting with one identified through a community leader, and subsequent participants were referred by those already engaged. This method was chosen because the total number of rural women in Tintang, Tongnoli, and Nagbali was unknown. Focus-group participants were also selected using snowball sampling, where those interviewed invited other rural women, they knew to join. Throughout the data-collection process, direct observations were made, including during interviews and focus-group discussions. The observations were unstructured, focusing on situations related to the study's objectives and ignoring those that were not. Thematic analysis was applied to the interviews, focus groups, and observations, following Braun and Clarke's (2006) six-step approach. The researchers familiarized themselves with the data by verbatim self-transcribing responses in the participants' local dialect (Dagbani) and translating them into English. After transcription, initial codes were created for each participant, and themes were identified within the responses to find relevant answers.

4. Findings and Discussions

4.1 Indigenous Tacit Knowledge

As noted in Figure 1, indigenous tacit knowledge emerged as the major type of knowledge shared among rural women in the northern region of Ghana. This indigenous knowledge shared a is primarily tied to their local expertise in agriculture, charcoal burning, shea nut picking and processing, and groundnut processing. Handcraft and brewing, hats and 'smock' weaving, calabash making, 'dawadawa' soups and medicines, and gathering firewood are other types of knowledge shared. Indigenous knowledge also involves societal and religious norms like educating their children on how to coexist peacefully with rivals and neighbours. According to the findings, older women pass on indigenous wisdom to younger generations as younger women observe the older women's daily routines. Rural women occasionally gather ingredients or resources and pass on their knowledge to rural girls or anyone willing to learn.



Source: Author's construct (2025)

Figure 1: Indigenous knowledge shared among rural women in the northern region, Ghana

> *"No new knowledge comes from outside the community, but among us, we collaborate to help plough in each other's farm so that each person can cover more acres. We are also able to have more harvest by sharing our indigenous knowledge. It helps us to support each other." N-P1*

> *"We have no knowledge to share apart from teaching each other how to process shea and burn charcoal for sale. However, the roads are bad; we can't even send it out to sell. We just sell to our neighbors" TON-P1*

"The only knowledge we share is on our local farming methods. Not health, education or anything." TIN-P10

"The only knowledge shared with us was on soap making. Every woman in Nagbali was trained in it but the capital to start making the soap is not available. Apart from that we only share our local knowledge on charcoal burning and farming." N-P2

The focus group findings below also confirmed indigenous knowledge as the only knowledge rural women share in the northern region of Ghana.

''We only share our indigenous knowledge which hasn't so far helped us to eradicate poverty. If we get someone to bring us some knowledge that will benefit us and help us out of poverty, we will appreciate it." N-SP1, N-SP2

"We only share the indigenous knowledge our parents passed on to us." TIN-SP1

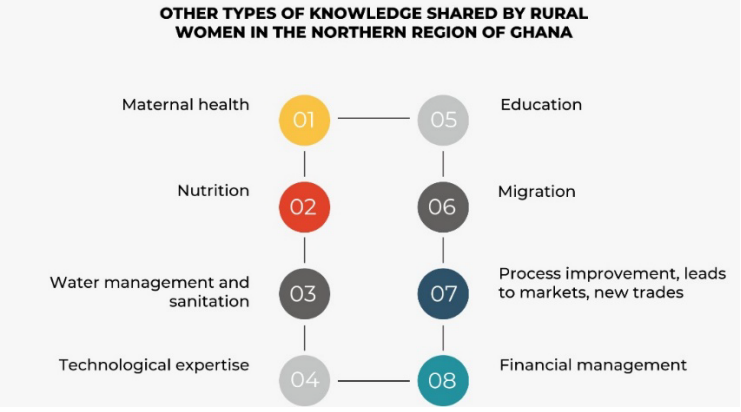
"The only knowledge we have is charcoal burning..." TIN-SP2

From the direct observations, it appeared most rural women appreciated the role indigenous knowledge play in sustaining their livelihoods. They always brought rural girls along to teach them different indigenous types of knowledge. An example is sharing knowledge on how to prepare specific herbal medicines and traditional birth attendance.

Several studies have demonstrated the effectiveness of indigenous knowledge in eradicating poverty among rural women (Adeyeye & Mason 2020:27; Bouzarjomehri 2018:19; Mhlongo 2021:378; Montanari & Bergh 2019:1; Ndlela, Mkwanazi & Chimonyo 2021:6; Nyeleka, Taruvinga, Zhou, & Mopipi 2019:231; Tire 2006:63). Unfortunately, imposing western viewpoints and practices has resulted in the devaluation of indigenous knowledge (Adeyeye & Mason 2020:29; Ali, Buergelt, Paton, Smith, Maypilama, Yuŋgirrŋa, Dhamarrandji, & Gundjarranbuy 2021:15; Ezeanya-Esiobu, Oguamanam & Ndungutse 2020:2). Similarly, several researchers have raised concern about the poor value placed on indigenous knowledge (Adeyeye & Mason 2020:30; Bouzarjomehri 2018:20; Ogar, Pecl & Mustonen 2020:162). According to Bouzarjomehri (2018:20), until recently, although research showed indigenous knowledge and practices to be useful to environmental protection and sustainable livelihood, policymakers and planners rejected them owing to modernisation until the late 1980s. Some participants (e.g. TON-P1 and TON-P2) were unclear about the worth of their indigenous knowledge, indicating that modernity has impacted how some indigenous people regard their local knowledge. While rural women still cherish their indigenous wisdom, the study's findings show that they are fed up with decades of the same procedures and knowledge passed down from their forefathers that never change or develop. This could explain their increased curiosity and drive to learn new things.

4.2 Other Types of Knowledge Shared Among Rural Women

To further understand the type of knowledge shared by rural women, it was crucial to establish their knowledge needs. Using interviews, focus groups and observations, the findings revealed that rural women need new knowledge, including maternal health, nutrition, education, water management and sanitation, education, financial management, technological expertise, leads to market centres and buyers, and knowledge to improve their shea processing and agricultural production as demonstrated in Figure 2 below.



Source: Author's construct (2025)

Figure 2: Other types of knowledge shared by rural women in the northern region, Ghana

This is evident in the following responses from the interview:

> *''We need new knowledge to improve our shea butter processing method. We are unable to process the shea because it goes along with a miller which the community lacks. Even if we had the miller, there is also no electricity for it to operate. The current local knowledge for processing shea butter is long and laborious and yet we get very little from the buyers for the shea butter." TON-P1 and TIN-P1*

> *"We need knowledge on leads to the market centres. Sometimes before we get to the market, sales have been closed due to difficulty in getting a means of transportation from the communities to the market in Sang. By the time we return home, it is usually dark, and we have probably sold nothing." TON-P5*

Most participants expressed the view that there are partner NGOs with the technology to speed up local shea processing times as well as buyer knowledge. Instead of teaching them how to use the technology, they operate as middlemen, buy the shea nuts for less from the rural women, and then use their equipment to extract the shea for sale at higher prices. This prompted TON-P1 to express that learning about new technology will help them advance their understanding of turning shea nuts into shea butter. A traditional birth attendant, TON-P3 also had this to say:

> *"I need new knowledge as a traditional birth attendant to enhance baby deliveries. I therefore do wish that my knowledge of childbirth will be updated to reflect contemporary procedures used elsewhere. Right now, sometimes the issues are beyond me.*

The interview findings was corroborated by the focus group finding where new knowledge emerged as a key theme in the types of knowledge rural women need as reported in the following responses.

> *"We need knowledge on how to prepare liquid soap like other communities" TIN-SP1*

> ***"**Any kind of knowledge that can help improve our lives would be welcomed." TIN-SP2*

The researchers observed that the current procedures the group of rural women employed to complete the local shea butter production process from beginning to end were time-consuming. Technology to improve this lengthy process is what most of the rural women desire.

While rural women still cherish their indigenous wisdom, the study's findings show that they are fed up with decades of the same procedures and knowledge passed down from their forefathers that never change or develop. This could explain their increased curiosity and drive to learn new things. The sharing of new types of knowledge is viewed as critical for rural women's poverty eradication (Eitzinger, Cock, Atzmanstorfer, Binder, Läderach, Bonilla-Findji, Bartling, Mwongera, Zurita & Jarvis 2019:110; Makate 2019:277; Mchombu & Mchombu 2014:5; Upali 2013:184; Wei et al. 2021:2). Meanwhile, a healthy combination of indigenous and other formal/technical knowledge has been promoted by several researchers (Bouzarjomehri 2018:18; Hess 2006; Kolawole 2001:13; Makate 2019:282; Ogar et al 2020:163). As a result, when new knowledge is transmitted among rural women, a strategy is required to ensure that the knowledge to be shared is not one-sided; this study intends to fill that need.

5. Recommendations to Enhance the Types of Knowledge Shared Among Rural Women in the Northern Region of Ghana

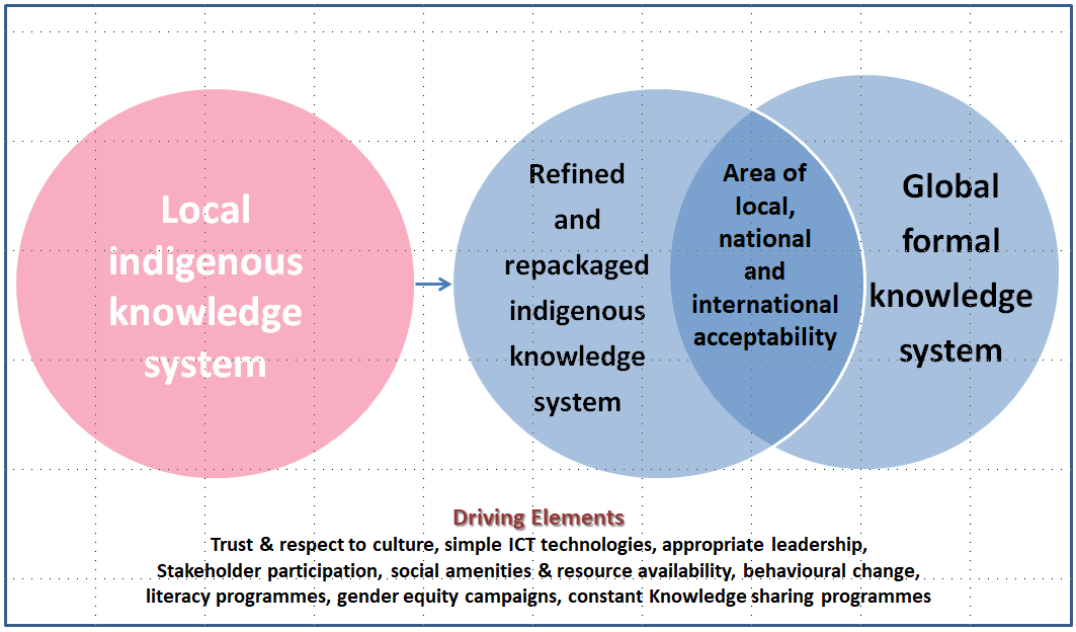
The finding revealed that rural women share indigenous knowledge but have limited access to formal/technical sources of knowledge to enrich their existing indigenous knowledge for poverty eradication. The researchers, therefore, suggests the following:

There is a need for rural women to increase their access to new types of knowledge to enhance poverty eradication. This could be accomplished by expanding mobile network access, community radios and usage of other knowledge-sharing tools and techniques suggested in the "Knowledge Sharing Strategy for Poverty Eradication among Rural Women" proposed by Bonuedie and Fombad (2024, p.12). These tools and techniques will improve access to new types of knowledge, such as maternal health, nutrition, water management, new trades, migration, education, process improvement, market leads, sanitation, and introduction to technologies that can scale up agricultural production and access to market information.

Efforts could be directed towards the education and skill development of these women. Providing rural women with training and educational opportunities will inspire their intellectual abilities to generate new ideas and novel solutions, which will result in the establishment of alternative businesses in rural communities to support

their agricultural production, as well as improve their capacity to receive other types of knowledge shared on new farming techniques and assimilate new technologies that are critical for increasing agricultural productivity.

New or external knowledge should be utilized to refine and repackage indigenous knowledge. The acceptable levels of indigenous and technical knowledge when refining and repackaging indigenous knowledge have become a subject of research (Ali et al., 2021; Dutfield, 2017; Kolawole, 2001). The question remains how much indigenous knowledge should be preserved, which knowledge systems to abandon, and how much formal knowledge should be adopted to enrich it. Findings suggest that simply overlapping indigenous and formal/technical knowledge may result in competition, with indigenous knowledge losing acceptance. Bouzarjomehri (2018) emphasized that indigenous and formal knowledge should complement, not compete with, each other. Refining indigenous knowledge involves removing undesirable aspects, while repackaging presents it in a more understandable and usable format (Mole, Ekwelem & Din, 2018). Some repackaged indigenous knowledge can be commercialized, while others may not. Trust, respect for culture, stakeholder participation, and ongoing knowledge-sharing are key elements of this theory.



Source: Researcher's construct (2025)

Figure 3: Theory on the refinement and repacking of indigenous knowledge

6. Conclusion

This paper explores the types of knowledge shared among rural women in the northern region of Ghana and established the types of knowledge shared for poverty eradication. Among which are knowledge related to local expertise in agriculture, charcoal burning, shea nut picking, processing, groundnut processing, handcrafting, brewing, weaving, and other traditional practices. Additionally, knowledge on societal norms, maternal health, nutrition, water management, climate change, and financial management are also shared. Despite the richness of indigenous knowledge, the study highlighted that rural women had limited access to external sources of knowledge that could enrich their existing knowledge for poverty alleviation. The findings further revealed the importance of sharing indigenous knowledge among rural women. Based on these findings, it was concluded that while rural women in northern Ghana predominantly rely on indigenous knowledge for poverty eradication, there is a need to enhance their access to external knowledge sources. This could significantly expand their capacity for overcoming poverty and improving their livelihoods. The paper recommends an increase access to new knowledge through mobile networks, community radios, and other knowledge-sharing tools that complement indigenous knowledge. Additionally, providing education and skill development opportunities will empower rural women, enabling them to generate innovative solutions, improve agricultural productivity, and integrate new technologies that can drive economic growth. The paper also suggests that external knowledge should be used to refine and repackage indigenous knowledge in ways that preserves its value while enhancing its applicability. A participatory approach that involves rural women and stakeholders is crucial when refining indigenous knowledge to avoid devaluation, as modifying it without due care can lead to its misrecognition. This

paper emphasizes the importance of preserving indigenous knowledge while also integrating new, external knowledge to enrich the types of knowledge shared among rural women.

The study was limited to rural women in Tintang, Tongnoli and Nagbali communities in the northern region of Ghana. A further study covering rural communities in other regions in Ghana is recommended. Second, despite the use of local interpreters fluent in Dagbani and other dialects, subtle meanings embedded in indigenous expressions may not have been fully captured or translated. Lastly, due to resource and time constraints, the research was limited to adult and younger women and did not include perspectives from men, who also play a role in knowledge transmission and community decision-making. Future research should explore how these recommendations can be applied in other rural communities. A mixed-method approach could also be considered in future for a more comprehensive understanding of the types of knowledge shared among rural communities in Ghana.

7. Practical and Theoretical Implications

Theoretically, the study contributes to ongoing discussions on knowledge integration in rural development by highlighting the complementarity of indigenous and formal knowledge. While indigenous knowledge—such as farming practices, craft-making, and maternal care is contextually grounded and widely shared among rural women, the findings reveal that its transformative potential is constrained without access to external technical knowledge. This reinforces existing literature that recognises the importance of both tacit and explicit knowledge in addressing complex development challenges (Cummings et al. 2019; Xin 2020:42).

Practically, the study offers context-specific recommendations to improve knowledge sharing among rural women in the northern region of Ghana. These include:

- Expanding access to new knowledge through improved mobile network coverage, community radio programming, and other accessible communication tools;
- Strengthening educational and skills development opportunities to enhance women's capacity to absorb and apply both indigenous and external knowledge;
- Promoting the refinement and repackaging of indigenous knowledge in a way that maintains cultural integrity while integrating useful external insights.

These implications are aligned with broader development objectives and policy frameworks, particularly the Sustainable Development Goals—Goal 1 (No Poverty) and Goal 5 (Gender Equality). The findings highlight the importance of inclusive and adaptive knowledge-sharing strategies that build on existing community strengths while addressing knowledge gaps that hinder innovation and productivity.

Ethics declaration: This is part of the PhD findings of the student at the university of South Africa the University of South Africa's (UNISA) ethical clearance standards were followed. The acknowledged all sources cited, listing all complete quoted references, and signing a declaration that the contents are the researcher's work. The researcher asked the Mion district assembly for permission to study the three rural communities in their district after gaining consent from the university.

AI declaration: No AI tools were used in the creation of the paper.

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AI-Supported Learning for Relational Capital Development: A Case Study in Higher Education

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Abstract: The systematic development of Relational Capital as part of Intellectual Capital is a critical element for career success. In two Austrian Master's programs in digital technology and innovation at FHWien der WKW, an innovative teaching approach integrated AI-assisted learning with individual coaching. A customized GPT model was deployed as a structured reflection tool, assisting students in assessing and strategically developing their professional networks over the course duration. While traditional lecture time was reduced to two hours, instructional resources were redirected to AI-assisted learning and to group-coaching to enhance learning outcomes.-This case study examines the use of generative AI as a dialogic tutor in a master's program on digital economy. Drawing on anonymized AI-student transcripts, coaching reflections, and structured prompts, the paper explores how AI supports strategic development of Relational Capital. Findings indicate high learner acceptance, evolving trust strategies, and improved metacognitive learning outcomes. AI shows strengths in guiding students through structured career planning exercises. However, concerns over trust and confidentiality emerged and lead students to adopt anonymization techniques to protect sensitive professional relationships. Beyond Relational Capital development, this study also highlights key pedagogical implications. AI's effectiveness depends on high-quality learning materials, and students required training in prompt engineering to navigate information overload. The role of educators shifted towards facilitating learning processes, mentorship and strategic guidance, focusing on critical engagement with AI-generated content. This case study contributes to the discourse on AI integration in higher education. It demonstrates its role not only in developing Relational Capital but also in shaping self-directed learning behaviors and pedagogical innovation.

Keywords: Relational capital, Generative AI, Dialogic tutoring, AI-Augmented learning, Prompt engineering in higher education

1. Introduction

Artificial intelligence (AI) has been integrated into higher education in various capacities over the past two decades, primarily through adaptive learning systems, intelligent tutoring, and predictive analytics (Zawacki-Richter et al., 2019; Marengo et al., 2024). These applications have traditionally focused on specific, narrowly defined tasks, such as automated grading, personalized learning pathways, and early warning systems for student retention. These tasks were reported by Salas-Pilco & Yang (2022) and Crompton & Burke (2023) for a global perspective.

However, the emergence of large language models (LLMs), such as OpenAI's GPT-4 and Google's Gemini after 2023, marks a fundamental shift in AI's role in education. These models enable general-purpose reasoning, dynamic content generation, and open-ended student interaction, fundamentally altering previous assumptions about AI in learning environments (Imran & Almusharraf, 2024). LLMs provide a general-purpose AI model that can write, analyze, explain, and generate educational materials dynamically. This shift challenges previous assumptions about how AI interacts with students and educators.

According to Open.ai (2024), LLMs require no pre-programmed task-specific training, unlike traditional AI applications that had to be developed for specific educational functions. Students and faculty can engage in natural conversations with LLMs, using AI as a thinking or sparring partner rather than just a tool for task automation. LLMs can handle complex reasoning and generate personalized instructions, thus making previous adaptive learning and tutoring AI models less necessary.

These developments suggest that findings from earlier AI research must be re-evaluated in the context of general-purpose AI models that can replace multiple previous AI applications at once.

A recurring theme in past AI research was the prohibitive cost and technical requirements associated with AI adoption in education due to the need to specifically train models (Crompton & Burke, 2023; Marengo et al., 2024). Before 2023, AI integration required institutional investment, faculty training, and dedicated infrastructure, limiting widespread adoption.

The rise of LLMs has overturned these assumptions (Open.ai, 2024). AI tools are now (almost) freely accessible through web-based applications, reducing cost barriers. Students can engage directly with AI models without

needing specialized training or institutional support. AI-enhanced learning environments can now be created by individuals, not just institutions, shifting control over AI adoption from universities to students and educators themselves.

This democratization of AI raises new challenges not addressed in previous research, particularly regarding AI literacy, critical thinking, and ethical engagement with AI-generated content.

Earlier research positioned AI as a tool that educators controlled, providing pre-programmed functions such as grading automation and predictive analytics (Gao et al., 2023). With the advent of large language models (LLMs), however, the role of AI in education has undergone a profound shift. Students can now autonomously engage with AI for research, writing, and problem-solving, without requiring educator mediation. This transition redefines AI not merely as a utility under teacher direction, but as an interactive and adaptive partner in learning processes (Guizani et al., 2025; Rupprecht, Rodenas, Stingl, 2025)

This development has significant implications for educational practice. First, there is a need to move away from traditional content delivery and instead prioritize the cultivation of critical engagement, enabling students to assess and challenge AI-generated outputs. Second, assessment strategies must evolve to evaluate students' capacity to use AI meaningfully and ethically, rather than simply reproducing content. Third, educators are tasked with developing pedagogical models where AI augments intellectual exploration and classroom dialogue, rather than serving purely administrative ends.

Crucially, LLMs should be seen as complementary rather than substitutive tools. While they can automate routine tasks and personalize learning, their effectiveness depends on thoughtful integration and the preservation of core human roles in teaching. Educators remain indispensable in fostering higher-order cognitive and ethical skills—critical thinking, creativity, and judgment—that AI cannot replicate. A balanced and responsible approach to AI in education must therefore leverage LLMs' capacities while ensuring that human oversight safeguards the quality and integrity of learning environments (Guizani et al., 2025). However, empirical studies exploring AI as a dialogic coach in knowledge-intensive domains remain scarce.

The notion of Relational Capital (RC) as a core dimension of Intellectual Capital has been central to the knowledge management discourse for decades (Edvinsson & Malone, 1997; Roos et al., 1997). Building on these foundations, scholars like Mouritsen et al. (2001) and Johanson et al. (2001) have emphasized the narrative, visual, and strategic dimensions of RC, especially in organizational contexts. However, its targeted application in higher education—and particularly its interplay with AI-driven tutoring—remains underexplored.

This paper aims to explore how generative AI tools, particularly large language models (LLMs), can support the development of Relational Capital among master's students in a digital economy program. Through a case study approach, we examine how AI was integrated into a university course as a dialogic tutor to help students identify, assess, and strategically expand their professional networks. The paper documents the pedagogical design, implementation challenges, and student perceptions over an 11-week period, offering insights into the opportunities and limitations of AI-supported RC development in higher education.

2. Method of Research

This case study examines the integration of AI-supported learning in higher education, focusing on the development of students' Relational Capital. The methodological framework is based on the principles of Intellectual Capital Reporting, as outlined by Bornemann and Reinhardt (2003) in the tradition of "Wissensbilanz made in Germany" (Bornemann et.al., 2015).

The study was conducted at FHWien der WKW, a university of applied sciences in Vienna, Austria, as part of a master's level course in digital economy offered during the winter semester of 2024. The participating students were enrolled in practice-oriented programs focused on digital technology and innovation. The AI-supported learning module was embedded into the formal curriculum and delivered in a hybrid format over 11 weeks. The primary goal was to enable students to strategically develop their individual Relational Capital, supported by AI tutoring and coaching interventions. The research unit of analysis was the student interaction with AI tools and follow-up coaching reflections, captured through transcripts, documentation, and thematic analysis.

The course design minimized traditional lecturing, reducing it to a two-hour session and reallocating time to small group coaching sessions and AI-supported self-learning. The AI agent was available to students at all times, serving as a knowledge provider and reflective partner. Its primary functions included supporting students in structuring their thoughts, formulating personal objectives for developing their RC, and offering methodological guidance and feedback.

Training of the AI system required only moderate technical expertise but benefited heavily from the availability of high-quality digital materials to ensure meaningful interactions. In autumn 2024, the technology available was a customized AI agent, a "special GPT" – which was later (2025) replaced by RAG technology.

The students were equipped with a starting prompt as outlined in table 1.

Table 1: Structured prompt with definition of tasks, context, methods, and format of output

Prompt	Function
Hi, I would like to work with you on Relational Capital. Could you start with an introduction and explanation for this topic and then ask 10 questions consecutive and stepwise that help me to better understand the concept?	Task
Currently, I am starting a 2-year MBA Program and would like to boost my career. My objective is to develop my own relational capital strategically to be optimally positioned in 2 years. I already have some foundations from my early professional life and jobs and education but would like to systematically develop this asset. Please be my tutor and coach. Be extensive and comprehensive in your explanations on master level. Provide sources for your hints, if applicable.	Context
In our dialogue, you will ask me about my status and descriptions, which will serve as inputs for this document.	Task
Later, we might talk about a SWOT analysis and the assessment of my Relational capital based on the 3 dimensions of quantity, quality and the current level of systematic management.	Method
Later, I will ask you to create a summary of our interaction. I wish you to create a word document which is structured according to various elements of relational capital.	Format
I wish you to drive this dialogue building on the logic of an Intellectual Capital Report.	Method
Once we have completed all the steps, I need a comprehensive and detailed report and summary,	Format
including relevant and customized hints, how to develop my Relational Capital in the next 2 years.	Method

Beyond AI-supported learning and following the recommendations of Guizani et al (2025), students participated in two circles of structured coaching sessions to provide individual support, apply AI-generated insights to real-world contexts, and critically reflect on their Relational Capital development. The focus of the first circle was on establishing a fundamental understanding of RC, reviewing existing contacts and formulating the strategic objective for the status of RC at the time of graduation. For most students, this objective meant to improve their career path. The second circle focused on identifying measures to accomplish this objective based on the status quo as well as by systematically leveraging the now clearly structured RC.

Data collection for this case study was based on transcripts of anonymized AI-student interactions, records of coaching sessions, and student reflections following a case study approach (Yin, 2018).

3. Case Study AI-Supported Learning for Relational Capital Development

Over 11 weeks, 39 students participated in two circles of 12 session each (total of 24) with about 3-4 participants per session to keep interaction as well as confidentiality high. We identified 3 general observations (high acceptance of AI as a learning assistant; confidentiality concerns; quality of AI guided learning), supported by exemplary episodes or narratives as evidence. After the quantitative overview, we will provide qualitative descriptions of these short episodes.

3.1 Quantitative Representation

Table 2 shows co-occurrences of episodes. We see the "reluctance to share personal networks" as most frequent among the cohort. Other episodes could be observed up to three times based on the data available. Less frequent episodes were eliminated here and in the qualitative description for limitations of space.

Table 2: Quantitative Insights from Transcripts

Finding	Episode #	Episode title	Similar Cases
High Acceptance of AI as a Learning Assistant	1	The AI as a Structuring Tool for Relational Capital Mapping	5
	2	AI as a Confidence Booster in Career Planning	3

Finding	Episode #	Episode title	Similar Cases
	3	Overcoming Conceptual Blocks with AI-Generated Reflection Prompts	4
Trust & Confidentiality Concerns	4	The Reluctance to Share Personal Networks	6
	5	The Fear of AI Bias and Misinterpretation	3
	6	Overcoming Initial Skepticism Through Experimentation	4
Quality of AI-Guided Learning	7	The AI as a Methodological Guide in Strategic Planning	5
	8	Refining Arguments Through Iterative AI Interaction	3
	9	AI-Generated Reflection Prompts as a Tool for Deeper Thinking	4

3.2 Qualitative Representation

While the number of student interactions is limited and far from representative, several situations reappeared in various similar forms and were condensed to episodes. For the sake of formal consistency, we grouped them to three clusters. The first cluster covers acceptance of AI as learning assistant with episodes 1-3; the second cluster covers trust and confidentiality with episodes 4-6; the third cluster covers the quality of AI guided learning with episodes 7-9.

3.3 High Acceptance of AI as a Learning Assistant

Below are three detailed qualitative episodes extracted from the transcripts, each illustrating how students interacted with the AI, how they perceived its usefulness, and how this contributed to their learning.

3.3.1 Episode 1: The AI as a structuring tool for relational capital mapping

During one of the coaching sessions, a student expressed frustration over how to systematically assess their personal and professional networks. Initially, they struggled with identifying which contacts were relevant to their career goals and how to categorize these relationships effectively. When prompted by AI, the student received a structured framework suggesting that relationships could be grouped by strength, reciprocity, and strategic importance. Encouraged by this clarity, the students used the AI to refine their own knowledge balance, realizing that some professional contacts were underutilized resources. In the coaching follow-up, the student reflected on how the AI's prompts helped them transition from intuitive networking to a structured, data-driven approach. They emphasized that without the AI's guidance, they would not have thought of quantifying their Relational Capital systematically.

3.3.2 Episode 2: AI as a confidence booster in career planning

Another student, preparing for a transition into a managerial role after graduation, initially doubted whether their existing network provided sufficient leverage for future career opportunities. They approached AI with broad, unspecific career questions, expecting only generic responses. However, through a series of iterative refinements, the AI prompted the student to analyze which network contacts had decision-making power in their desired industry. Through multiple interactions, the student gained confidence in reaching out to contacts they had previously undervalued, particularly former professors and internship supervisors. In the final coaching session, they reflected on how AI had subtly changed their approach from passive observation to proactive engagement, demonstrating that AI's role extended beyond answering queries to shaping strategic behavior.

3.3.3 Episode 3: Overcoming conceptual blocks with AI-generated reflection prompts

A student with a background in engineering had difficulty understanding the abstract concept of Relational Capital. In earlier discussions, they saw networking as transactional rather than strategic and struggled to define what "capital" meant beyond financial assets. In frustration, they asked the AI to explain why relationships should be considered a form of capital. The AI responded with a metaphor comparing a well-maintained

professional network to a diversified investment portfolio, which immediately resonated with the student's technical mindset. This analogy shifted their perspective, allowing them to recognize the long-term value of trust and credibility in professional settings. In the subsequent coaching session, they actively engaged in discussing the nuances of social capital and even began advising their peers on optimizing their own networks, demonstrating that the AI was not only accepted but had transformed their conceptual understanding of the topic.

3.4 Trust and Confidentiality Concerns

Below are three episodes illustrating how students dealt with issues of trust and confidentiality when interacting with AI. These episodes highlight different strategies students employed to protect sensitive information while still benefiting from AI-assisted learning.

3.4.1 Episode 4: The reluctance to share personal networks

One student, preparing a Relational Capital analysis for career planning, expressed hesitation about entering specific names or organizational affiliations when interacting with the AI. Initially, they provided only vague descriptions, such as "a senior colleague" or "a mentor in a consulting firm," fearing that the AI might store or misuse their data. However, after a coaching session where strategies for anonymization were discussed, the student adopted a coded labeling system, referring to contacts by functional role rather than name (e.g., "Industry Mentor A" or "Former Manager B"). This allowed them to work through relationship evaluations systematically without disclosing personally identifiable information. In later reflections, they stated that this strategy enabled them to fully engage with the AI while feeling in control of their data, demonstrating that trust concerns could be mitigated through structured anonymization.

3.4.2 Episode 5: The fear of AI bias and misinterpretation

Another student, who had previously used AI tools in a corporate setting, expressed skepticism about how the AI would interpret sensitive career dilemmas. In one case, they sought advice on navigating office politics and securing internal promotions, but they worried that the AI's responses might be too generic or reinforce biases present in its training data. To test this, they posed the same question in multiple rephrasings, checking for consistency and potential biases in the AI's advice. This experiment revealed that the AI provided strategic guidance but lacked nuanced, situational awareness, reinforcing the student's belief that critical judgment must accompany AI use. During the coaching debrief, they reflected that while AI was helpful for structuring their thought process, they would never fully rely on it for confidential career decisions. Instead, they saw it as a neutral, external perspective that supplemented—but did not replace—human mentorship.

3.4.3 Episode 6: Overcoming initial skepticism through experimentation

At the beginning of the course, a student voiced strong reservations about engaging with AI in a personal learning process, fearing that every input might be recorded, analyzed, or later repurposed without their consent. This led them to avoid deep engagement with the AI assistant in early sessions, opting instead to rely solely on coaching and peer discussions. However, after observing how peers successfully used anonymization techniques and how the AI never required personal data to generate meaningful responses, they gradually began incorporating AI interactions into their workflow. By the final coaching session, they admitted that their initial reluctance had been based more on assumption than experience and acknowledged that structured, anonymized use of AI could be both effective and secure. Their case underscores how exposure and controlled experimentation helped them transition from distrust to a pragmatic, strategic engagement with AI.

3.5 Quality of AI-Guided Learning

Below are three episodes illustrating how students interacted with AI for structured learning. These episodes highlight different ways the AI contributed to methodological guidance, structured reflection, and deeper learning outcomes.

3.5.1 Episode 7: The AI as a methodological guide in strategic planning

A student working on their RC assessment struggled to identify the criteria for evaluating the strength of professional relationships. Initially, they relied on intuition, listing contacts without clear differentiation. When engaging with AI, they received a structured response suggesting a three-dimensional model: frequency of interaction, level of trust, and strategic importance. This structured approach led the student to reclassify their relationships, moving from a flat list to a multi-tiered network analysis. In the subsequent coaching session, they

expressed surprise at how the AI helped them see overlooked patterns in their network. They noted that, without this structured approach, they would have continued making career decisions based on gut feeling rather than a strategic analysis of their RC.

3.5.2 Episode 8: Refining arguments through iterative AI interaction

Another student, preparing a written reflection on the role of weak ties in professional networking, found their arguments lacking depth and coherence. They approached AI with open-ended prompts, asking for counterarguments and alternative perspectives. Through multiple iterations, the AI challenged their assumptions, introducing granular distinctions between bonding and bridging social capital (Granovetter, 1973). Encouraged by this, the students reformulated their arguments, integrating new theoretical perspectives and citing empirical studies suggested by the AI. During the coaching review, they described this process as like having an academic sparring partner, helping them strengthen their reasoning before finalizing their paper. This case illustrates that AI did not merely provide information but actively contributed to the refinement of argumentation.

3.5.3 Episode 9: AI-generated reflection prompts as a tool for deeper thinking

A student unfamiliar with the concept of Relational Capital initially struggled to see its relevance to their own career development. When engaging with the AI, they received a set of structured reflection prompts, such as:

- "Which professional relationships have played an unexpected role in shaping your career path?"
- "How do you maintain and invest in weak ties, and what has been the outcome?"
- "If you had to quantify the value of your network, which factors would you include?"

At first, they dismissed these questions as overly abstract. However, after attempting to answer them within the AI chat, they realized that these structured prompts forced them to articulate tacit knowledge about their professional interactions. In the coaching debrief, they admitted that, without AI-generated reflection prompts, they would have remained unaware of the latent potential in their existing networks. This episode demonstrates that AI-supported reflection exercises can trigger deeper self-awareness and more structured career planning.

4. Findings and Discussion

This case study investigated how AI-supported learning environments influence students' development of Relational Capital in a Master's level higher education module. Based on anonymized transcripts, coaching records, and student reflections, three core patterns emerged.

1. **High Acceptance of AI as a Learning Assistant:** Students broadly appreciated the AI agent as a competent and non-judgmental reflection partner. It supported structuring thoughts, identifying patterns in personal networks, and formulating strategic objectives for relational development. Especially valuable were AI-generated prompts that encouraged iterative clarification and reflection. Students with technical backgrounds responded particularly well to the structured logic and metaphoric framing (e.g. comparing RC to investment portfolios).
2. **Trust and Confidentiality Considerations:** A recurrent theme was students' hesitation to share sensitive network information with the AI. In response, several adopted anonymization strategies (e.g. using role-based labels). Trust was negotiated pragmatically—students accepted varying levels of disclosure depending on whether they used paid or free AI services. Those with prior exposure to AI systems often tested for bias or inconsistencies before deeper engagement.
3. **Enhanced Methodological Quality Through AI Interaction:** AI-supported learning contributed substantially to the clarity and structure of student reasoning. Students used AI not only to receive feedback but to challenge their own assumptions and refine arguments. This iterative process deepened their understanding of RC as a strategic asset. Students reported shifts from intuitive to model-based decision-making in career planning and network analysis.

These findings reflect the thematic clusters explored through Episodes 1–9 (see Table 1). While not generalizable beyond this cohort, the patterns offer insight into the role of generative AI in supporting metacognitive learning processes.

The integration of generative AI into this course module reconfigures the relationship between learners, educators, and educational technology. Rather than replacing traditional instruction, AI functioned as a dynamic, dialogic support structure—shaping both the content and process of learning.

4.1 From Tool to Partner: Rethinking AI's Role

Students treated AI not as a static source of information, but as an adaptive partner in sensemaking. This echoes recent scholarship (e.g. Guizani et al., 2025) calling for a shift from automation to augmentation in AI pedagogy. The observed improvements in conceptual clarity and strategic planning suggest that AI can catalyze deeper levels of engagement—particularly when aligned with domain-specific prompts and supported through human coaching.

4.2 Navigating Trust Without Overengineering Ethics

While data privacy concerns were present, they were rarely framed in terms of abstract ethical dilemmas. Instead, students employed situational solutions—choosing subscription models, pseudonyms, or compartmentalized inputs. These pragmatic adaptations suggest that AI trust can emerge organically within well-scaffolded learning environments. Regulatory structures and institutional policies remain relevant but need not be the focal point of pedagogical design.

However, trust appears to be a general prerequisite for students to share information about their personal networks, regardless of whether the thinking partner is an AI chatbot or a human teacher.

4.3 Designing for Productive AI-Learner Interaction

The effectiveness of AI-supported learning in this case depended on three interrelated factors:

- Quality of Prompting: Students who invested in iterative dialogue with the AI saw greater cognitive benefit. Prompt engineering emerged as a new skill for academic reflection.
- Contextual Embedding: The AI performed best when supported by a well-designed course structure, including pre-curated learning materials and live coaching.
- Shifting Educator Roles: Faculty transitioned from delivering content to enabling intellectual autonomy. Coaching sessions focused less on factual correction and more on epistemic framing, strategic thinking, and emotional validation.

This case supports a hybrid pedagogy model (Schmid et al, 2021) where AI mediates individual reflection, and human educators support integration and judgment. For such models to succeed at scale, both students and educators must develop new literacies—technical, strategic, and relational.

5. Limitations and Future Research

This study draws on a small cohort of students within a specific course design and cultural context of students of the digital economy. The focus on developing RC was both, an educational goal to raise awareness for the importance on early career building as well as to leverage students' capabilities to systematically leverage RC with AI over time. Future research should explore how these dynamics unfold in more diverse settings, and how AI-supported learning can be sustained over longer educational trajectories. Of particular interest are the longitudinal effects on professional behavior and decision-making once students leave the formal learning context.

Ethics Declaration: Ethical clearance was not required for the research.

Statement on the use of AI: Artificial intelligence tools were employed to support various stages of the research process. Automated transcription software was used to convert audio recordings of coaching sessions into text. OpenAI's ChatGPT-4.0 was utilized to summarize these transcripts, identify thematic episodes, and extract frequency data for analytical purposes (see Table 2). Additionally, ChatGPT-4.0 and DeepL Write © were employed to enhance the consistency, clarity, and readability of the manuscript, as English is not the authors' first language. All content was subsequently reviewed and validated by the authors to ensure it accurately reflects the research findings and interpretations. The authors affirm full responsibility for the interpretation and validation of all AI-assisted outputs.

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Artificial Knowledge and its Challenges for Knowledge Management Systems

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Abstract: It is a paradox that literature exploded in the last years with papers on "artificial intelligence", but only a few of them dealt with "artificial knowledge". The purpose of this paper is to analyze the concept of "artificial knowledge" and to compare it with human knowledge. That helps us to bridge the gap between artificial knowledge and knowledge management. More specifically, we focus on Generative Artificial Intelligence (GenAI), which has the capacity to simulate a human-like dialogue using natural language. The relevance of the present research comes from the need to understand the similarities and dissimilarities between artificial knowledge and human knowledge, and how both of them can be integrated into knowledge management systems. It is a conceptual paper based on a systematic literature review and a critical thinking approach. We used the theory of knowledge fields and knowledge dynamics for human knowledge and a GenAI analysis for artificial knowledge. Findings show that ChatGPT can answer a human interrogator by formulating texts comparable to those written by people. However, the imitation of human knowledge is not in its nature but in its functionality. The generation of artificial knowledge is completely different than that of human knowledge. Human knowledge is created by our sensory system and the brain through several processes, like perception and reflection. Artificial knowledge is generated by GenAI based on syntactic rules without any correlation with semantics. Computers cannot think and have no cognitive processes. Knowledge managers should be able to integrate both artificial and human knowledge into knowledge management systems. The main contribution of this paper is that it analyzes artificial knowledge and its generation from a knowledge management perspective. The main limitation of the present research comes from the scarcity of papers on the subject of artificial knowledge.

Keywords: Human knowledge, Artificial knowledge, Artificial intelligence, Generative artificial intelligence, Knowledge management systems

1. Introduction

Knowledge Management Systems (KMS) are complex, integrated human and technology systems designed to create, transfer, transform, translate, store, retrieve, and efficiently use intangible resources within an organization. They can be considered a result of integrating information management systems within the organizational management systems (Becerra-Fernandez & Sabherwal, 2010; Liu, 2020; North & Kumta, 2018). In the first stage of this integration, information systems were centered on processing data and information, where *information* is the fundamental concept defined by Claude E. Shannon from a mathematical perspective, without any associated meaning (Bratianu & Bejinaru, 2019, 2023). In knowledge management, the focus is on processing information and knowledge, where the concept of *information* has always associated meanings (Davenport & Prusak, 2000; Massingham, 2020; Nonaka & Takeuchi, 2019). In the second stage of this integration, information systems using Generative Artificial Intelligence (GenAI) focus on *artificial knowledge*, a product of processing big data and information by the new artificial intelligence programs capable of creating humanlike dialogue (Baker, 2023, 2025; Russell & Norvig, 2022).

Artificial knowledge (AK) is an emergent concept, and although the literature is almost saturated with papers concerning AI, there are only a few papers addressing the concept of AK. Unfortunately, even these papers do not explain the meaning of AK and its main differences with respect to human knowledge (Di Vaio et al., 2024; Harfouche et al., 2017; Saviano, Del Prete & Caputo, 2023). The purpose of the present paper is to analyze the emergence of AK, its main features from a human perspective, and what are the challenges for its integration into KMS. We hope this way to bridge the knowledge gap in the literature and provide some useful recommendations to researchers and knowledge managers in dealing with the integration process of human and artificial knowledge. Therefore, we may consider the following research questions (RQ):

RQ1: What are the main features of artificial knowledge by comparison with human knowledge?

RQ2: What are the main challenges for integrating artificial knowledge into knowledge management systems?

The structure of the present paper is as follows. After this brief *Introduction*, there is a detailed section on *Literature review*, where we critically analyze the most significant papers and books published on this subject. Then, we present the *Methodology* used in the present research, followed by a section on *Results and discussions*. The paper ends with *Conclusions and limitations*, and *References*.

2. Literature Review

In his seminal book *The Science of the Artificial* (1996), Herbert Simon demonstrates how people live in a hybrid world composed of natural and artificial things, and each world is governed by specific laws and sciences. *Artificial knowledge* and *artificial intelligence* are powerful concepts that belong to *information science*, a science of the artificial. Based on Shannonian information, information entropy, and Boolean algebra, information science is defined as "a discipline that investigates the properties and behavior of information, the forces governing the flow of information, and the means of processing information for optimum accessibility and usability. It is concerned with that body of knowledge relating to the origination, collection, organization, storage, retrieval, interpretation, transmission, transformation, and utilization of information" (Borko, 1968, p. 3).

Artificial intelligence (AI) is a metaphor coined by John McCarthy at the international conference organized by Dartmouth College in 1956 (Baker, 2025; Lee & Qiufan, 2024; Russell & Norvig, 2022). The metaphor suggests that AI imitates natural intelligence from a computing perspective. However, computers do not think like people. They are working based on algorithms and huge datasets. After a slow and long incipient phase due to the limited power and computational speed, AI attracted scientists' attention when IBM's Deep Blue computer won against the chess champion Garry Kasparov in a chess competition (1997). The computer was not necessarily smarter than Gary Kasparov, but it could perform thousands more operations with incredible speed than the human chess player. In 2011, IBM Watson beat champions Ken Jennings and Brad Rutter at the game Jeopardy. The next surprise came in 2016 when DeepMind's AlphaGo program beat Lee Sedol, the World Go player (Hawkins & Blakeslee, 2004; Lee & Qiufan, 2024; Russell & Norving, 2022). Today, AI encompasses a multitude of programs from those having a general purpose to those focusing on natural language processing, knowledge representation, automated reasoning, machine learning, deep learning, computer vision, and robotics (Russell & Norvig, 2022).

More recently, researchers in AI invested their efforts in developing GenAI due to its capacity to generate texts, images, audio, video documents, or even new software in response to requests coming from users (Lee & Qiufan, 2024; Yu, 2023). GenAI uses *deep learning models* and, for text generation, *large language models (LLM)*. The most well-known application is ChatGPT (Generative Pretraining Transformer) produced by OpenAI, and launched in November 2022 (Baker, 2023, 2025). ChatGPT came as a disruptive force in all domains of human activity due to its capacity to generate a humanlike dialogue. In a very short time, it became almost a universal tool in research, education, medicine, publishing, arts, and many other areas. There is already a series of ChatGPT programs that have been developed by OpenAI. The program is *generative* because it is capable of generating text based on developed patterns and predictions. That is a significant shift from the previous AI applications with predefined sets of possible alternatives offered to the user. "LLMs use parameters to predict the next word in a sentence – meaning they predict the word most likely to follow the words in your prompt, and then the word that most likely follows its first predicted word, and so on until the model believes it has finished the most probable pattern" (Baker, 2025, p. 8). *Pretraining* is a process of training the program to construct patterns from huge data sets, which will be used then in predicting the outputs. For instance, the program is run with a huge number of images of different cats, such that the program can create patterns for meant possible "a cat". Then, when the program receives a new image, it should be able to recognize if that image also represents a cat or not. It is important to underline the fact that a good pattern can be created if and only if the dataset contains millions of images of cats, or any other targeted objects. Therefore, these patterns are a result of specific working algorithms and not of the person who performed their design. *Transformers* are the models used for language translation. They have the capacity to create humanlike dialogue. They are complex neural networks based on probabilistic algorithms that try to imitate the way the human brain works (Baker, 2023, 2025; Harfouche et al., 2017; Russell & Norvig, 2022).

The outcome of the ChatGPT or any similar program to a user's prompt represents artificial knowledge, that "is created through a recursive process that extracts, organizes, and aggregates tacit and explicit knowledge in order to articulate, automate, and amplify them" (Harfouche et al., 2017, p. 1). However, we should emphasize that GenAI applications cannot work on *tacit knowledge* and cannot aggregate it within the explicit knowledge.

That is a misunderstanding of the authors, who probably have a background in information systems. Tacit knowledge is experiential knowledge obtained directly from practice by the human body and processed mostly by the cognitive non-consciousness zone of the human brain (Nonaka, 1994; Nonaka & Takeuchi, 1995; Polanyi, 1983). Tacit knowledge is embodied knowledge, and GenAI cannot have access at it directly. It must be transformed into explicit knowledge through conversion according to the theory of Nonaka and Takeuchi (1995, 2019) through the SECI (Socialization, Externalization, Combination, Internalization) cycle, or by articulation according to the theory of Tsoukas (2011), supported by other researchers as well (Hadjimichael, Pyrco & Tsoukas, 2024; Hadjimichael, Ribeiro & Tsoukas, 2024). "Tacit knowledge cannot be 'captured', or 'converted' but displayed – manifested – in what we do. New knowledge comes about not when the tacit knowledge is converted to explicit, but when tacit knowledge is re-punctuated (articulated) through dialogical interaction" (Tsoukas, 2011, p. 473). It is important to explain this aspect to understand why GenAI cannot be involved in tacit knowledge processing. It is a specific human process.

Although GenAI applications create the impression of reasoning and judgment, they cannot perform such tasks because "Computers are unable to reflect on their own performance, to know that it knows as does a human person. Computers, as already noted, can never step outside the code, reflect on the code, and contribute their own observations" (Sangzoni, Guzman & Busch, 2017, p. 11). Using metaphorical thinking (Lakoff & Johnson, 1999) many authors consider that GenAI imitates the human brain in learning, reasoning, and making decisions, but in reality, computers don't think. They don't have the human values to develop wisdom, and therefore, they cannot be wise. Moreover, artificial knowledge does not reflect any truth. It is a simple result of an algorithm that works based on syntactic rules. For computers, artificial knowledge has no semantics or meaning. Users introduce artificial knowledge into a semantic field and give meaning to this artifact we call artificial knowledge (Baker, 2023, 2025; Lee & Qiufan, 2024; Russell & Norvig, 2022).

An emergent issue related to AI and especially to GenAI is the ethical dimension (Floridi, 2023). GenAI applications are very powerful tools, and they can be used with good or bad intentions by different people. Yet, the domain of using AI tools is not sufficiently regulated from an ethical perspective, and that may lead to many harmful consequences. For instance, many students have the temptation of using ChatGPT and similar products for writing their homework and dissertation theses. Many researchers have the temptation of using ChatGPT for writing academic papers or even books. As Yu (2023) remarks, "students using ChatGPT to complete assignments may lead to academic dishonesty and cheating behaviors, which have already sparked opposition and resistance from some universities, publications, and scholars. At the same time, the misuse of ChatGPT in scientific research has also aroused strong opposition and concerns within the academic communinity" (Yu, 2023, p. 3). However, the solution is not forbidden using GenAI in education or research, but to create an ethical framework of using those intelligent tools for the benefit of learning and knowledge creation. That means to create a new mindset of using AI tools within a new framework of digital governance, digital ethics, and digital regulation (Baker, 2023, 2025; Floridi, 2023; Yu, 2023).

3. Methodology

The present paper is a result of qualitative research (Booth, Sutton & Papaioannou, 2016; Maxwell, 2013; Tracy, 2020), based on a systematic literature review and a critical analysis of the concepts, ideas, and theories related to artificial knowledge and artificial intelligence. We considered a knowledge management framework and tried to find out the main features of artificial knowledge by comparison with human knowledge (Bratianu & Bejinaru, 2019, 2023; Davenport & Prusak, 2000) and the most significant challenges of integrating artificial knowledge and artificial intelligence within knowledge management systems. Also, we analyzed how artificial knowledge is generated and what is its compatibility with human knowledge creation at the individual and organizational levels. In other words, our research focused on the impact of artificial knowledge on the processes composing the knowledge creation dynamics cycle developed by Nonaka and Takeuchi (1995, 2019).

4. Results and Discussions

Artificial knowledge is an emergent concept associated with artificial intelligence (Di Vaio et al., 2024; Harfouche et al., 2017; Saviano, Del Prete & Caputo, 2023). It is an artifact produced by AI applications, especially by GenAI, like ChatGPT that has the capacity of generating a humanlike dialogue based on texts and images (Baker, 2023, 2025; Russell & Norvig, 2022). However, there is a scarcity of research concerning artificial knowledge and its impact on knowledge management systems. To understand the novelty brought by artificial knowledge to knowledge management systems, we need to analyze it by comparison with human knowledge and its dynamics.

From ancient times, *knowledge* has been considered *a justified true belief* (Audi, 2011; Nonaka & Takeuchi, 1995; Russell, 1972). Therefore, knowledge allows us to find and express the truth. Plato and other Greek philosophers considered that knowledge must be objective and free of any emotional influence. "It follows that we cannot know things through the senses alone, since through the senses alone we cannot know that things exist. Therefore, knowledge consists in reflection, not in impression, and perception is not knowledge" (Russell, 1972, p. 153). Developing further this paradigm, Descartes created the theory of dualism between mind and body, underscoring the fundamental role of thinking (Descartes, 1997). In contrast to the European philosophical approach to knowledge and knowing, the Japanese approach was to consider the oneness of mind and body, the oneness of humanity and nature, and the oneness of self and others (Kaufman, 1994; Nakagawara, 2004; Nonaka & Takeuchi, 1995).

Polanyi (1983) questioned the paradigm of objective knowledge resulting from Descartes' rationality and introduced the idea of *the tacit dimension* of knowing. "I shall reconsider human knowledge by starting from the fact that we can know more than we can tell" (Polanyi, 1983, p. 4; italics in original). Polanyi underlined the fact that perception is a component of our cognition and that knowledge incorporates emotional aspects beyond the rational ones. Kolb (2015) showed that the tacit dimension is characteristic of experiential learning, i.e. learning by doing. Finally, Nonaka (1994) formulated in a coherent way the new paradigm of tacit and explicit knowledge, which can be illustrated by the iceberg metaphor (Nonaka & Takeuchi, 1995). *Tacit knowledge* is acquired directly from practice and is processed by the cognitive unconscious zone of our brain, a fact of which we hardly are aware of that knowledge. "Subjective insights, intuitions, and hunches fall into this category of knowledge. Furthermore, tacit knowledge is deeply rooted in an individual's actions and experience, as well as in the ideals, values, or emotions he or she embraces" (Nonaka & Takeuchi, 1995, p. 8). *Explicit knowledge* is rational and can be expressed using natural or symbolic languages. It represents the visible part of an iceberg, while tacit knowledge represents the hidden part of that iceberg that is under the water. Within the same paradigm of tacit and explicit knowledge, many researchers consider knowledge as *a flow*, or *a stock-and-flow* (Nissen, 2006; Nonaka, Toyama & Hirata, 2008). However, the flow metaphor is limited by the tangibility and linearity of the fluid flow.

Using metaphorical thinking (Andriessen, 2008; Lakoff & Johnson, 1999), Bratianu and Bejinaru (2019, 2020) developed the theory of knowledge fields and knowledge dynamics. According to this theory, *knowledge* manifests as a field that is intangible, dynamic, and nonuniform. The authors consider three basic fields: rational knowledge, emotional knowledge, and spiritual knowledge. The *rational knowledge field* contains explicit knowledge. It is that knowledge resulting from rational learning that can be expressed using natural or symbolic languages. Rational knowledge is the dominant form of knowledge in any human activity due to its capacity to be codified and communicated. Science, technology, and education are based on rational knowledge. The *emotional knowledge field* contains that form of knowledge we acquire directly from experience. It is a form of tacit knowledge generated by human emotional states (Damasio, 1999, 2012; Kolb, 2015). It is wordless and highly embodied (Hadjimichael, Ribeiro & Tsoukas, 2024). It can be communicated using body language. Cognitive sciences show that emotional knowledge plays a critical role in decision-making (Hill, 2008; Kahneman, 2011). The *spiritual knowledge field* contains human values and ideals that drive our existence. Spiritual knowledge has its roots in Aristotle's *phronesis* or practical wisdom (Aristotle, 1999; Kaiser, 2024).

Knowledge dynamics reflects the variation of knowledge in time and space, as well as its transformation from one form into another (Bratianu & Bejinaru, 2020). The most used model for knowledge creation dynamics is that conceived by Nonaka (1994) and developed further by Nonaka and Takeuchi (1995, 2019). It is known as the SECI (Socialization, Externalization, Combination, Internalization) knowledge cycle. It contains four basic processes: two processes of knowledge transformations along the epistemological dimension and two processes of knowledge transfer along the ontological dimension. All of these processes are integrated into a continuous knowledge cycle that evolves like a spiral in time within an organizational framework. *Socialization* is a process of tacit knowledge transfer between people working together within a certain proximity. *Externalization* is a process of transforming tacit knowledge into explicit knowledge within the human brain, using natural or symbolic languages. *Combination* is a process of knowledge transfer within a social context, where individual knowledge can be amplified and integrated into organizational knowledge. *Internalization* is a process of transforming explicit knowledge into tacit knowledge through learning. From a thermodynamics perspective, knowledge dynamics is a process of transforming one form of knowledge field (rational, emotional, spiritual) into another.

After such a synthetic presentation of human knowledge, we can answer the first research question by showing the main features of artificial knowledge. It is an artifact, produced by GenAI as a result of a machine learning process and an interrogation coming from a human agent. Artificial knowledge is not created but generated by pretrained algorithms capable of learning and answering human agents' questions (Baker, 2023, 2025; Russell & Norvig, 2022). These algorithms create patterns from the input dataset and, based on them, make predictions for the possible answers using syntactic rules. Therefore, computers don't think based on the meanings of the questions but use syntactic rules to predict the most probable sequence of words in generating their texts. Artificial knowledge can be wrong from a semantic point of view, although it is coherent with the logic of the pretained algorithm. In such a situation, ChatGPT has hallucinations (Baker, 2023, 2025), increasing the vulnerabilities for knowledge risks (Bratianu, 2022; Bratianu et al., 2020). Figure 1 illustrates the main processes that contribute in generating artificial knowledge.

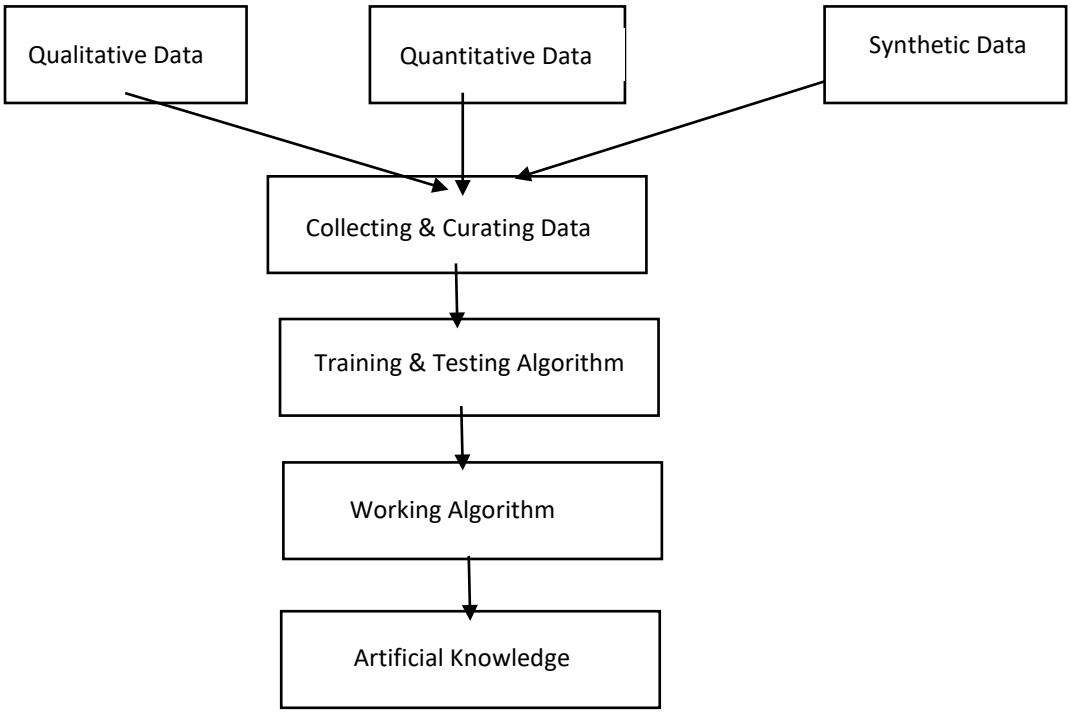


Figure 1: Generation of artificial knowledge (Source: Own research)

To answer the second research question, we need to analyze the integration process of artificial knowledge in the SECI model. Artificial knowledge cannot be aggregated with tacit knowledge, and artificial intelligence cannot act upon the transformation of tacit knowledge into explicit knowledge or the reverse. Therefore, artificial knowledge cannot be integrated into socialization, externalization, or internalization processes. The only process that is open to artificial intelligence and artificial knowledge is the combination. The main challenges for knowledge management systems focus on a new design of the combination process and of the system of decision-making, where artificial intelligence may increase its efficiency.

There are two other important challenges: enhancing knowledge sharing and organizational learning. These two processes can be amplified by creating dynamic databases and platforms for knowledge sharing. They can be useful, especially for large companies where proximity for knowledge sharing is not possible. Also, organizational learning can be enhanced using ChatGPT or similar programs that are able to stimulate individual learning and are capable of adaptation to specific organizational cultures and human capital. Artificial knowledge generation influences the distribution probability of organizational knowledge and increases knowledge entropy, with favorable consequences on innovation processes.

In Table 1, we present the main aspects of analysis concerning the comparison between human knowledge and artificial knowledge.

Table 1: A comparison between human knowledge and artificial knowledge

Features	Human knowledge	Artificial knowledge
Generic definition	A justified true belief	A prediction
Outcome of	Human learning	Machine learning
Linguistic dimensions	Semantic, Syntactic, and Pragmatic	Syntactic
Types of knowledge	Tacit and explicit	Explicit
Fields of knowledge	Rational, emotional, and Spiritual	Rational
Integration in the SECI model	Socialization, Externalization, Combination, and Internalization	Combination

5. Conclusions and Limitations

Artificial knowledge is an emerging concept that impacts knowledge management systems. Although using metaphorical thinking we call it *knowledge*, it is totally different than human knowledge. It has a different generation model (Russell & Norvig, 2022) and does not answer the generic request of being *a justified true belief* (Nonaka & Takeuchi, 1995, 2019). Artificial knowledge is a result of huge data processing by GenAI and a prompt interrogation from a user. It is produced based on specific algorithms that incorporate mechanisms of deep learning and large language models. Although artificial knowledge is coherent with the working algorithm, it might sometimes be wrong, displaying hallucinations. That is a new type of knowledge vulnerability that leads to new knowledge risks related to decision-making.

By comparison with human knowledge, artificial knowledge is only rational, lacking the capacity to incorporate emotional and spiritual knowledge fields. Therefore, it cannot evolve towards wisdom and wise decision-making. Artificial knowledge dynamics is limited to changes within the limits of the algorithm, and it cannot have any impact on human knowledge dynamics on the epistemological dimension. Only on the ontological dimension, artificial knowledge can influence the process of combination from the SECI model through enhancing knowledge sharing and organizational learning. However, artificial knowledge is useful in knowledge management systems because it generates humanlike dialogue with people in real-time.

The present research has some limitations coming from the scarcity of papers published on the subject of artificial intelligence. These limitations can be relaxed by enlarging qualitative research with in-depth interviews with experts, and by quantitative research. The aim will be to find out the best solutions for integrating artificial knowledge with human knowledge within knowledge management systems.

Ethics declaration: Ethical clearance was not required for the present research.

AI declaration: The authors have not used any of the AI tools for creating and writing this paper.

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Measuring Knowledge Vulnerabilities in Knowledge Processes: A Scale Development

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Abstract: The aim of this paper is to propose and test a new measuring scale for the concept of "knowledge vulnerabilities". With this research, we are continuing our work on a research project concerning knowledge risks and knowledge vulnerabilities that can manifest in organizations, alongside knowledge processes. In the context of a scarce literature concerning knowledge vulnerabilities, this research adds value by understanding and measuring knowledge vulnerabilities, as weak points of the knowledge system and of the knowledge management routines that could trigger or facilitate the appearance of risks, exposing the organization to threats. In this paper, we present an instrument for measuring knowledge vulnerabilities related to the knowledge processes within an organization, in the form of a questionnaire. This instrument is developed starting from a previously tested instrument, with 21 items, proposed by Neștian and Guță (2023). The new instrument contains 42 items, with newly developed items reflecting a deeper understanding of knowledge vulnerabilities. The taxonomy for knowledge vulnerabilities is based on a recent perspective of organizational knowledge dynamics (Bratianu, Neștian and Guță, 2022). In this research, seven knowledge processes are considered and vulnerabilities related to them are proposed: vulnerabilities related to knowledge creation, vulnerabilities related to knowledge acquisition, vulnerabilities related to knowledge loss, vulnerabilities related to knowledge sharing, vulnerabilities related to knowledge use, vulnerabilities related to emotional knowledge dynamics and vulnerabilities related to spiritual knowledge dynamics. The questionnaire has been applied in private companies, on both managers and non-managers. Principal components analysis was undertaken to highlight the components forming the construct of *vulnerabilities related to knowledge processes*. The factors resulting from applying the statistical method of principal components analysis on the data collected with this improved questionnaire are composed starting from a larger number of items and are better aligned with the theoretical perspective used, compared with the questionnaire developed in 2023 by Neștian and Guță. The items of the questionnaire loaded in the principal components can be used for relevant future studies on knowledge vulnerabilities. The resulting components offer a better picture regarding the conceptualization of the notion of vulnerabilities associated with knowledge processes.

Keywords: Knowledge vulnerabilities, Knowledge processes, Factor analysis, Measuring scale, Knowledge dynamics

1. Introduction

The wider context in which we are conducting this research is that of knowledge management systems as functional frameworks in any organization. Knowledge management systems "are composed of people, technology, and processes. The performance of any knowledge management system impacts on the organizational performance and its business sustainability" (Bratianu, Bejinaru and Ursache, 2024, p. 71). In these systems, specialized knowledge-related activities are carried out, in an organized, facilitated or spontaneous manner, ensuring that the organization, decision-makers, and all employees possess the appropriate knowledge to do their jobs. When we categorize these activities by their nature and purpose, we can distinguish several well-defined groups considered by theorists (Massingham, 2020; Nonaka and Takeuchi, 1995, 2019) as knowledge processes, such as knowledge acquisition, knowledge creation, knowledge sharing, or knowledge use. According to Harries (2012), the term *knowledge process* has two different meanings: "some refer to knowledge-intensive business operations that draw on a wide range of knowledge sources, require high expertise to complete, and present multiple choices between options that call for knowledge-based judgements; others refer to internal knowledge management functions that provide a service to such business processes" (Harries, 2012, p. 156). The first meaning is the narrowest, as it lacks the broader systemic vision that we can find in the second, which embraces the idea of organizational function, a typical part of a system. We consider knowledge processes to be those sets of activities carried out in organizations, in which transfers and transformations of knowledge are present, with the aim of ensuring adequate knowledge in all

organizational activities. Knowledge transfer occurs by sharing or disseminating knowledge from one individual or group to another. Knowledge transformations refer to activities where knowledge is modified, restructured, or reinterpreted in order to generate new insights, to adapt it to different contexts, or make it more useful for specific applications.

These processes can be more or less effective, more or less faulty, more of less secured. We build this research around the concept of knowledge vulnerabilities, the weak points in these processes that could trigger or facilitate the appearance of knowledge risks.

2. Literature Review

The taxonomy of knowledge processes we are going to use in this research is that proposed in 2022 by Bratianu, Neștian and Guță (2022): knowledge creation, knowledge acquisition, knowledge sharing, knowledge use, knowledge loss, emotional knowledge processes, and spiritual knowledge processes. This taxonomy is based on the theory of knowledge fields and knowledge dynamics (Bratianu and Bejinaru, 2019, 2020).

The particularities of knowledge processes derive from the nature of knowledge, which, as Bratianu (2022) states, is an intangible resource that should be understood as a nonlinear field composed of rational knowledge, emotional knowledge, and spiritual knowledge. The nonlinearity raises questions about the value of knowledge and the value created by these knowledge processes. This is due to the fact that the value of an organization's knowledge may be more or less volatile and needs to be looked at from the perspective of its dynamics, and also put in the context of the knowledge processes that may be affected by a loss in the value of knowledge, due to the manifestation of different types of knowledge risks (Bratianu, Neştian, and Guţă, 2022).

The concept of *knowledge risk* is derived from the generic concept of risk, when applied to knowledge processes, having probability and impact as main characteristics. Knowledge risks reflect potential situations in which there could be some negative consequences of decisions regarding knowledge processes under the influence of internal and external factors (Cameron and Raman, 2005; Massingham, 2010; Massingham, 2020; Society for Risk Analysis, 2018). According to Perrott (2007, as cited in Durst, 2019, p. 21), knowledge risk "describes a likelihood of any loss resulting from the identification, storage or protection of knowledge that may decrease the operational or strategic benefit of a company". Due to the nature of their occurrence, knowledge risks are clearly linked to the specific knowledge processes in any organization (Cameron and Raman, 2005; Durst and Zieba, 2020; Massingham, 2020; Nakash and Bouhnik, 2022; Waring and Glendon, 1998). Understanding, identifying and evaluating knowledge risks can help firms in mitigating possible damages as a result of activating one of these risks.

Our study is focused on *knowledge vulnerabilities*, a concept deeply related to the concept of *knowledge risks* appearing in knowledge systems and knowledge management routines. Vulnerabilities are considered weak points of the knowledge system and of the knowledge management routines that may generate or initiate the knowledge risks under the pressure of some external forces (Bratianu and Bejinaru, 2022; Fuchs, Birkmann and Glade, 2012, Sapountzaki, 2012, Sarawitz, Pielke and Keykhah, 2003, as cited in Bratianu and Bejinaru, 2022). Bratianu and Bejinaru (2022, p. 688) are considering that "vulnerabilities reflect some system's weaknesses with respect to some external forces that may produce physical, financial, operational, or human damages. Vulnerabilities show why different systems have different reactions to the changes produced in the external environment". Knowledge vulnerabilities can lead to possible adverse consequences for the firm and its performance. Knowledge vulnerabilities are potential roots of knowledge risks, and due to their hidden forces, they are generally ignored by managers. For instance, in a knowledge-intensive organization, let's imagine that there is a large segment of employees who should retire almost simultaneously. When they retire, they will take with them all their experience and competencies, which help the firm to achieve a competitive advantage. Therefore, they will produce a huge knowledge loss that is a significant risk in losing that competitive advantage (DeLong, 2004). The knowledge vulnerability consists in the existence of that large segment of retiring employees, and the knowledge risk will be a huge knowledge loss for the firm. If managers are aware of that vulnerability, then they should find solutions for programming a gradual retirement, together with measures of transferring most of the experience from the retiring people to those who remain within the firm. That means intergenerational knowledge sharing programs. In any firm, one knowledge vulnerability can generate several possible knowledge risks. Also, a knowledge risk can have several potential knowledge vulnerabilities. For instance, the risk of knowledge loss can be generated by the vulnerability discussed above, but also by the dissatisfaction of some experts who might decide to leave the firm for other opportunities to work. If managers are aware of the knowledge vulnerabilities in their firms, they can identify them and take measures to reduce or eliminate them. In this way, there will be a decrease of knowledge risks

probabilities in that firm, and a significant reduction in the possible negative consequences for the firms' business.

In this research, seven knowledge processes are considered and vulnerabilities related to them are proposed: vulnerabilities related to knowledge creation, vulnerabilities related to knowledge acquisition, vulnerabilities related to knowledge loss, vulnerabilities related to knowledge sharing, vulnerabilities related to knowledge use, vulnerabilities related to emotional knowledge dynamics and vulnerabilities related to spiritual knowledge dynamics.

3. Methodology

3.1 Nature of the Study

The study is exploratory, the present research being part of a larger research project. Regarding the concept of "knowledge vulnerabilities", the literature is quite scarce. It is mostly theoretical and not much has been published on the subject of measuring knowledge vulnerabilities, nor on linking the concept with knowledge processes. Neștian and Guță (2023), in an exploratory and quantitative study, have proposed two scales, one for measuring knowledge vulnerabilities and another one for measuring knowledge risks. Both scales from the above-mentioned study have been developed based on a new taxonomy of knowledge risks, proposed by Bratianu, Neștian and Guță (2022). This new classification has been proposed in the literature by considering organizational knowledge dynamics and proposes knowledge risks typologies along seven clusters regarding knowledge processes: knowledge creation, knowledge acquisition, knowledge loss, knowledge sharing, knowledge use, emotional knowledge dynamics and spiritual knowledge dynamics. Neștian and Guță (2023) have considered these seven clusters both for knowledge risks and for knowledge vulnerabilities. This research is based on the above-mentioned studies and it is focused on developing a measurement scale for the construct of "knowledge vulnerabilities". We are using a deductive approach, quantitative methods of analysis and the research strategy is survey-based (Saunders, Lewis and Thornhill, 2007).

3.2 The Research Instrument

The research instrument that we are proposing and testing is a questionnaire, that contains the following:

- A filter question – applied so that only respondents from private companies would answer the whole questionnaire, since we were interested only in this type of organization and not also on public institutions or not-for-profit organizations; also, respondents not working at the time of completing the questionnaire could not complete the whole questionnaire.
- A measurement scale for the construct "types of knowledge vulnerabilities".
- One question concerning the position of the respondent in its organization – management or execution position.
- One question concerning the length of service of the respondent within the organization: under one year; between one and five years; over five years.
- One open question about the organization's field of activity.

The scale for each of the latent variables "type of knowledge vulnerability" ranges from one to five. One means total disagreement (the situation is not found in the organization); 2 – disagreement (the situation is rather not found in the organization); 3 – neither disagreement, nor agreement (the situation is sometimes found in the organization); 4 – agreement (the situation is found to a large extent in the organization); 5 – total agreement (the situation is characteristic to the organization). The scale contains a total number of 42 items, with six items for each of the seven types of knowledge vulnerabilities related to knowledge processes. This newly proposed instrument is developed based on a previous tested instrument, developed by Neștian and Guță (2023), which contains 21 items. Our instrument contains 42 items and includes newly developed items that reflect a deeper understanding of the concept of "knowledge vulnerabilities".

The survey has been conducted online, as part of a larger survey. Google Forms was used and data has been collected between 19th and 31st of December 2024. A number of 198 answers were obtained and the filter question helped us eliminate 28 answers, thus remaining with a total of 170 respondents working in commercial societies at the moment they completed the questionnaire. In order for an answer to be considered complete and afterwards to be sent, providing answers to all questions and items was set as mandatory in the Google form. The questionnaire was sent though different channels, such as software that we use in our teaching and research activities and social media.

3.3 The Sample

Out of the total of 170 respondents working in private companies, 57.1% are managers and 42.9% are non-managers. Concerning the length of service in the organization (seniority), the greatest percentage of respondents, 46.5%, worked for over five years in the organization, 42.4% worked between one and five years, and 11.2% worked for under a year in the organization, at the time of completing the questionnaire. The distribution of respondents by seniority is an argument concerning the trustworthiness of the respondents' answers, since employees with greater seniority in a company ought to know and understand the company better, from a knowledge management point of view. Since we were interested in developing a measuring scale to be used regardless of a company's field of activity, we did not limit our sample to certain fields of activity. Thus, among the fields mentioned by the respondents, we can find: accounting/ auditing/ financial/ tax consulting, agriculture, alcoholic beverages production, architecture and urban planning design, automobiles sales, automotive industry, aviation, banking/ financial services, business services outsourcing, business to business certified translations, business/ management consulting, call centre (debt collection), chemical industry, commerce, construction, custom printing, e-commerce, education/ training, fast moving consumer goods, fintech, foreign exchange/ investments, gear wheel production/ specific processes for aircraft, global payments, heavy trade in metallurgical products, hospitality, human resources, information and communication technology, insurance, marketing/ market research, mass media, medical field, non-banking financial sector, pharmaceutical field, private security, production of solutions for energy efficiency, real estate development, shoe cleaning services, sports betting, trade of professional measuring and testing equipment for telecommunications, transportation/ logistics, wellness, zootechnics.

3.4 Methods and Techniques Used for Data Analysis

Microsoft Excel and Statistical Package for the Social Science (SPSS, version 20) was used for data processing and analysis. Consistency analysis and Principal components analysis (PCA) have been conducted in SPSS. Consistency analysis was undertaken both for the entire instrument (without the nominal scales and the open question) and for the results obtained for the construct's components "type of knowledge vulnerability", for determining the internal consistency. PCA was undertaken for extracting the components of the latent variable "knowledge vulnerabilities". Although the instrument proposed in this study has been developed based on a previous tested instrument, developed by Neștian and Guță (2023), our instrument contains a double number of items, having newly developed ones, which reflect a better and deeper understanding of the construct of "knowledge vulnerabilities". Considering that all items in the questionnaire were mandatory in the online form, we have no missing values. The scale developed for measuring knowledge vulnerabilities has both positively and negatively formulated items, thus, part of the items had to be reversed. We decided to reverse the positively formulated items, given the nature of the concept under study. In total, 34 out of 42 items have been reversed, before proceeding to consistency analysis and PCA.

4. Results

4.1 Consistency Analysis

We tested the internal consistency for the scale "type of knowledge vulnerability", which means that we tested the whole instrument, but without the nominal scales and the open question. The Cronbach alpha coefficient obtained for the scale for types of knowledge vulnerabilities, with a total of 42 items, is equal to 0.946. The scale is reliable, the coefficient exceeding the threshold of 0.7 (Hair et al, 2006).

4.2 Components Resulted for Knowledge Vulnerabilities

The results obtained though PCA are shown in Table 1 below. Items are displayed in descending order of the loadings. Only loadings greater than 0.55 are shown.

Table 1: Results for "Types of knowledge vulnerabilities"

Rotated Component Matrix							
	Component						
	1	2	3	4	5	6	7
KS2: Employees' current work includes activities that involve sharing knowledge with each other.	0.791						
KS3: We have a system that incentivizes employees to share their knowledge with other colleagues, without losing any privileges.	0.743						

Rotated Component Matrix							
	Component						
	1	2	3	4	5	6	7
KS1: The organization incentivizes employees to share with colleagues the knowledge they use in their work.	0.713						
KS4: The employees use various face-to-face or on online platforms solutions to freely dialogue with colleagues on topics or projects in which they are involved.	0.702						
KS6: The firm encourages employees and managers to attend professional conferences and workshops from within the country and from abroad and then share the novelties which they found there.	0.627						
KC4: We have developed an efficient system for stimulating creative thinking and collecting employees' proposals for creating new processes, products and services.		0.794					
KC5: We have developed strategies to stimulate knowledge creation in line with current and future market requirements, by rewarding the most valuable ideas.		0.734					
KC2: We are connected in real time to the challenges / issues in the business environment.		0.640					
KC6: We have an open system for innovation, through which we analyse what customers want and stimulate them to contribute with ideas to the creation of new products and services.		0.608					
KC3: We have a group / department that specifically deals with the innovation process in the firm.		0.597					
EKD1: Employees are put in situations where they feel strong negative emotions at work, affecting their performance.			0.878				
EKD2: The way in which changing managers from their position is usually carried out generates emotional problems for employees, affecting their performance.			0.843				
EKD5: The leadership style of the managers generates a predominantly negative emotional climate.			0.817				
SKD2: The firm's set of values and principles highlights the importance of creating products and services for the society that meet quality requirements and lead to an increasing respect towards the firm.				0.754			
SKD5: The firm's top management has vision, defining strategies for the firm's development and achievement of competitive advantages.				0.681			
SKD4: The firm's managerial philosophy is based on creating an atmosphere of collaboration internally, and partnerships with other firms and governmental institutions externally.				0.626			
SKD6: In relations with partners or collaborators from abroad, we are aware of the importance of knowing their cultural values and respecting them.				0.552			
KL3: We have a system for incentivizing older employees to share their experience and knowledge with younger colleagues.					0.709		
KU3: We created a knowledge map in the firm, so that to be able to know who knows what and what experience they have, so that in new projects we don't constantly start from scratch.					0.665		
KA3: The firm has developed a strategy to attract and hire people with experience and the skills needed for the new business areas.					0.620		
KL5: The firm makes efforts, so that in its relations with suppliers, customers and other business partners, to preserve its manufacturing secrets or other types of valuable knowledge.						0.802	
KL4: The firm makes efforts to protect its new products and services by obtaining patents or other forms of intellectual property in accordance with applicable law.						0.761	
KU6: Before introducing them, we test the new procedures, technologies or processes, to reduce risks and errors.							0.740

Rotated Component Matrix							
	Component						
	1	2	3	4	5	6	7
KU5: We are aware that some information and knowledge become outdated when we introduce new procedures, technologies or processes in the production of products and services.							0.720
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.							

In the table, "K" is the abbreviation for "knowledge", "A" stands for "acquisition", "C" for "creation", "L" for "loss", "S" for "sharing" and "U" for "use". EKD means "emotional knowledge dynamics" and SKD means "spiritual knowledge dynamics". The number allocated to each item, for example 2 in the case of the item KS2, is the number of the item within the knowledge process theoretical cluster: item number 2 for knowledge sharing.

The solution obtained contains a number of 24 items out of the total of 42 items. A number of 18 items have been eliminated through principal components analysis because of issues such as the following: very few significant correlations with other items; low communalities; similar levels of loadings on two different components; lack of loadings over 0.5 on a component or individual measure of sample adequacy (MSA) below 0.5. In our decisions, we guided after Hair et al (2006). Since our sample is consists of 170 valid answers, which is above the threshold of a sample size of 150 answers in order for a factor loading of 0.45 to be statistically significant (Hair et al, 2006), we could have kept all the items with loadings of 0.45 or above. However, striving for practical significance, we decided to keep only items with loadings above 0.5. It is considered that only loadings equal to at least 0.5 have practical relevance (Hair et al, 2006). There is one exception – we had an item with a loading just above 0.5, but we decided to eliminate it from the solution, because it did not frame well, at a conceptual level, within the component. Removing this item led to a higher level of the total variance explained by the seven extracted components, equal to 70.16%.

The value of Kaiser-Meyer-Ohlin (KMO) test is 0.886. The obtained value indicates a very good solution obtained through principal components analysis. The Sig value of Chi-square (Bartlett's Test of Sphericity) is 0.00. This guarantees, with a likelihood of 95%, that there are statistically significant correlations between the variables (Pintilescu, 2007).

We propose the following labels for the components, considering the items loaded on each of them:

- component 1: vulnerabilities related to knowledge sharing (with a Cronbach alpha equal to 0.874)
- component 2: vulnerabilities related to knowledge creation (Cronbach alpha 0.821)
- component 3: vulnerabilities related to emotional knowledge dynamics (0.846)
- component 4: vulnerabilities related to spiritual knowledge dynamics (0.788)
- component 5: vulnerabilities related to knowledge from experience (0.718)
- component 6: vulnerabilities related to knowledge loss (0.735)
- component 7: vulnerabilities related to knowledge use (0.600).

Regarding the Cronbach alpha values obtained for the components resulted after applying principal components analysis, although it is recommended that the coefficients' value exceed 0.7, values equal to or above 0.6 are accepted in exploratory research, according to Hair et al (2006).

5. Discussion

Considering the aim of the paper, which is to propose and test a new measuring scale for the concept of "knowledge vulnerabities", a discussion is needed concerning labeling the obtained components. Thus, regarding the factor labels, a closer look in Table 1 at component 5 – vulnerabilities related to knowledge from experience, shows us a problematic component from the point of view of its conceptual content. One of the seven components that we obtained through factor analysis should have been vulnerabilities related to knowledge acquisition.

Considering the three items included in component 5, from a conceptual perspective we see that one item (KL3) is for vulnerabilities related to knowledge loss when older employees share their experience, another one for vulnerabilities related to creation of knowledge maps about experiences (KU3) and only the last one is for vulnerabilities related to knowledge acquisition through hiring people with experience (KA3). Thus, we

decided that labelling component 5 as vulnerabilities related to knowledge from experience is a more appropriate label compared with vulnerabilities related to knowledge acquisition.

However, at a closer look, the result can be explained. The conceptual focus of the three items is the following: KL3 – incentivizing knowledge sharing to limit losses, KU3 – structuring knowledge, KA3 – knowledge acquisition through new employees. Thus, for example, the item that we considered to measure vulnerabilities related to knowledge loss (KL3), can be considered to reflect knowledge acquisition, not per se, but as a form of acquisition through or from the experiences – and also the knowledge – that older employees have. The emphasis is on the existence, within the organization, of a system for incentivizing this type of behaviour. Also, the item that we considered to measure vulnerabilities related to knowledge use (KU3), can be considered to reflect knowledge acquisition in an indirect way, through the experience of other colleagues in the firm. Considering that, by creating a knowledge map, other employees may acquire new knowledge, item KU3 can be conceptually linked with knowledge acquisition.

Then, if we were to compare the results obtained in this research with those obtained by Neștian and Guță (2023), first of all, we can notice what we obtained a number of seven components. Six of the resulted components could be labelled exactly according to the conceptual perspective, even if some of the items had to be deleted when applying principal components analysis. Knowledge creation has resulted in a component by itself, compared to Neștian and Guță's (2023) research, but, considering knowledge acquisition, we did not obtain a component for this type of vulnerability. Instead, we named the component as vulnerabilities related to knowledge from experience. Concluding, this is a major difference between the mentioned study and the results obtained in the present study.

Considering the other five components that we have obtained by applying principal components analysis, the comparison with Neștian and Guță's (2023) study looks as follows: emotional knowledge dynamics and spiritual knowledge dynamics, which were combined in a single component, have differentiated themselves in two different components. Also, knowledge loss and knowledge use have resulted in two different components, as compared to having them together in one component in Neștian and Guță's (2023) research. Vulnerabilities related to knowledge sharing is a component by itself in our study as well as in Neștian and Guță's (2023) study.

6. Conclusion

The purpose of this research is to propose and test a measurement scale for knowledge vulnerabilities, an emergent concept in knowledge management that is strongly related to knowledge risks. However, there is a scarcity in the literature concerning knowledge vulnerabilities although their understanding and measurement can reduce or even eliminate the knowledge risks associated with knowledge intensive organizations.

The results that we obtained were possible through widening the number of items, aligning them better with the theoretical perspective used and through a larger sample. We have obtained a solution with seven factors and 24 items, compared to four factors and 15 items in Neștian and Guță's (2023) study. Six of the seven factors are, from a conceptual point of view, aligned with categories of knowledge processes stated as theoretical foundation, allowing us to name them accordingly, and thus confirming the conceptual clarity of the research instrument.

The proposed instrument and the results obtained have practical implications for managers, for example in decision-making processes which are strongly influenced by knowledge dynamics (Bratianu, Paiuc and Bejinaru, 2024; Hill, 2008; Kahneman, 2011).

Also, the items in our questionnaire loaded in the principal components obtained can be used in future relevant studies. In terms of the entire questionnaire, all the 42 items may be subject to confirmatory factor analysis, for testing the validity for a construct's theoretical structure or the factorial structure of a measurement instrument (Byrne, 2010).

Concerning the conceptualization of vulnerabilities associated with knowledge processes, the components that we have obtained through principal components analysis offer a better picture.

The limitations of our study are related to the fact that we did not use systematic sampling, nor did we take, so far, a confirmatory approach, which is needed for validation purposes. Future research can include an extension of the sample and consider a confirmatory approach.

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Knowledge Sharing and Creation Through Seed Funding

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Abstract: Even though international network building is increasingly recognized to be important for research, the use of seed funding as a means of building researchers' collaboration networks prior to actual grand writing network building and knowledge sharing has not been addressed. Research is a knowledge creation and knowledge sharing activity. Networking can increase social capital and thus enhance research productivity of HEI's. International research collaboration networks are important for knowledge production, research productivity, and enhancing innovation capabilities. The enhancement of innovation capabilities is also linked to the mission HEI's have of collaborating and enhancing the local business community in Finland. Innovation capabilities can be seen as innovation drivers, which improve the competitive advantages of a company or specific region. A number of instruments are in place for pure academic networking; however, these differ from seed funding as seed funding in most cases also includes networking outside of academia, e.g., local SME's. This research depicts different seed funding sources used to construct international funding application research networks and also highlights the challenges, which should be addressed when considering this approach. The research question the paper addresses is, how do we best utilize seed funding to enhance knowledge sharing. The paper uses a case study approach presenting a number of successful seed funding research collaboration cases led by LAB University of Applied Science, which have also led to successful research funding applications with international partners. The study highlights possible pitfalls and also challenges encountered during the seed funding research collaboration period. Conclusions as to best practices with regards to utilization of seed funding to enhance knowledge sharing and creation are also presented. The findings emphasize the importance of strategic planning and proactive engagement in building effective research networks.

Keywords: Seed funding, Knowledge creation, Knowledge sharing, Network building

1. Introduction

The importance of network building has been determined as essential for the success of higher education institutions (HEI). (Haley et al, 2024; Huang, 2014) The design of networks promoting research productivity is also seen as important, with interdisciplinary research increasing productivity of researchers. . Academic networking research also suggests that networks can affect academic career success directly through employment, publication, and conference opportunities and simultaneously positioning the networking academic to new emerging trends and current data. (Bogdanova et al, 2022; Heffernan, 2021) Different dimensions of social capital are enhanced by networking (Gonzales-Branbila, 2014), with regard to both the density of the social network or the size of the network. (Barthauer et al, 2016) It has also been shown that social capital significantly impacts collective intelligence, thus investing in social capital enables academia as well as business organizations to share perceptions and perspectives and attain deeper collective thinking. (Al-Omoush, 2022; Meltovaara et al, 2021) Social capital is a critical component of inter-organizational relationships and networks. (Golgeci & Kuivalainen, 2020). Social capital consists of the social networks of relationships, patterns, expectations and beliefs that promote interactive collaboration and coordination for mutual benefits (Putnam et al, 1994). Social capital can thus be seen as the basis and also the driver for networking and collaborative activities of both academia and other organizations and thus enhance and stimulate collaborative innovation as well as collective intelligence. (Al-Omoush, 2022) Knowledge sharing has also been positively associated with innovation capability. (Ganguly et al, 2019) Developing innovation approaches is imperative, and can be undertaken through new collaboration activities. (Makkonen et al, 2023; Leimu & Meltovaara, 2011)

International research collaboration can foster the exchange of knowledge across borders, leading to breakthroughs that would be difficult to achieve in isolation, also research challenges are often viewed as global in nature. (Chankseliani et al, 2021) For researchers, especially within HEIs, building strong networks is essential for driving knowledge production, enhancing research productivity, and strengthening their institutions' competitive edge.(Marginson, 2011; Rosenberg et al, 2023) Despite the recognition of the importance of network building, one critical aspect has remained underexplored: the role of seed funding in establishing these research networks before the onset of larger, more formal grant applications. collaborations foster the exchange of knowledge across borders. This paper describes different types of seed funding and also

provides a case study example of successful international network co-operation fostered by seed funding and aims to provide deeper understanding of how network building, supported by seed funding, can enhance networking and also the broader socio-economic missions of HEIs.

2. Literature Review

The theoretical framework underpinning this study draws on established models of knowledge creation, social capital, and institutional interaction to explore how seed funding supports research collaboration. Central to this perspective is Nonaka's (1994) SECI model, which describes knowledge creation as a dynamic process involving the transformation of tacit and explicit knowledge through four stages: *socialization, externalization, combination,* and *internalization*. Seed funding, in this context, provides a temporary but strategic environment for initiating the early phases of this process, functioning as a shared context or Ba (Nonaka and Konno, 1998) where ideas can begin to emerge and circulate.

Effective collaboration also depends on the development of social capital: the trust, norms, and shared goals that support knowledge sharing within networks (Nahapiet and Ghoshal, 1998). The formation and durability of these networks, particularly in cross-sectoral partnerships, are shaped by underlying institutional logics (Thornton, Ocasio and Lounsbury, 2012), which can either facilitate or hinder alignment between academic, commercial, and policy actors.

At the interpersonal level, the sharing of tacit knowledge (Polanyi, 1966) often requires co-located interaction and sustained engagement. This is reflected in Wenger's (1998) theory of communities of practice, which emphasizes the importance of mutual engagement and shared practice in fostering meaningful learning. Finally, in evaluating the impact of seed funding, we adopt a systems-oriented view inspired by Sanderson's (2000) framework for assessing policy initiatives in complex environments, highlighting learning and capacity-building as outcomes in their own right, regardless of whether direct funding results are achieved.

3. Methodology

This paper uses a qualitative approach, which is contextual; in other words, the paper represents the viewpoints of specific university representatives: the emotions, prejudices, and motivations of the participants in the context of research, development, and innovation activities of research staff (Gray, 2017). The research question of the study is: How can seed funding be used by HEI's to further successful research proposals? Two approaches were applied in this study: a case study approach and an action research approach. Case studies are adequate and necessary when describing research tasks. The case study method has been applied extensively across fields, particularly in the education field and is an appropriate method to solving complex problems (Montes-Rodríguez et al, 2019; Brusila-Meltovaara & Karppinen, 2025).

The action research approach is a method of systematic inquiry of university lecturers, who act as researchers of their own practice, constantly questioning the practices and methods in use and being active drivers for change. The action research process is frequently described as a cyclical process, as shown in Figure 1.

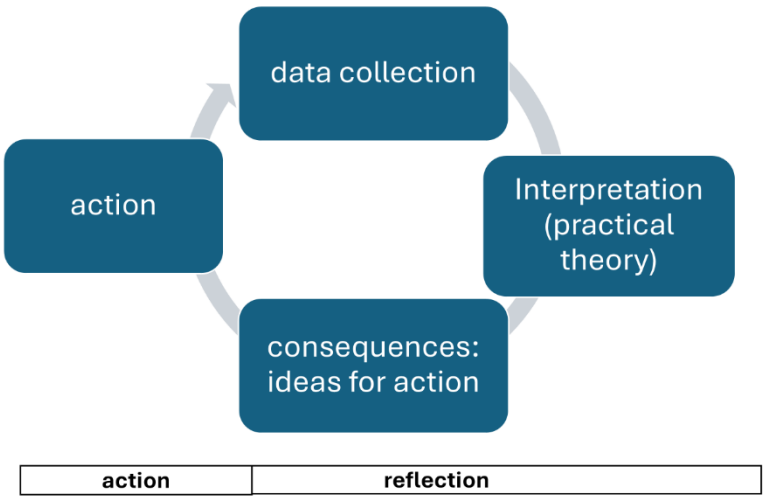


Figure 1: The circle of action and reflection (Altrichter et al. 2007)

Problems, problem-solving abilities, and community are the focus of action research. Action research influences the functions and environment of the researched phenomenon by enhancing and developing the community's problem-solving skills. Engaging actively in the community's practices associated to the research phenomenon is crucial for conducting action research. The process starts with practical actions that yield data through systematically documented observations (Brusila-Meltovaara et al, 2022). This study was undertaken within LAB University of Applied Sciences in Finland and it covers three research grant application cases utilizing seed funding.

4. Case Studies: Seed-Funded Research Collaborations

Three seed funding cases are examined in this paper: the Erasmus+ Alliances for Innovations Baltic Digi tour, the Interreg CB application Entrepreneurial Skills of International Students (ESI) and the interreg BSR application LAB Midas..All three seed funded project did not succeed in obtaining project funding, however they allowed for knowledge sharing and networking, which constructed a base for further co-operation. The three cases, the duration and funder are depicted in Table 1.

Table 1: Seed funding cases

	Baltic Digit tour	**ESi**	**Midas**
Project implementation period	01.10.2020-30.09.2021	01.10.2021 – 30.06.2022	01.09.2022-31.12.2023
Funder	Interreg Baltic Sea Region Seed Money	the Regional Council of Päijät-Häme, Supporting Sustainable Growth and Vitality of Regions (AKKE)	Interreg Baltic Sea Region

4.1 Case 1: Baltic DigiTour

The Baltic DigiTour was undertaken for the benefit of touristic stakeholders and also to advance the capacity of exploiting digitalization in the field of touristic attractions. The increased competition over people's free-time, tourism attractions have to enhance digitalization as a mixture of three angles, namely, to bring together IT processes and digital services, digitalized and physically enhanced, thus, holistic guest / visitor experience and digital marketing in order to be attractive and gain visitors. With the seed funding a consortium of ten particpants was established as follows:

- LAB University of Applied Sciences, HEI, Finland
- Stralsund University of Applied Sciences, HEI, Germany
- Mecklenburg-Vorpommern Tourist Board, DMO, Germany
- University of Szczecin, HEI, Poland
- National Marine Fisheries Research Institute, tourist attraction, Poland
- Rostock Marketing
- Business Academy North
- Experyment
- University of Dubrovnik
- Lithuanian Sea Museum.

As a result the consortium submitted an international funding application called ComeToLearn, Community-based Methodology in Tourism for interorganizational learning for innovation to the Erasmus+ Alliances for innovation funding programme with a deadline of September 2021.

ComeToLearn focused on the development of inter-organizational social learning formats for continuing professional development. The development was undertaken to ensure resilience, quality, and innovativeness with the example of the tourism sector. Technological development brings about changes to the tourism sector at a high speed, creating a need for digital transformation which is complex, ever-changing and uncertain. Consequently, new knowhow and skills are needed to support the transformation needs continuing professional development (CPD). While vocational training institutes and universities provide formal educational programmes and a variety of MOOCs and other material e.g. by the NGT Alliance is available, the power of social learning with peers in a connectivity approach could add to CPD motivation and quality.

A study with tourism professionals from businesses, DMOs and educators in 2021 in the Baltic Sea Region (n=244) showed the preferred learning modes of online, self-paced learning but an equal appreciation of social, peer-to-peer learning and learning by doing. While the study proved high interest in joining an online learning community on digital transformation with various interests of contribution, the roles, processes, and artefacts needed to benefit both professionals and students in this industry of micro, small and medium-sized enterprises would benefit from a best-practice guide, which this project aims to develop: a Community-based Methodology in Tourism for inter-organizational learning for Innovation. Focusing on the development of digital and managerial skills in an approach of continuing professional development the project implements various modes of managerial skills in an approach of continuing professional development the project implements various modes of community-based learning of students and professions in an action research approach in three pilot communities. These pilots are accompanied by a course qualifying learning community managers for establishing and guiding the communities. The pilots are accompanied by continuous evaluation to build towards the transferable methodology for inter-organizational community-based learning. (Marx et al. 2021) Challenges and lessons learned from this seed funded project where that managing interdisciplinary collaboration and balancing academic and business objectives needs to be paid special attention to. The submitted proposal did not obtain funding and the consortia was not strong enough to apply again.

4.2 Case 2: ESI - Entrepreneurial Skills of International Students

Finland requires an increasing number of skilled workers from abroad to sustain labor availability, regional vitality, and competitiveness due to its own demographic development. Accelerating integration and employment of immigrants is crucial for economic sustainability. The availability of skilled professionals has been recognized as a major challenge for business growth and internationalization. The project aimed to prepare an international consortium and develop a project proposal to improve entrepreneurial skills among international students. The main applicant was LAB University of Applied Sciences.

A consortium was created consisting of four universities all in different countries: LAB University of Applied Sciences, HEI, Finland, Tallinn University of Technology, HEI, Estonia, Riga Technical University, HEI, Latvia and Mid Sweden University, HEI, Sweden. An International funding application called QUEST - Co-create your entrepreneurial future in a dynamic community was submitted to the Interreg Central Baltic programme with a deadline in March 2022.

The proposal entailed enhancing employment opportunities through entrepreneurship. Young educated people are faced with lack of employment opportunities and leave the regions in search of work. This is a common challenge the QUEST project consortium identified for the entire Central Baltic Region. Entrepreneurship is a viable alternative to employment. With an entrepreneurial mindset and attitudes, creative skills can be utilized to establish start-ups, develop business, make use of knowledge existing in ecosystems and create new connections between businesses and individuals. The QUEST project was set up to develop and implement an international practical entrepreneurship training programme aimed at empowering the entrepreneurial skills of young people, including international students. The programme was to constructed through joint educational modules, simulations and international boot camps. The training programme was to be supported by establishing and clarifying existing collaboration channels, such as building new multidisciplinary student teams and further developing professional networks. This development can be seen to enhance integration of young people into the professional ecosystems. Suggested online learning and collaborative environments enable accessibility of the learning materials to the project target groups and beyond. Besides, online community management enables the creation of international entrepreneurial teams, and this is further supported by international events. (Bogdanova & Rantanen 2024).

The consortium created additional project ideas and submitted two project proposals for Interreg Central Baltic in 2024. Also the networking arranged a visit was for a group of staff from LAB to Tallin Technical University. Challenges and lessons learned from this seed funded project were that this seed funding partnership created other project ideas and consequently two other project proposals were submitted for the Interreg Central Baltic funding application in 2024. The actual seed funded project proposal did not get funding.

4.3 Case 3: LAB Midas

The Project was a preparatory project focusing on establishing how the lessons learned from projects implemented through different funding sources in the Baltic Sea Region could better be utilized in the development work of regions, businesses, and associations. The study examined the need for an event focused

on projects in the Baltic Sea Region. The event would showcase project results, best practices, and lessons learned from various countries in a clear and accessible format for businesses and other organizations. The planned event would function as a "Slush!" for projects, where completed projects of the year present their outcomes to a broader audience. The proposed venue for the event was Lahti. The tentative themes for the event were: low carbon solutions, circular economy and digitalization.

A key aspect of the project was also the training for how to effectively communicate project results to different target groups ("elevator pitch"). The training was aimed at research and organizational staff. Additionally, a digital platform will was proposed to be piloted as a means to expand project visibility through short video presentations. The key actions of the project proposal were to map project actors and projects in the the Baltic Sea Region (BSR), create a collaboration network and planning joint activities and prepare aa joint funding application for the IR-BSR call in early 2023. One of the key achievements was the creation of the consortium, which consisted of eleven main and fourteen associate partners shown in Table 2and 3.

Table 2: LAB Midas main partners

Main Partners	Country	Type of institution
LAB University of Applied Sciences (Lab-ammattikorkeakoulu Oy)	Finland	Higher education and research institution
Aarhus University (Aarhus Universitet) -	Denmark	Higher education and research institution
Riga Technical University (Rīgas Tehniskā universitāte) -	Latvia	Higher education and research institution
Tallinn University of Technology (Tallinna Tehnikaülikool)	Estonia	Higher education and research institution
Kaunas Science and Technology Park (Kauno mokslo ir technologiju parkas)	Lithuania	Business support organization
University of Agder (UiA) (Universitet i Agder)	Norway	Higher education and research institution
Hanse-Parlament e.V.	Germany	Business support organization
Skåne Food Innovation Network (SFIN) (Livsmedelsakademin) -	Sweden	Interest group
Kaunas University of Technology (Kauno technologijos universitetas)	Lithuania	Higher education and research institution
Warmia and Mazury Regional Development Agency (Warmińsko-Mazurska Agencja Rozwoju Regionalnego S.A.)	Poland	Sectoral agency

Table 3: MIDAS Associate partners

Associate Partner	Country	Type of institution
The Regional Council of Päijät-Häme (Päijät-Hämeen liitto)	Finland	Regional public authority
Baltic Institute of Finland (Suomen Itämeri-instituutti)	Finland	NGO
Kaunas IN	Lithuania	Sectoral agency
Association of Technology and Innovation Business Support (Technologijų ir inovacijų paramos verslui asociacija)	Lithuania	NGO
University of Applied Science (BHH) (Berufliche Hochschule Hamburg) -	Germany	Higher education and research institution
Free and Hanseatic City of Hamburg, Senate Chancellery (Freie und Hansestadt Hamburg, Senatskanzlei)	Germany	Local public authority

Associate Partner	Country	Type of institution
Varodd Utvikling AS - Norway (Education/training centre and school)	Norway	Education/training centre and school
Latvian Chamber of Commerce and Industry (Latvijas Tirdzniecības un Rūpniecības kamera)	Latvia	Business support organisation
Tallinn Science Park Tehnopol Foundation SA (Tallinna Teaduspark Tehnopol)	Estonia	Infrastructure and public service provider
University of Warmia and Mazury (Uniwersytet Warmińsko - Mazurski)	Poland	Higher education and research institution
Hamburg Investment and Development Bank (Investitions- und Förderbank Hamburg)	Germany	Business support organisation
Latvian Council of Science (Latvijas Zinātnes padome)	Latvia	National public authority
Region Skåne	Sweden	Infrastructure and public service provider
Invest Skåne	Sweden	Business support organisation

The associated partners contributed to the project by supporting innovation ecosystems, facilitating collaboration, providing expertise, and enhancing the visibility of research and business networks in the Baltic Sea Region. The overall objective of the project was to enhance the resilience of SMEs in the Baltic Sea Region by democratizing access to the results of RDI projects. The project sought to address key challenges and barriers that SMEs face in accessing the results of RDI projects and to develop practical solutions to help SMEs overcome these challenges. Ultimately, the project aimed to create a more connected and collaborative innovation ecosystem in the BSR that can support the growth and resilience of SMEs in the region.

Key achievements included the construction of the consortium and the submission of the International funding application to the Baltic Sea Innovation Forum - Improving SMEs Resilience with Shared Results of Publicly Funded RDI Projects. The project idea was communicated at the matchmaking platform: https://matchmaking.interreg-baltic.eu/landingpage/. Because of this, LAB was invited to participate in another project proposal for the Interreg Baltic Sea call. The project BSO4CE - Building Capacities and Skills for Circular Economy Coaches was submitted in 2024 but didn't receive funding. The project aimed to contribute to the 'Increase Prosperity' goal by improving SME competitiveness and compliance with the green transition, particularly in rural areas.

5. Comparative Synthesis of the Cases

The three seed-funded case studies presented, namely, Baltic DigiTour, Entrepreneurial Skills of International Students (ESI), and LAB Midas, offer important insights into how seed funding can be leveraged to initiate cross-border collaborations, but they also expose recurring challenges. A comparative analysis across five key dimensions: objectives, network formation, outcomes, barriers, and legacy, reveals both patterns and divergences, as outlined below.

Table 4: Comparative synthesis

Dimension	Baltic DigiTour	ESI	LAB Midas
Primary Goal	Strengthen tourism sector through digital skills transformation	Improve entrepreneurial skills and integration of international students	Connect and showcase BSR project outcomes; improve SME access to RDI
Sectoral Focus	Tourism / Education	Education / Entrepreneurship	Innovation policy / SME development
Networking outcome	10 partners; HEIs, DMOs, SMEs	4 HEIs in 4 countries	25 partners (11 main, 14 associate); HEIs, NGOs, public sector, SMEs
Cross-Sector Integration	Moderate (academia & tourism stakeholders)	Low (academic only)	High (broad multi-sectoral involvement)
International Scope	Strong (6 countries)	Moderate (Nordic-Baltic)	Very strong (8+ countries)

Dimension	Baltic DigiTour	ESI	LAB Midas
Funding Outcome	Erasmus+ proposal submitted (unsuccessful)	Interreg CB proposal submitted (unsuccessful)	Interreg BSR proposal submitted; spin-off proposal (BSO4CE) also submitted (unsuccessful)
Follow-Up Activities	None; consortium dissolved	2 follow-up proposals in 2024; staff mobility	Further consortia invitations; regional visibility; ongoing networking
Key Challenges	Interdisciplinary coordination; digital-only collaboration; weak follow-up	Unaligned goals; digital engagement	Complex coordination; balancing institutional logics; resource intensity

6. Discussion

This study explored how seed funding supports international research collaboration and knowledge creation through three comparative cases. The findings demonstrate that while seed funding can provide the initial platform for knowledge partnerships, its long-term value depends on how effectively networks are built, aligned, and sustained. Each result is interpreted through relevant theoretical lenses to explain why some collaborations endured and others dissipated.

6.1 The Role of Strategic Alignment and Network Quality as a Mediator of Knowledge Sharing

All three cases, *Baltic DigiTour*, *ESI*, and *LAB Midas*, used seed funding to initiate cross-border partnerships. However, only *LAB Midas* led to sustained engagement, follow-up proposals, and wider institutional visibility. This divergence reflects strategic fit theory and absorptive capacity (Cohen & Levinthal, 1990), which emphasize the need for alignment between project goals, institutional capability, and stakeholder expectations.

In *LAB Midas*, partners shared a clear regional mission and innovation agenda, enabling the project to act as a knowledge "on-ramp" rather than a stand-alone effort. In contrast, *Baltic DigiTour* lacked such coherence, and the collaboration dissolved after the initial failure. These outcomes also reflect Nonaka and Konno's (1998) concept of *Ba*: a shared space for knowledge creation. Where seed funding created meaningful Ba (as in Midas), knowledge processes progressed. Where Ba was weak or fragmented, the collaboration stalled.

Seed funding's role in facilitating network formation is a necessary but insufficient condition for impactful collaboration. According to social capital theory (Nahapiet & Ghoshal, 1998), the strength of relational and cognitive ties among participants directly shapes their ability to share and mobilize knowledge. In *LAB Midas*, a broad and well-coordinated network fostered mutual trust and complementary expertise. This created what Wenger (1998) would describe as a nascent community of practice, where participants were united not just by tasks, but by shared meaning and learning trajectories.

In *Baltic DigiTour*, however, the lack of alignment and weak relational capital meant that no community or sustained interaction emerged. This reinforces that networks must be intentionally cultivated; they do not automatically result from co-funding or shared deliverables.

6.2 Tacit Knowledge as Barrier and Beyond Binary Success

The reliance on virtual collaboration during the pandemic limited the socialization and externalization phases of Nonaka's (1994) SECI model. The sharing of tacit knowledge (Polanyi, 1966): insights, intuitions, and practices that are hard to articulate, depends on trust and embodied interaction. These were constrained in all three cases due to the absence of physical co-presence, limiting opportunities for collective sensemaking and innovation.

Traditional project evaluations often assess seed funding by binary outcomes, namely, whether follow-up funding was secured. However, this study supports a systems-thinking perspective (Sanderson, 2000), emphasizing learning, network resilience, and strategic positioning as equally valid results. Even without securing funding, *ESI* and *LAB Midas* enhanced their institutions' reputational capital and proposal capabilities.

This is particularly significant for peripheral HEIs like LAB University of Applied Sciences. As argued in regional innovation systems theory (Asheim & Gertler, 2005), seed funding can be a critical mechanism for inserting such institutions into broader knowledge ecosystems, where long-term value lies in accumulated relational and strategic assets, not just project funding.

7. Conclusions

Networking is essential for enhancing research productivity and knowledge production, research productivity and knowledge sharing. Seed funding provides a means to build consortia and allows for international networking in project proposal construction. Belonging to the seed funding consortium often resulted in additional project ideas or in the inclusion of as member of other project proposals, thus knowledge sharing and networking occurred in all three cases presented in the paper.

Challenges and lessons learned from this seed funded projects where that managing interdisciplinary collaboration and balancing academic and business objectives needs to be paid special attention to. Also the projects needs a full time dedicated experiences project manager. International networking is often time-consuming and resource intensive. The effort in international consortia is often greater than in a national consortium and requires significant effort and establish and maintain. Travel and Logistics should also be taken into account even though meetings can be undertaken online, face to face encounters are beneficial to enhance deeper understanding of project partners and also allow visits to different organizations.

Future research should be taken into examining seed funding cases, which have resulted in positive project proposal decisions. By examining those best practice procedures and networking can be highlighted to further ensure future successful seed funded project proposal. Future research should also look at the life span of the consortium set up during the seed funding. This could again establish best practices to building consortia spanning longer than one project proposal.

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AI declaration: An AI tool was not used in the submission of this paper.

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The Impact of Vertical Trust on Knowledge Sharing Practices in Innovation Sector Companies

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Abstract: Modern enterprises functioning in conditions of international competition seek factors that support the increase in their market value. One of these is knowledge, which may be shared or exchanged in various forms by employees, managers or employee teams in an organization. Sharing necessary information and professional experience in an organization is essential in order to resolve problems with the aim of achieving innovative solutions. A factor which supports this process of sharing knowledge is that of trust, which has an influence on tightening interpersonal cooperation within employee groups and organizations with the aim of realizing common interests. The most significant entity creating trust in an organization is that of a manager who undertakes actions on behalf of building trust between employees and their superior. The acceptance of the assumption that a manager has an impact on the level of organizational trust facilitated the formulation of the aim of this paper, which is the identification of trust between employees and their head, while also its impact on the practice of sharing knowledge in enterprises of the innovative sector. The assumed aim was executed thanks to the application of the phone survey method with the CATI technique (Computer Assisted Telephone Interview). On the basis of the method of random sampling, a sample was created consisting of 575 employees in enterprises of the innovative sector. As a result of the research conducted, a statistically significant dependency was discovered between the indicators of vertical trust and sharing knowledge, while also experience on the part of employees in the analysed enterprises. The positive impact of trust on the process of accumulating knowledge and the frequency of sharing it have been indicated.

Keywords: Organizational trust, Vertical trust, Knowledge, Sharing knowledge

1. Introduction

In the 21st century economy, innovation and knowledge are key to achieving competitive advantage in the global marketplace. Knowledge is the most valuable resource because it embodies intangible assets, routines and creative processes that are difficult to imitate. In the process of developing new technologies and products, knowledge sharing (KS) is essential. Through knowledge sharing, employees' knowledge base increases and the chance for innovative ideas to emerge increases (Kmieciak, 2020). A key question is what makes individuals effective in sharing knowledge with others in organisations. Trust is considered to be one of the factors behind the decision to share one's knowledge. It can be defined as "the extent to which a [party] is confident in and willing to act on the basis of, the words, actions, and decisions of another" (McAllister, 1995, p. 25). Trust in an organisation includes mutual respect and understanding, which promote opportunities for effective pooling and use of knowledge resources (Kamaşak, Bulutlar, 2010). In the knowledge sharing process, the relationship between the manager and the other team members is important. These relationships are often built on a foundation of trust. One can speak in this case of vertical trust, i.e. between a manager and their subordinates. This trust must be nurtured by managers in order to achieve positive results (Afsar, Masood, 2018). It seems interesting to explore the relationship between these subjects of trust. However, little empirical research has been conducted on the correlation between vertical trust and knowledge sharing (e.g. Le, Lei, 2018). Therefore, explaining how vertical trust influences knowledge sharing and reduces reluctance to share knowledge will bring valuable insights into new pathways to organisational knowledge building. To fill the theoretical gap discussed above, four research questions were formulated:

RQ1: To what extent is there trust between manager and employees in innovation sector companies?

RQ2.: What relationships are there between vertical trust attributes and knowledge sharing indicators?

RQ3.: What attributes of a manager conducive to trust have an impact on knowledge sharing?

RQ4.: To what extent do vertical trust attributes minimise employees' reluctance to share knowledge?

2. Theoretical Background

In companies operating in innovative sectors, knowledge is seen as a critical resource for achieving competitive advantage. It is one of the key resources for the success of both individuals and organisations (Pereira, Mohiya, 2021). Sharing knowledge refers to activities in which knowledge is shared or exchanged in various forms by employees, groups or organisations (Meyer 2023). Knowledge is information that has been analyzed and organized in such a way that it can be understood and used to solve problems and make decisions (Cao et al.,

2024). The creation of new knowledge is a key activity of organisations, requiring careful management. One important aspect of knowledge management is to encourage individuals in the organisation to share knowledge with other members of the organisation. Knowledge sharing is the mutual transmission of information and experience from one actor to another. It involves sharing the necessary information and work experience within a team to solve problems to achieve innovative solutions. The process of knowledge sharing between individuals involves the transformation of knowledge held by an individual into a form that can be understood, assimilated and used by other individuals (Pangil et al., 2014). In the context of team collaboration, knowledge sharing enables team members to achieve synergy by reusing, modifying and applying collective wisdom to solve new problems (García-Sánchez, 2019).

Trust is an important driver of knowledge sharing. People will be more inclined to share knowledge with others who can be trusted than with those whom they distrust. In the case of organisations, one can speak of organisational trust, which is defined as the perceived trustworthiness of the organisation as estimated by the dimensions of transparency, honesty, competence, benevolence and reliability, and based on personal experience and identification (Pirson, 2008). In an organisation, the subject of trust can be an individual employee, colleague, supervisor or subordinate (Shah et al., 2024), an employee team (de Jong et al., 2021), management (Dirks, de Jong, 2022) or the organisation (Bai et al., 2024). Tam and Lim(2009) suggested that organisational trust can be considered at two levels: trust between co-workers (horizontal trust) and trust in superiors (vertical trust). Trust in coworkers is defined as "the willingness of a person to be vulnerable to the actions of fellow coworkers whose behaviour and actions that person cannot control" (Tan Lim, 2009, p. 46). It can be conceptualised as an implicit construct based on an individual's own tendency to trust others and the perceived trustworthiness of other team members, which in turn leads to collaborative and monitoring behaviour between team members (Costa, Anderson, 2011). In contrast, Tan and Lim (2009, p. 46) defined vertical trust as "an employee's willingness to be vulnerable to the actions of the organization, whose behavior and actions he or she cannot control". This trust refers to the complementary trust experienced or expressed by subordinates and superiors towards each other at any given time. Vertical trust as a variable in the supervisor-subordinate relationship works reciprocally and includes both the trust of a subordinate in his or her supervisor and vice versa (Özyilmaz, 2010). In other words, employees' trust in their superiors tends to be related to their trust in management in general (Weibel et al, 2016). Empirical research confirms the relationship between trust and knowledge sharing. Afsar et al. (2018), noted that trust motivates employees to collaborate and support their ideas through reciprocity and knowledge sharing. Hsu and Chang (2014), found a positive relationship between interpersonal trust and knowledge sharing. Employees who trust their leader and co-workers are more likely to submit to their leader's guidance and opinions without questioning their credibility, leading to more innovative behaviour (Zafar et al., 2024). According to Kmieciak (2020), vertical trust is positively related to the generation and implementation of innovative ideas. Trust in supervisors enhances identification with the organisation, job performance (strongest level of positive correlation), job satisfaction, and organisational citizenship behaviour (Rahayuningsih, 2019). Trust in the manager increases knowledge sharing by reducing the fear of losing one's unique value and improving the willingness to document knowledge (Renzl, 2006).

In sum, the cited studies allow a conclusion that trust in an organisation, and in particular vertical trust, is a significant variable that is useful for explaining knowledge sharing processes in an organisation.

3. Methods and Sample

In Poland, research on the impact of vertical trust on knowledge sharing in companies of innovative industries is relatively rarely undertaken. The Author's intention is to fill this research gap by analysing the impact of vertical trust attributes on knowledge sharing and on the reduction of reluctance to share knowledge among employees working in innovative industries companies. Therefore, an empirical study was conducted among employees in innovative sectors in which a one-time survey method was used on an unweighted sample. The research tool was a standardised survey questionnaire. The survey design was based on a five-point Likert scale. The survey was conducted using a CATI (Computer Assisted Telephone Interview) telephone survey. The sampling frame was innovative industry enterprises employing more than 50 people. Based on the random selection method, a research sample was constructed consisting of 575 individuals employed in companies in innovative industries, i.e. pharmacy (25.2%), energy (23.3%), automotive (26.4%) and IT (25%). The surveyed employees were white-collar (97.2%) and blue-collar (2.8%) workers, with work experience of 4–8 years (10.3%), 9–13 years (23.8%), 14–18 years (33.7%) and 19 or more years (32.2%). Due to random sampling, the survey was performed on a representative sample using the following parameters: margin of error α 4%, confidence interval: 95%.

4. Findings

A factor influencing knowledge sharing among employees is organisational trust, in particular trust between a manager and his or her subordinates. To identify this relationship, a research construct was developed consisting of statements exploring aspects of vertical trust in detail, based on, among others, the scale proposed by Krot and Lewicka (2016). In the study of employees of companies in innovative industries, vertical trust was identified at a higher than average level ($\bar{x}$= 4.12, SD=0.840) (Table 1). According to the respondents, subordinates' trust in their superiors is mainly inspired by managers keeping their promises to subordinates, evaluating employees fairly, being open to talking to employees about their concerns and is also reflected in being loyal to the manager.

Arithmetic averages identified differences in the degree to which vertical trust attributes were present in different sized companies. A Kruskal–Wallis rank-sum ANOVA test was performed to identify these differences. Statistically significant differences were found for the attributes: VT1- H =15.87554; p =.0072; VT4- H =15.97103 p =.0069; VT7 - H =16.60897 p =.0053. No differences were observed for the other attributes.

Table 3: Measures of central tendency and dispersion of vertical trust attribute (VT) scores

ITEM	$\bar{x}$	SD	Me	Mo	Min	Max
VT1 I have confidence in the manager	4,12	0,840	4	4	2	5
VT2 In the company, employee motivation is high because supervisors trust them	4,03	0,895	4	4	2	5
VT3 In the company, superiors primarily act as advisors and intellectual partners to subordinates	4,08	0,874	4	4	2	5
VT4 In my company there is an atmosphere of genuine mutual trust between employees and superiors	4,05	0,859	4	4	2	5
VT5 I believe that my boss makes good decisions	4,07	0,872	4	5	2	5
VT6 If I had trouble with anything regarding work, I could safely discuss my concerns with my supervisor	4,10	0,851	4	5	2	5
VT7 I am loyal to my boss	4,11	0,880	4	5	2	5
VT8 I believe that my supervisor evaluates employees fairly	4,11	0,867	4	5	2	5
VT9 My boss is interested in my needs if they arise	4,04	0,852	4	4	2	5
VT10 I believe my supervisor makes good decisions	3,98	0,894	4	4	2	5
VT11 Generally in the company, managers keep their promises	4,12	0,834	4	5	2	5
VT12 I believe that my boss's motives and intentions are good	4,02	0,835	4	4	2	5

Source: Author's own elaboration

Rating scale: 1 — I strongly disagree, 2 — I disagree, 3 — I neither agree nor disagree, 4 — I agree, 5 — I strongly agree

Legend: $\bar{x}$ — mean, SD — standard deviation, Me — median, Mo — mode, Min — minimum, Max — maximum

The level of vertical trust in an organisation is significantly influenced by the manager, who can stimulate trust-based behaviour in their subordinates. In a study of employees of innovative industry companies, the characteristics of managers were analysed, recognising that they have a strong influence on building trust in relations with subordinates and employees of other work teams. Transparency in decision-making (FM1) ($\bar{x}$=4.28, SD=0.760 on a scale where 1 — very low, 2 — low, 3 — medium, 4 — high, 5 — very high) was considered to be the most important trait of a manager enhancing subordinates' trust in him/her. The next most important characteristics of a manager are compassion and empathy (FM2) ($\bar{x}$=4.19, SD=0.803), consistency in decision-making (FM3) ($\bar{x}$=4.19, SD=0.753), attitude of partnership and understanding (FM4) ($\bar{x}$=4.18, SD=0.725) and showing reliability in actions (FM5) ($\bar{x}$=4.18 SD=0.831). Slightly lower scores were given for attitude of acceptance of others and open mindedness (FM6) ($\bar{x}$=4.16, SD=0.826), manager's skills and competence (FM7) ($\bar{x}$=4.13, SD=0.831), manager's timbre of voice and appropriate communication (verbal, non-verbal, written and visual) (FM8) ($\bar{x}$=4.11, SD=785), honesty and observance of rules (FM9) ($\bar{x}$=4.09, SD=0.850) and displaying integrity and ethics (FM10) ($\bar{x}$=4.08, SD=0.839). Thus, the ideal manager who gains trust of his or her subordinates should have qualities that are conducive to creating space for the development, collaboration, inclusion and involvement of employees in achieving the organisation's goals.

An analysis of the characteristics of managers that foster vertical trust building provides interesting insights. Spearman's rank correlation analysis between traits of managers and attributes of trust revealed relationships of varying strength (Table 2). The most positive statistical relationships occurred between the manager's timbre of voice and appropriate communication (verbal, non-verbal, written and visual) (FM3) and VT1, VT2, VT6, VT7, VT8, VT9, VT10, VT11 and VT12, with limited strength. Stronger correlations were found between compassion and empathy demonstrated by the manager (FM2) and VT1, VT6, VT7, VT8, VT9, VT10, VT11 and VT12, and transparency in the manager's behaviour (FM10) and VT1, VT3, VT7, VT8, VT9, VT10, VT11 and VT12. Besides, correlations were observed between the manager's displaying integrity and ethics (FM6) and VT1, VT7, VT8, VT9, VT10, VT11 and VT12, and the manager's showing reliability in actions (FM9) and VT1, VT7, VT8, VT9, VT10, VT11 and VT12.

Table 2: Spearman's rank correlation coefficient between manager characteristics supporting trust building (FM) and vertical trust (VT) attributes

	FM1	FM2	FM3	FM4	FM5	FM6	FM7	FM8	FM9	FM10
VT1	0,589*	0,491*	0,439*	0,486*	0,506*	0,056**	0,135*	0,106*	0,079**	0,046
VT2	0,063**	0,052**	0,008	0,020	0,061**	0,058**	0,046	0,082*	0,045	0,047
VT3	0,094*	0,037	0,045	0,034	0,076**	0,029	0,042	0,078**	0,036	0,046
VT4	0,041	0,021	0,054**	0,026	0,008	0,045	0,030	0,045	0,061**	0,046
VT5	0,040	0,045	0,051**	0,014	0,018	0,086*	0,025	0,017	0,109*	0,087*
VT6	0,056**	0,092*	0,061**	0,041	0,044	0,052**	0,001	0,092*	0,088*	0,016
VT7	0,619*	0,610*	0,496*	0,546*	0,496*	0,038	0,098*	0,128*	0,070**	0,043
VT8	0,648*	0,653*	0,441*	0,599*	0,565*	0,007	0,110*	0,101*	0,025	0,008
VT9	0,613*	0,471*	0,360*	0,470*	0,551*	0,007	0,087*	0,109*	0,014	0,008
VT10	0,598*	0,419*	0,470*	0,458*	0,566*	0,055**	0,082*	0,087*	0,106*	0,046
VT11	0,125*	0,115*	0,115*	0,056**	0,118*	0,026	0,063**	0,090*	0,048	0,012
VT12	0,097*	0,088*	0,079**	0,051**	0,086*	0,034	0,069**	0,098*	0,060**	0,009

*p<0,001, **p<0,005

In the process of creating innovative solutions, the sharing of knowledge by employees with their colleagues as well as with employees from other teams in the company plays an important role. An analysis of Table 3 shows that respondents rate knowledge sharing below average ($\bar{x}$=2.31, SD=0.963). The statement "Lack of knowledge accumulation is a major problem in my company" was rated highest, indicating a significant barrier to knowledge sharing. Slightly lower rated were the statements: "Employees find time to share knowledge with both colleagues and employees from other teams". "Employees are willing to share knowledge that someone asks for", "People with expert knowledge are always ready to help colleagues" and "Employees have opportunities to pass on knowledge and experience to other employees". The lowest rating was given to the company's openness to knowledge sharing and embedding knowledge sharing in daily working practices. Thus, a significant barrier to the creation of new knowledge is a company's lack of openness to knowledge sharing and the lack of knowledge accumulation within an organisation, which hinders the development of innovation in the surveyed economic sectors.

Table 3: Measures of central tendency and dispersion of knowledge sharing (KS) indicator scores

Statements	$\bar{x}$	SD		Me	Mo	Min	Max
KS1 Employees in my team are willing to share knowledge that someone asks for	2,34	0,998		3	3	1	5
KS2 Employees in my team find time to share knowledge with colleagues	2,41	0,938		3	3	1	5
KS3 Employees in my company are willing to share knowledge that someone asks for	2,34	0,925		3	3	1	5
KS4 Employees in my company find time to share knowledge with other employees	2,41	0,875		3	3	1	5

Statements	$\bar{x}$	SD		Me	Mo	Min	Max
KS5 Employees in my company have opportunities to pass on knowledge and experience to other employees	2,29	0,866		2	3	1	4
KS6 My company is open to sharing knowledge among employees	2,12	0,949		2	3	1	5
KS7 In my company, knowledge sharing is embedded in daily working practices	2,24	0,881		2	3	1	4
KS8 In my company, people with expert knowledge are always ready to help colleagues	2,31	0,951		2	3	1	5
KS9 My colleagues routinely share knowledge during work	2,20	0,935		2	3	1	5
KS10 Lack of knowledge accumulation is a major problem in my company	2,48	1,113		2	3	1	5

Source: Author's own elaboration

Rating scale: 1 — I strongly disagree, 2 — I disagree, 3 — I neither agree nor disagree, 4 — I agree, 5 — I strongly agree

Legend: $\bar{x}$ — mean, SD — standard deviation, Me — median, Mo — mode, Min — minimum, Max — maximum.

The study assumed that there were significant correlations between vertical trust attributes and knowledge sharing indicators (Table 4). Spearman's r correlation coefficient analysis was used to diagnose these relationships. The most significant correlations between vertical trust and knowledge sharing indicators occurred for the attribute "superiors primarily act as advisors and intellectual partners to subordinates" (VT3) and KS1, KS2, KS3, KS4, KS6, KS7, KS8, KS9, KS10. These correlations were negative. Further, statistical relationships were identified between evaluating employees fairly (VT8) and KS2, KS3, KS4, KS6 and KS10; being loyal to the manager (VT7) and KS4, KS5, KS6, KS10; and the manager's interest in employees' needs (VT9) and KS5, KS6, KS9, KS10. All correlation coefficients were negative.

Table 4: Spearman's rank correlation coefficient between the attributes of vertical trust (VT) and indicators of knowledge sharing (KS)

	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8	SK9	SK10
VT1	-0,009	-0,037	-0,185*	-0,011	-0,026	-0,215*	-0.007	0,021	-0,182*	0,002
VT2	-0,205*	-0,068**	-0,055**	-0,214*	-0,057**	-0,231*	-0,045	-0,031	-0,069**	-0,057**
VT3	-0,233*	-0,187*	-0,215*	-0,212*	-0,007	-0,270*	-0,094*	-0,061*	-0,200*	-0,056**
VT4	-0,199*	-0,040	-0,062**	-0,053	-0,060**	-0,211*	-0,082*	-0,014	-0,072**	0,002
SVT 5	-0,058**	-0,039	-0,027	-0,052	-0,006	0,007	-0,022	-0,002	-0,020	0,079**
VT6	-0,043	-0,017	-0,024	-0,008	-0,026	-0,003	-0,023	-0,022	-0,068**	0,026
VT7	-0,052**	-0,068**	-0,066**	-0,206*	-0,190*	-0,198*	-0,077**	-0,013	-0,074**	-0,187*
VT8	-0,016	-0,193*	-0,181*	-0,194*	-0,064**	-0,210*	-0,036	-0,011	-0,068**	-0,213*
VT9	-0,012	-0,064**	-0,067**	0,006	-0,194*	-0,202*	-0,012	0,021	-0,205*	-0,226*
VT10	-0,019	-0,042	-0,082**	-0,011	-0,204*	-0,215*	-0,030	0,001	-0,048	-0,067**
VT11	0,003	-0,011	-0,011	-0,012	-0,024	-0,186*	-0,050	0,002	-0,027	-0,028
VT12	0,037	-0,018	-0,037	-0,002	-0,048	-0,041	-0,025	0,042	-0.019	-0,052**

*p<0,001,**p<0,005

The manager is the central actor of vertical trust. It can be assumed that a manager's attributes are conducive to knowledge sharing among employees (Table 5). The study found that the strongest statistical relationships occurred between emphasising reliability and ethicality (FM10) and openness to knowledge sharing by employees (KS6) and embedding knowledge sharing in daily working practices (KS7). Another characteristic with

multiple associations with knowledge sharing indicators is the manager's skills and competences (FM7), which mainly influences the indicators: employees have opportunities to transfer knowledge and experience to other employees (KS5) and the company's openness to knowledge sharing by employees (KS6). On the other hand, an attitude of acceptance of others and an open mind (FM6) mainly influences the willingness to share knowledge that someone asks for (KS3), the openness of employees to share knowledge (KS6) and the creation of opportunities to transfer knowledge and experience to other employees (KS5).

Table 5: Spearman's rank correlation coefficient between manager characteristics supporting trust building (FM) and knowledge sharing (KS) indicators

	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8	SK9	SK10
FM1	-0,015	-0,041	-0,028	-0,034	-0,053**	-0,010	-0,025	-0,017	-0,161*	-0,048
FM2	-0,027	-0,030	-0,155*	-0,166*	-0,036	-0,186*	-0,203*	-0,035	-0,047	-0,034
FM3	0,004	-0,172*	-0,027	-0,029	-0,040	-0,163*	-0,033	-0,014	-0,033	-0,172*
FM4	0,037	-0,017	-0,052**	-0,041	-0,023	-0,049	-0,025	-0,155*	-0,005	-0,019
FM5	0,015	-0,027	-0,176*	-0,028	-0,041	-0,197*	-0.183*	-0,017	-0,019	0,004
FM6	-0,023	-0,042	-0,196*	-0,172*	-0,177*	-0,179*	-0,160*	-0,034	-0,166*	-0,045
FM7	-0,030	-0,001	-0,171*	-0,047	-0,209*	-0,261*	-0,052**	-0,164*	-0,052**	-0,08
FM8	0,006	-0,032	-0,039	-0,026	-0,181*	-0,049	-0,156*	-0,161*	-0,163*	0,005
FM9	-0,020	-0,039	-0,165*	-0,046	-0,030	-0,223*	-0,203*	-0,012	-0,165*	-0,181*
FM10	0,008	-0,188*	-0,188*	-0,155*	-0,047	-0,243*	-0,201*	-0,038	0,181*	-0.186*

*p<0,001,**p<0,005

The knowledge sharing process in companies faces numerous barriers. One of them is the reluctance of employees to share it. Research shows that the main reason for reluctance to share knowledge (RSK) is the belief that the people they work with should not access their workspace (RSK5) ($\bar{x}$=3.24, SD=0.937). Besides, employees' reluctance to share knowledge is due to not sharing useful information with others (RSK3) ($\bar{x}$=3.14, SD=1.148), protecting their ideas from being used by others in the company (RSK4) ($\bar{x}$=3,09, SD=0.990), reluctance to transform personal knowledge and experience into organisational knowledge (RSK1) ($\bar{x}$=3.07, SD=1.030) and failure to share innovative achievements with other employees (RSK2) ($\bar{x}$=2.93, SD=1.271).

Vertical trust can reduce employees' reluctance to share knowledge with other employees. Analysis of Table 6 confirms the potential of trust attributes to reduce employees' reluctance and fear of knowledge sharing, This is especially true for the attribute Employees' motivation is high because supervisors trust them (VT2), which reduces most of the examined reasons for reluctance to share knowledge, i.e. RSK1, RSK2, RSK3, RSK4 and RSK5. Also, the attribute of acting as advisors and intellectual partners to subordinates (VT3) reduces most of the reasons for reluctance to share knowledge, i.e. RSK1, RSK2, RSK4 and RSK5. The remaining attributes of trust reduce the causes of reluctance only to a small extent. In conclusion, vertical trust is a factor that reduces employees' reluctance to share knowledge. In particular, it reduces concerns about unauthorised use of ideas by other employees in the company and employee reluctance to share knowledge due to not sharing useful information with others.

Table 6: Spearman's rank correlation coefficient between attributes of vertical trust (VT) and reasons for reluctance to share knowledge (RSK)

	RSK1	RSK2	RSK3	RSK4	RSK5
VT1	-0,040	-0,032	-0,029	-0,165*	-0,025
VT2	-0,183*	-0,202*	-0,170*	-0,180*	-0,159*
VT3	-0,159*	-0,168*	-0,019	-0,176*	0,051**
VT4	-0,001	-0,011	-0,001	-0,164*	0,030
SVT5	-0,016	-0,012	0,004	-0.042	-0,168*
VT6	-0,027	-0,034	-0,015	0,155*	-0,172*

	RSK1	RSK2	RSK3	RSK4	RSK5
VT7	-0,043	-0,054**	-0,031	-0,197*	-0,019
VT8	-0,035	-0,036	-0,032	-0,180*	-0,022
VT9	-0,176*	-0,156*	-0,050**	-0,195*	-0,036
VT10	-0,016	-0,005	-0,032	-0,192*	-0,029
VT11	-0,018	0,018	-0,174*	-0,158*	-0,026
VT12	-0,030	-0,045	-0,198*	-0,037	-0,003

*p<0,001,**p<0,005

5. Conclusions

Trust is a factor that improves a company's competitiveness in the market, as it allows the effective use of employee potential to create innovation. The study on the mediating role of vertical trust in knowledge sharing processes made it possible to answer the research questions posed. The analysis of the research results indicates the above-average level of vertical trust, with the highest value achieved by the attributes: keeping promises made to subordinates by the manager, evaluating employees fairly, being open to talking to employees about their concerns and being loyal to the manager. They create an environment conducive to knowledge sharing within the company. When vertical trust is high, employees feel secure and are more likely to act creatively (Zafar et al., 2024). Important in building vertical trust are the manager's qualities such as compassion and empathy demonstrated towards employees, transparency in decision-making, consistency in decision-making, an attitude of partnership and understanding, showing reliability in actions, showing interest in employees' needs, which foster trust between subordinates and the manager.

Vertical trust positively influences knowledge sharing. The study has shown that trust in both leaders and colleagues has a substantial impact on team knowledge sharing, with higher levels of trust positively affecting knowledge sharing behaviours (Liang et al., 2024). Also, the Author found that vertical trust attributes are important moderators of knowledge sharing, in particular, the company's openness to knowledge sharing by employees, employees' willingness to share knowledge with other employees that someone asks them to share, routinely sharing knowledge during work and finding time to share knowledge with other employees.

The manager plays an important role in the knowledge sharing process. The study has shown that his/her qualities: exhibiting integrity and ethics, leadership skills and competences, and displaying an attitude of acceptance of others and having an open mind significantly enhance the knowledge sharing process of employees.

There are numerous barriers to knowledge sharing processes. Knowledge sharing can be hindered by several factors, such as lack of trust or fear of loss of power or status, cultural barriers and lack of incentives (Usmanova et al., 2020). A common obstacle is knowledge concealment, whereby an individual withholds knowledge requested by another person (Anand et al, 2022). The Author's research identified the reasons for reluctance to share knowledge, which are primarily related to the fear of it being used by other employees for their own purposes.

In the study, it was interesting to look for correlations between attributes of vertical trust and reluctance to share knowledge. Vertical trust attributes such as employees' motivation being high because superiors trust them, superiors' acting as advisors and intellectual partners to subordinates and being interested in the needs, if any, of subordinates reduce most of the reasons for reluctance to share knowledge.

In conclusion, the results of the conducted research fairly unambiguously indicate the importance of vertical trust in knowledge sharing processes aimed at creating innovations by employees of companies in innovative industries. However, they are insufficient to make a clear statement about the strength of the impact of trust on the creation of new knowledge and innovation. The results of this study can help practitioners and managers to create an organisational environment that encourages employees to share their knowledge, leading to increased innovation, productivity, and effective decision-making.

The Author of this article would like to point out the limitations of using the results of the research on the role of managers versus stimulating innovation in enterprises in Poland. The study was conducted using the survey

method, which was intended to outline the complex issue of the influence of trust between a superior and a subordinate and to provide a starting point for broader research into its role in knowledge sharing processes.

Further research into the determinants of the impact of vertical trust on knowledge sharing in organisations is worth undertaking. A suggestion for future research is to go beyond knowledge sharing and link the discoveries made to employee innovation. The correlation of vertical trust and knowledge sharing with innovation has rarely been addressed in recent literature.

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Rethinking the Future of Intellectual Capital: Emerging Perspectives in IC Theory and Practice

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Abstract: Intellectual capital (IC) theory, emphasizing that the primary source of organizational value is derived from intangible, knowledge-based resources, has long been recognized as a critical driver of sustainable competitive advantage. However, as the business landscape continues to evolve in the face of technological, institutional and socio-political disruptions, and natural disturbances, it seems viable that the theories for understanding IC and practices for managing it should also be updated. This paper seeks to challenge and advance existing IC theory by presenting a forward-looking exploration of the evolving landscape of IC. We propose some critical theoretical and practical updates that can bridge the gap between conceptual advancements and real-world applications. By adopting an ecosystem-oriented approach, we highlight how IC operates across different levels of analysis- from individual to societal - and how multilevel, dynamic, and complex interactions within the IC ecosystem contribute to innovation, value creation, and sustainable development. The paper challenges traditional IC frameworks by emphasizing the fluid, interconnected nature of IC, arguing that a more holistic, dynamic model is essential for understanding and leveraging IC in today's rapidly changing environment. Furthermore, we argue that future IC agendas must address broader concerns, including sustainability, IC ethics, IC diplomacy, fair and socially equitable distribution of value, and societal justice. Recognizing this progress in IC research and practice as essential for sustainable growth and social well-being in the coming era, we aim to contribute to a deeper understanding of emerging paradigms and to align IC theory and practice with future economic, technological and social transformations.

Keywords: Intellectual capital (IC), IC ecosystem, IC diplomacy, IC ethics, Sustainability, Digitalisation, Future

1. Introduction

The concept of intellectual capital (IC) has significantly influenced the discourse on organizational value creation over the past few decades. Traditionally encompassing human capital, structural capital, and relational capital (Edvinsson and Malone, 1997; Stewart, 1997), but recently expanded with new dimensions, such as renewal, entrepreneurial, trust capital, spiritual, and emotional capital (Cabrilo et al., 2024; Buenechea-Elberdin et al., 2017; Bratianu, 2025), IC has been considered as a key driving force of value creation and competitive advantage in the knowledge economy (Kianto et al., 2025). However, the increasing complexity of the contemporary world—driven by rapid digitalization, global socio-political tensions, environmental crises, and institutional realignments—demands a fundamental reassessment of how IC is understood, measured, and managed (Kianto et al., 2025; Kianto and Cabrilo, 2023).

Recent studies have highlighted the limitations of traditional IC models in capturing the dynamic and interconnected nature of knowledge-based value creation in the digital era (Kianto 2007; Bratianu 2025; Pedro et al., 2023; Kianto et al., 2023). Static taxonomies and firm-centric perspectives often fail to account for the multilevel and dynamic nature of IC that shapes IC interactions and flows within and beyond organizational boundaries. In this context, researchers have begun to adopt broader, more holistic views—reframing IC as a complex and evolving ecosystem embedded in social, technological, institutional, and environmental contexts (Matos et al., 2020; Kianto et al., 2023; Konno, 2025; Lin, 2025; Bratianu, 2025; Alppivuori and Kianto, 2025).

Rethinking of IC ecosystem opens new avenues for inquiry that extend beyond performance measurement and strategic management. It encourages critical reflection on issues such as sustainability, equity, ethics, and societal wellbeing (Kianto et al., 2025). The integration of concepts like IC diplomacy (Dumay and Garanina, 2013), IC ethics (Kianto et al., 2023; Ulliah et al., 2022), and the fair distribution of value (Dumay, 2025) highlights the need to reposition IC theory and practice within the broader goals of sustainable development and social justice.

This paper aims to contribute to the rethinking of IC through the lens of complex, dynamic, and ecosystem thinking. We discuss updates to IC that not only accommodate organizational concerns but also foreground the societal and environmental implications of IC activities. In doing so, we seek to advance the current IC research

and practice by suggesting new thinking and novel perspectives for IC and to adapt it to the new dynamic and interconnected digital reality.

2. Reframing Intellectual Capital Theory and Practice

2.1 Intellectual Capital as an Open, Dynamic, and Multilevel Ecosystem

Given the increasing complexity of today's knowledge economy, it is crucial to approach IC from a broader, multilevel, and ecosystem perspective. IC is embedded in a web of interconnected actors and institutions, where its creation and application are shaped by dynamic relationships across multiple levels (Kianto et al., 2025a; Bratianu, 2025). This calls for a multilevel view of IC—encompassing individual, team, organizational, institutional, national, and regional dimensions (Lin, 2025; Bratianu, 2025; Alppivuori and Kianto, 2025)—rooted in personal capabilities, group practices and cultures, and societal infrastructures (Secundo et al., 2016). As highlighted in recent contributions, a narrow, firm-centric focus, although prevalent (Lin and Edvinsson, 2021), is no longer sufficient; understanding IC's role in global societal transformation requires embracing its complex, networked, and dynamic nature of IC (Konno, 2025; Lin, 2025).

The intellectual capital (IC) ecosystem continuously co-evolve that confirms IC dynamics (Kianto et al., 2017; Konno, 2025) and prove that IC circulate through virtuous cycles of learning and unlearning (Nonaka and Konno, 1998) within and between agents, levels, and parts of the ecosystem (Bratianu, 2025). The resulting ecosystem is therefore *complex* because of its non-linear interactions, *dynamic*, because IC is flowing and constantly changing, and *open*, relying on trust-based networks and openness for the co-creation of value (Konno, 2025).

2.2 Intellectual Capital Ecosystem for Societal Innovation

IC ecosystem provides the knowledge resources and capabilities**,** while innovation ecosystem offers the structure, the place, and diverse participants (Konno and Schillaci, 2021) through which these resources are activated for societal and environmental innovation (Konno, 2025)**.** Quintuple Helix Innovation Model (Carayannis and Campbell, 2010), as an extension of Triple Helix (Etzkowitz and Leydesdorff, 2000) and the Quadruple Helix (Carayannis and Campbell, 2009), integrates knowledge flows across five key knowledge subsystems: academia, industry, government, civil society, and the natural environment. IC serves as the foundation for knowledge creation, exchange, and application within and between these helices. Universities provide the foundation for knowledge creation and human capital development, while businesses transform this knowledge into practical applications and marketable innovations. Governments support the system through regulatory frameworks, funding mechanisms, and infrastructure. Civil society contributes through societal needs, ensuring that innovation aligns with broader social values. The inclusion of the natural environment adds a sustainable dimension to an ecosystem (Koch, 2025). This model highlights the multilevel and systemic nature of IC, emphasizing how dynamic interactions among diverse players in the ecosystem drive innovation, sustainability, and societal transformation (Carayannis, Barth, and Campbell, 2012).

2.3 Intellectual Capital Diplomacy for Societal Transformation

In an interconnected, knowledge-driven world, the effective mobilization of each spark of collective intelligence in the IC ecosystem enhances an individual, organization, and national ability to participate in international collaborations and contribute to addressing global challenges such as climate change, geopolitical crises, and digital transformation (Koch, 2025; Ordoñez de Pablos, 2024). Following the concept of science diplomacy (European Commission, 2023), that may be understood as the use of scientific collaborations among nations to address common problems and build international partnerships, we put collaboration, trust and shared values, and the flow and exchange of IC across borders in the centre of IC diplomacy.

IC diplomacy may be defined as the ability to establish and maintain trustful relationships, mutual understanding and value creation partnerships across organizational or national boundaries through the strategic management and exchange of IC (Dumay and Garanina, 2013). A collective intelligence framework can support the understanding of how multi-level structures, connectivity and contactivity patterns (Lin, 2025) and technological platforms can improve the flow of IC across innovation ecosystems to generate the desired innovation, peace and societal transformation (Secundo et al., 2016).

IC diplomacy promotes individual and collective intelligence and fosters innovation and societal transformation through trustful and open knowledge dissemination (Secundo et al., 2016). When leveraged strategically, IC serves not only as a foundation for excellence and innovation of the ecosystem but also as a catalyst for global cooperation, sustainable development and peacebuilding (Kianto et al., 2025). Shared values bind people together; therefore, IC diplomacy and IC companionship (Szogs, 2025) may be critical tools to build bridges

across geopolitical divides, promote mutual understanding, and align IC research efforts with societal needs (Kianto et al., 2025; Dumay, 2025).

IC diplomacy seems vital for harmonizing IC ecosystems and extracting human capital to address global challenges and advance societal transformation in a way that is inclusive, ethical, and grounded in shared human values.

2.4 Integrating Ethics Into Intellectual Capital Theory and Practice

Ethical capitalism refers to an approach to capitalism in which businesses and markets operate not solely for profit maximization, but also according to ethical principles that prioritize social justice, environmental sustainability, and the long-term well-being of all stakeholders (Koch, 2025). It challenges the traditional shareholder-centric model of capitalism by promoting a more inclusive and responsible economic system (Freeman, 2010; Porter and Kramer, 2011). In ethical capitalism, companies are expected to consider the consequences of their actions on employees, customers, shareholders, partners, communities, the environment, and future generations, integrating ethical decision-making into corporate governance and strategic planning (Sandel, 2012).

As organizations and societies rely strongly on intangible assets and IC, ethical questions related to inclusivity, fairness, and the responsible use of artificial intelligence (AI) become paramount (Kianto et al., 2025; Salmelin, 2025). Future IC research calls for a robust ethical framework that goes beyond traditional intellectual property rights to protect knowledge ownership. *Ethical IC research* must engage with broader societal values, including social justice, equity, and sustainability. Moreover, ethical leadership—grounded in integrity, honesty, credibility, transparency, and a commitment to the common good—plays a crucial role in shaping IC practices that contribute to both organizational and societal well-being (Kianto et al., 2023).

2.5 Intellectual Capital and Sustainability

IC plays a major role in driving growth, competitiveness, and sustainability, improving society's well-being and the economic performance of businesses (Cabrita et al., 2023). It positively influences organizations' sustainable performance in social, environmental, and financial aspects, and emphasizes its role in exploiting business opportunities, encouraging innovativeness, and taking risks for transformation to achieve social, environmental, and economic benefits (San et al., 2022). IC contributes to sustainable business practices and sustainable regional competitiveness, which cannot be achieved without the proper development of intangible resources (Januškaitė and Užienė, 2018). Dwianika and Gunawan (2020) link IC to the concept of long-term value creation, which in turn contributes to the deceleration of climate change and the reduction of negative economic impacts (Hariastuti and Lukmandono, 2022). The future depends on human capacity to adapt, identify opportunities, acquire the necessary skills and knowledge, and transform them into economic value — all while remaining in balance with nature and ecosystems (Cabrita et al., 2023). It is increasingly acknowledged that IC research and practice have to take into account what is supposed to be sustainable to develop organisational wealth, regional competitiveness and sustainable value, and look from an IC ecosystem perspective and not isolated from, but originally integrated with, nature and society (Kianto et al., 2025a). The concepts of IC, sustainability, and both social and economic value should be explored in conjunction in order to develop balanced economic, societal and environmental solutions as well as holistic conceptual models.

2.6 Rethinking Intellectual Capital in the era of Digitalisation

New technologies are disrupting the conventional business, economy and society by impacting almost all sectors (Matos et al., 2020; Inshakova et al., 2020), as well as a wide range of internal organizational functions (Esmer et al., 2019) and occupations (Beke et al., 2020). There is a lack of studies analysing fundamental changes in the role of IC under the influence of digital technologies (Užienė, 2021). IC, as the organizational resource and key driver of wealth creation in the knowledge economy, undergoes various changes under this influence (Viedma Marti and Cabrita, 2012). Understanding these changes is important, as it helps organizations identify and develop IC as a critical asset driving business performance, and supports the rational implementation of Industry 4.0 transformations (Cabrita et al., 2018). AI plays a special role in this context, leading to better performance and higher productivity. However, it may also surpass human potential and diminish emotional value, empathy, and the human spirit. AI is a powerful tool, but using it effectively requires the right skills to harness its full potential. One must also understand the philosophy and methods behind the surface (Salmelin, 2025).

AI, along with other emerging technologies, is having a disruptive effect on IC. It remains unclear which forms of IC are most susceptible to the disruptive nature of AI and digital technologies, and how we should balance the

pursuit of greater added value with the risk of losing the authenticity of IC (Kianto et al., 2025a). Numerous questions in the theory and practice of intellectual capital remain unresolved. For instance, who owns the value created by AI-based IC? Who benefits from it? Can we distinguish between human and machine-based values? How can we ensure the sustainable and fair sharing of risks and value added in the modern world? How can we preserve existing knowledge within organizations while maximizing the value created by new technologies? Against the backdrop of digitalization, the ability to comprehensively assess ongoing technological and social changes is essential to avoid fragmented decision-making, select the appropriate intellectual capital strategy, preserve know-how, and ensure continuous and sustainable value creation.

2.7 The Imperative of Interdisciplinarity

The complexity of IC theory is increasing. It opens the door for new explorations crossing disciplines and integrating insights from various fields to address complex, real-world challenges, including the sustainability crisis, climate change, public health, social equality, global piece, and well-being, that cannot be solved by any single discipline alone (Kianto et al., 2025a). This raises the question of where individual theories begin and end. Are there boundaries between individual theories? Can value creation and the well-being of global society still be examined in the context of a single chosen theory? Future IC theory and practice will inevitably have to transform integrating knowledge and insights from different disciplines, such as economics, psychology, sociology, political economy, environmental science, art and technologies, to provide more holistic understanding of the complex nature of IC, its management and valuation (Kianto et al., 2025). The complexity of management and organizations is growing (Schneider et al., 2017). Responding to their environments, organizations require integration of a wider range of variables, often from different domains, to provide more holistic explanations. IC theory and practice are no exception. They are multifaceted and context-dependent, reflecting broader trends in economic and societal development. Petty and Guthrie (2000) initiated a discussion on the interdisciplinary nature of IC theory, describing it as both its greatest strength and its Achilles' heel. In the current context of increasing environmental complexity, this interdisciplinarity is under growing pressure, as IC theory and practice are increasingly tasked with addressing multifaceted and systemic challenges. Only interdisciplinary research that fosters collaboration, knowledge sharing, continuous learning, and innovation may reveal hitherto invisible solutions and opportunities to fully translate IC into value and global societal well-being (Kianto et al., 2025).

3. Visionary Pathways in Intellectual Capital Theory Development

The aforementioned factors are substantially transforming the theoretical foundations of intellectual capital (IC) and necessitate a critical re-examination of its evolving role within organizational management and broader socio-economic systems. A range of novel conceptual and practical trajectories is emerging, reflecting the dynamic and interdisciplinary nature of IC.

Within this context, eight key thematic domains can be delineated, each warranting rigorous scholarly inquiry and future research engagement: 1) the need for multilevel approach towards IC; 2) an examination for IC dynamics; 3) redefining of value and economic models at the basis of IC; 4) a better recognition of sustainability and ethics in IC research; 5) a focus of the role of AI in IC; 6) a reviewed emphasis on humans and culture; 7) a focus on non-rational and non-technological aspects of IC; and 8) an interdisciplinary approach towards research (Kianto et al., 2025a).

These domains pave the way for further theoretical development of IC and underscore the urgency of sustained scholarly attention. Addressing the new realities of the 21st century requires innovative approaches to IC management. It must be acknowledged that the issues examined within IC theory are becoming increasingly complex, manifesting as multidimensional and interrelated phenomena highly relevant to business, society, and the economy. A more in-depth exploration of these research avenues raises numerous compelling questions for IC theorists, business practitioners, and social scientists alike.

4. Conclusion

To conclude, it is evident that IC theory and practice are facing significant challenges due to the increasing complexity of the knowledge economy, societal changes, environmental pressures, geopolitical shifts, technological advancements, and transformations in value creation. Emerging perspectives call for a shift away from static approaches towards more dynamic and integrated solutions that include considerations of sustainability, ethical values, ecosystem thinking, and digital transformation in IC theory and practice. Additionally, there is a growing recognition of the importance of multilevel approaches that redefine IC not just

as an organizational asset but as a strategic ecosystem-based lens for navigating complexity and fostering innovation at micro, meso, and macro levels within future societies. IC theory clearly extends beyond organizational boundaries, addressing a wide range of issues from individual performance management to broader societal challenges. To remain relevant, scholars and practitioners must align IC practices more effectively with the challenges and opportunities of the 21st century, characterized by increasing complexity, interconnectedness and interdisciplinarity.

The traditional tripartite framework of human, structural, and relational capital remains foundational, yet it no longer fully captures the multi-dimensional, fluid, and ecosystem-based nature of contemporary value creation. Next-generation IC solutions must incorporate the full complexity of the phenomenon, situational awareness, spirituality, and responsiveness to societal changes and global dynamics. With the rise of artificial intelligence, data analytics, and digitalization, there's a need to reconceptualise IC, increasingly incorporating algorithmic, data-driven, and platform-based dimensions. Consequently, issues related to resource ownership and management, along with digital ethics, are becoming essential components of IC management practices. At the same time, IC is getting closely connected with sustainability goals by incorporating environmental, social, and governance issues into its measures, thereby aligning IC with long-term value creation and societal impact rather than short-term performance.

Recent IC research increasingly draws upon diverse fields, including complexity theory, societal transformation, diplomacy, and digital innovation. This interdisciplinary approach opens up richer analytical perspectives and moves IC theory beyond linear, accounting-based models of the past. Future research should delve deeper into these emerging pathways, linking theoretical innovation with practical application and positioning IC as a critical enabler of multilevel, ecosystem-based and sustainable value creation.

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How Does AI-Driven Knowledge Management Enhance Sustainability of Startups? A Conceptual Framework

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Abstract: In response to growing sustainability imperatives and environmental uncertainties, startups are increasingly expected to embed green values into their strategic and operational processes. However, their limited resources, organisational learning base, and process maturity often hinder their capacity to achieve sustainable competitive advantage. Drawing on an integrative review of the literature, the study conceptually examines how AI-driven knowledge management (KM) contributes to the sustainability of startups. Based on the Resource-Based View and Dynamic Capability Theory, this paper identifies and integrates six core constructs: Green Entrepreneurial Orientation (GEO), Green Knowledge Management (GKM), Dynamic Capabilities (DCs), Big Data Analytics and Artificial Intelligence (BDA-AI), and Sustainable Competitive Advantage (SCA). These constructs are synthesised into a conceptual model that explains the mechanisms through which green strategic intent and knowledge practices interact with digital enablers to foster sustainable advantage. The proposed model highlights three key pathways. First, GEO is positioned as a strategic antecedent that directly enhances GKM and SCA, indicating that a green entrepreneurial mindset can drive sustainability-oriented knowledge processes and competitive outcomes. Second, GKM enhances DCs, which in turn contributes to SCA, with DCs mediating the GKM-SCA relationship, reinforcing the role of dynamic adaptability in transforming knowledge into sustainable advantage. Third, BDA-AI is proposed as a moderator that strengthens the effects of GKM on DCs and DCs on SCA by accelerating sensing, learning, and reconfiguration processes, particularly in uncertain and resource-constrained environments. Building upon these interrelationships, eight hypotheses are developed to construct the conceptual framework and provide a basis for future empirical validation. This study advances the theoretical discourse on sustainable entrepreneurship by integrating sustainability, KM, and AI perspectives. It offers practical insights for startups and policymakers seeking to leverage digital technologies for long-term viability. While conceptual, the proposed model provides a foundation for empirical validation and future refinements to account for contextual dynamics such as industry-specific challenges and policy influences.

Keywords: Green knowledge management, Artificial intelligence, Sustainable competitive advantage, Green Entrepreneurial orientation, Dynamic capabilities, Startups

1. Introduction

In an era marked by environmental degradation and social complexity, the imperative for sustainable development has extended to every tier of the global economy. Despite their agility and innovation potential, startups often lack the structural resources and capabilities required to navigate uncertainty and achieve long-term sustainability (Pöhlmann et al., 2025). This raises a central question: how can startups build and sustain competitiveness in resource-constrained, volatile environments?

Knowledge Management (KM), defined as the systematic processes of capturing, organising, sharing, and applying knowledge of an organisation (Davenport and Prusak, 1998), has long been recognised as a driver of innovation, adaptability, and performance (Scarso and Bolisani, 2024). For startups, harnessing knowledge assets efficiently is crucial to survival and success (Agostini et al, 2023). However, traditional KM often falls short of supporting the dynamic, sustainability-oriented needs of new ventures, as it tends to prioritize static efficiency over adaptive innovation (Rauter et al, 2017) and fails to leverage data-driven capabilities for sustainability-focused decision-making (Mikalef et al, 2019). The emergence of AI, with its capabilities in data processing, learning, and decision support, offers new possibilities to revitalise KM practices (Mikalef and Gupta, 2021).

Despite the growing adoption of AI across business domains (Thayyib et al, 2023), its application within KM, particularly in the context of startup sustainability, remains underexplored (Zahra, 2021). Most existing studies examine AI, KM, or startup sustainability as isolated domains (Alfiero et al, 2025), leaving theoretical and practical gaps. This study seeks to address this gap by developing a conceptual framework to explain how AI-driven KM can enhance the sustainability of startups. Specifically, two central research questions guide this

inquiry: (1) Why do startups often fail to attain sustainable competitive advantage? and (2) How can AI-driven KM support the development of sustainability-oriented capabilities? Grounded in the Resource-Based View (RBV) and Dynamic Capability Theory (DCT), the framework conceptualises AI-driven KM as a strategic enabler of dynamic capabilities and green knowledge assets. Through a critical review of the literature, six interrelated constructs are identified: Green Knowledge Management (GKM), Green Entrepreneurial Orientation (GEO), Dynamic Capabilities (DCs), Big Data Analytics (BDA), Artificial Intelligence (AI), and Sustainable Competitive Advantage (SCA).

This study contributes in three ways. First, it integrates AI, KM, and sustainability into a cohesive model tailored to startup contexts. Second, it advances theory by linking RBV and DCT with BDA-AI technologies to explain how startups develop adaptive, sustainability-enabling capabilities. Third, it introduces GEO and positions BDA-AI as a moderator, highlighting strategic and technological levers for sustainable entrepreneurship. These contributions offer a foundation for future empirical work and practical guidance for startups pursuing sustainable growth.

The next sections are structured as follows. Section 2 reviews the theoretical foundations and key literature on KM, AI, GEO, and sustainability in startups. Section 3 outlines the research methodology, including the approach to measuring constructs. Section 4 presents the conceptual development and formulates the research hypotheses, highlighting key interrelationships among GEO, GKM, DCs, BDA-AI, and SCA. Section 5 introduces the proposed conceptual framework, integrating these constructs into a unified model. Finally, Section 6 concludes the study, discussing theoretical contributions, practical implications, limitations, and directions for future research.

2. Literature Review

This section critically reviews the theoretical and empirical literature on integrating KM and AI to enhance startup sustainability. It introduces the RBV and DCT as theoretical foundations, explores the role of KM and AI, examines GEO's contribution to SCA, and highlights existing research gaps.

2.1 Theoretical Foundations

This study draws on RBV and DCT to explain how startups strategically leverage knowledge and dynamic capabilities to pursue sustainability under uncertainty. These theories offer a robust lens to understand how AI-enhanced KM generates non-replicable advantages.

2.1.1 Resource-Based view (RBV)

RBV posits that sustainable competitive advantage arises from resources that are valuable, rare, inimitable, and non-substitutable (VRIN) (Barney, 1991). In startups, tangible resources are typically limited, making intangible assets, such as knowledge, routines, and entrepreneurial expertise, particularly critical (Alvarez and Barney, 2005). While RBV was traditionally applied to large firms, recent adaptations extend its relevance to startups by recognising the strategic importance of knowledge-based and digitally enabled resources (Nambisan et al, 2019). Technology-enhanced KM systems can augment the VRIN attributes of knowledge assets, transforming them into key drivers of sustainable growth (Helfat et al, 2023). However, RBV alone offers limited insights into how firms continuously adapt and reconfigure their resources in volatile environments, where DCT becomes essential.

2.1.2 Dynamic capability theory (DCT)

DCT complements RBV by emphasising the ability to sense opportunities, seize them through resource mobilisation, and transform organisational routines to adapt to change (Teece et al, 1997; 2007). These capabilities are crucial for startups navigating rapid technological shifts, market fluctuations, and evolving sustainability demands (Eisenhardt and Martin, 2000). AI-driven KM aligns with DCT by enabling real-time sensing (via analytics), efficient seizing (through decision automation), and continuous transformation (via knowledge-driven innovation) (Teece, 2018; Sheng et al, 2017). Thus, while RBV explains what resources matter, DCT explains how they can be reconfigured to maintain sustainable advantage. AI-enabled KM strengthens this process by facilitating adaptive learning and knowledge-based reconfiguration, positioning it as a strategic enabler for startup sustainability.

2.2 KM and Sustainability

Davenport and Prusak (1998) provided one of the earliest frameworks for KM, focusing on structured processes, whereas more recent perspectives highlight its role in fostering innovation and adaptability (Migdadi, 2022; Scarso and Bolisani, 2024). For startups, effective KM enhances innovation, learning, and adaptability, but traditional KM systems often fail to meet their needs.

2.2.1 Green knowledge management (GKM)

GKM incorporates environmental concerns into KM by embedding sustainability principles into knowledge processes and organisational culture (Robinson et al, 2006). It supports green innovation by fostering the creation, sharing, and application of environmental knowledge in startups (Wang et al, 2022; He et al, 2024). While promising, research on GKM has primarily focused on large firms, leaving its application in startups underexplored (Centobelli et al, 2017). Given startups' agility and innovative potential, GKM could serve as a strategic asset for sustainability. Yet empirical understanding of its effectiveness in resource-constrained contexts remains limited.

2.2.2 KM challenges in startups

Startups face structural barriers to KM, including informal routines, limited budgets, and a lack of codification practices (Oliva and Kotabe, 2019). The absence of institutionalised knowledge systems often leads to knowledge silos and loss of critical know-how during transitions or scaling phases (Centobelli et al, 2017). These challenges undermine long-term learning and adaptation. AI can mitigate these limitations by automating knowledge tasks, supporting tacit knowledge capture, and facilitating real-time decision support. This integration is further explored in the following section.

2.3 AI's Transformative Role

AI and BDA introduce a new paradigm in KM by enabling more intelligent, scalable, and adaptive systems. This is particularly relevant for startups seeking agility without sacrificing learning depth or process efficiency.

2.3.1 Big data analytics in KM

BDA bridges AI and KM by enabling the processing of large, diverse datasets in real-time. It enhances knowledge quality, relevance, and timeliness, contributing to better-informed decisions (Shabbir and Gardezi, 2020). In startups, BDA allows for data-driven insights into market trends, customer behaviour, and environmental risks, supporting strategic agility even with limited resources (Behl et al, 2019).

2.3.2 AI-driven KM

AI-driven KM uses machine learning, NLP, and predictive analytics to automate knowledge acquisition, personalise access, and support strategic planning (Taherdoost and Madanchian, 2023). It enables knowledge flow across decentralised teams, simulates future scenarios, and helps institutionalise learning in fast-changing environments (Jarrahi et al, 2023). For startups, key advantages include enhanced cognitive capabilities, scalability without increased overhead, and organisational knowledge retention. When aligned with sustainability, AI-driven KM becomes a foundation for dynamic, eco-conscious decision-making (Al Halbusi et al, 2025).

Beyond decision support, AI can directly drive innovation outcomes (Abu et al, 2024). Specifically, AI enhances green innovation by enabling predictive optimisation of energy and resource use, extracting sustainability insights from unstructured data through natural language processing, and supporting data-driven design improvements that align with environmental goals.

2.4 Green Entrepreneurial Orientation (GEO)

GEO reflects a firm's strategic commitment to environmental sustainability through green innovation, proactiveness, and risk-taking (Shehzad et al, 2023). These dimensions promote eco-conscious decisions and resource-efficient practices, improving environmental performance and stakeholder trust (Ameer and Khan, 2023). Though GEO research has focused more on mature firms, its application to startups shows promise. It can reduce costs through waste minimisation, build resilience, and support legitimacy in sustainability-focused markets (Yan and Hu, 2024). GEO also strengthens dynamic capabilities by aligning entrepreneurial orientation with green strategy execution.

2.5 Critical Synthesis and Research Gap

The literature underscores the potential of knowledge-based strategies and AI in achieving sustainable competitive advantage. However, studies remain fragmented across domains, AI, KM, sustainability, and entrepreneurship are often explored in isolation. There is limited understanding of how AI-enhanced KM interacts with GEO through the lens of dynamic capabilities (Mikalef et al, 2021; Al Halbusi et al, 2024) in volatile startup environments.

This study addresses this gap by integrating RBV and DCT into a unified framework that explains how AI-driven KM systems enable startups to align strategic resources, organisational agility, and sustainability goals. The framework aims to advance theory while offering practical insights into technology-enabled sustainable entrepreneurship.

3. Methodology

This section first presents an integrative literature review that distils the core constructs. It then summarises our measurement design, highlighting the use of adapted 5-point Likert scales and exemplar items to lay the groundwork for future empirical testing.

3.1 Integrative Review Approach

This study adopts a critical literature review methodology to develop a conceptual framework examining how AI-driven KM can enhance sustainable competitive advantage in startups. A systematic search of academic databases, including Scopus, Web of Science, and Google Scholar, was conducted to identify theoretical and empirical studies relevant to KM, AI, entrepreneurship, and sustainability.

Following established guidelines for integrative literature reviews (Torraco, 2016), this study screened relevant literature to extract key constructs and examine their roles in prior research, focusing on empirical studies. The review process focused on identifying how these constructs, such as green KM, AI, BDA, GEO, DCs, and SCA, have been positioned in the literature as antecedents, mediators, moderators, or outcomes. These relational insights were then used to develop theoretically grounded hypotheses.

Drawing on this synthesis, this paper proposed a conceptual framework to illustrate the potential pathways through which AI-driven KM may influence the development of DCs and ultimately contribute to SCA in startup contexts. This framework serves as a foundation for future empirical exploration.

3.2 Measurement of Constructs

All constructs in this study will be measured using 5-point Likert scales (1 = “strongly disagree” to 5 = “strongly agree”), with items to be adapted from established sources to ensure content validity. For Green Knowledge Management (GKM), we will include items such as “Employees in our firm have easy access to information on best environmentally friendly practices” (Khan et al., 2024; Yu et al., 2022). Green Entrepreneurial Orientation (GEO) will be tapped with items like “Our firm proactively seeks out green market opportunities even under conditions of uncertainty” (Jiang et al., 2018; Al Halbusi et al., 2024). To capture Dynamic Capabilities (DCs), we will draw on the sensing–seizing–reconfiguring framework, exemplified by “We continuously reconfigure our internal processes to respond to environmental changes” (Wilden et al., 2013; Jantunen et al., 2018). Big Data Analytics and Artificial Intelligence (BDA-AI) will be operationalised with items such as “We use predictive analytics to forecast and mitigate our environmental impacts” (Benzidia et al., 2021). Finally, Sustainable Competitive Advantage (SCA) will be measured by items like “Our green products/services achieve higher market share relative to competitors” (De Guimaraes et al., 2018).

4. Conceptual Development and Hypotheses

The critical review identified six recurring constructs that form the foundation of AI-driven sustainable advantage in startups: GKM, BDA-AI, GEO, DCs, and SCA. While widely discussed in the literature, these elements are often examined in isolation or within specific disciplinary silos. Table 1 summarises the primary variable relationships examined in this study, highlighting directional effects, core theoretical contributions, and representative supporting literature.

Table 1: Key Construct Interactions and Representative Studies

Pathway	Direction	Core Contribution	Representative Studies
GEO → GKM	Direct Effect	GEO stimulates green knowledge activities and systems	Shehzad et al (2023); Baquero (2024, 2025)
GEO → SCA	Direct, Indirect	Drives sustainable advantage, partly through knowledge practices	Pratono et al (2019); Habib et al (2021)
GKM → SCA	Innovation Enablement	Facilitates green innovation and long-term sustainability	Zhang (2024); Asbeetah et al (2025)
DCs → SCA	Capability Deployment	Translates dynamic capability into sustainable advantage	Li et al (2024); Ma et al (2025)
GKM → DCs → SCA	Mediating Influence	Channels green knowledge into dynamic capabilities to achieve sustainable advantage	Lin and Chen (2017); Qader et al (2022)
BDA-AI → (GKM → DCs), (DCs → SCA)	Moderating Influence	Strengthens knowledge processes and capability effectiveness	Yu et al (2022); Khan et al (2024)

4.1 The Effect of GEO on GKM and SCA

GEO, which combines environmental and market orientations, has been increasingly recognised as a strategic driver of sustainability. Recent empirical studies highlight GEO's influence on organisational processes and outcomes, particularly in shaping sustainability strategies and competitive advantage. Within this context, GEO also significantly affects GKM practices, such as green knowledge acquisition, sharing, and integration.

Empirical evidence confirms GEO's influence on both SCA and broader sustainable performance, often through mediating mechanisms such as inter-organisational learning (Pratono et al, 2019), KM (Alfandi et al, 2023), and market orientation (Habib et al, 2021). Furthermore, GEO directly enhances GKM (Shehzad et al, 2023) and its related components, including green knowledge acquisition (Baquero, 2025), KM capability (Baquero, 2024), and green knowledge sharing (Le and Zhang, 2024). These knowledge practices support the development of sustainability-enabling capabilities.

These findings suggest that GEO contributes directly and indirectly to SCA by fostering GKM activities that underpin strategic adaptability and innovation. For startups typically constrained by limited resources, environmental volatility, and heightened innovation pressure, embedding green values within entrepreneurial orientation and strategically leveraging knowledge processes may provide a viable route to achieving sustainable differentiation and long-term competitiveness.

Accordingly, the following hypotheses are proposed:

H1: GEO positively influences GKM in startups.

H2: GEO positively influences SCA in startups.

4.2 The Effect of GKM on DCs and SCA: The Mediating Role of DCs

As an extension of traditional KM, GKM plays a central role in developing organisational capabilities for sustainability. KM practices such as knowledge acquisition, sharing, and application have been widely recognised as enablers of SCA through their influence on green innovation and firm performance (Abbas and Sağsan, 2019), laying a foundation for aligning environmental goals with strategic execution.

Although studies focused specifically on GKM remain relatively scarce, recent research affirms its relevance. GKM significantly enhances green competitive advantage (Zhang, 2024) and corporate sustainability through mechanisms like green knowledge acquisition (Asbeetah et al, 2025) and green knowledge sharing (Zairbani and Kumar, 2025). These practices promote innovation-driven environmental performance and strategic positioning.

Dynamic capabilities are also critical in advancing sustainability. Green DCs have been linked to improved environmental and financial outcomes, particularly when aligned with green supply chain and knowledge management strategies (Li et al, 2024). The capacity to absorb and act on green knowledge enhances agility, an essential asset for startups navigating uncertainty.

Moreover, growing evidence suggests that GKM plays a formative role in developing DCs. GKM fosters sensing, seizing, and reconfiguring capabilities by facilitating the flow and application of sustainability-oriented knowledge (Teece, 2007). Lin and Chen (2017) empirically validated that green knowledge sharing strengthens

DCs, leading to enhanced innovation and competitive advantage, thus supporting the mediating role of DCs between GKM and sustainability outcomes. This finding aligns with DCT, which positions knowledge as a core enabler of adaptive capability.

Thus, GKM is posited to impact SCA both directly and indirectly through the development of DCs, leading to the following hypotheses:

H3: GKM positively influences SCA in startups.

H4: GKM positively influences DCs in startups.

H5: DCs positively influence SCA in startups.

H6: DCs mediate the relationship between GKM and SCA in startups.

4.3 The Roles of Big Data Analytics and Artificial Intelligence (BDA-AI)

In the evolving landscape of sustainable entrepreneurship, startups increasingly rely on data-centric technologies to improve decision-making and competitiveness. Among such technologies, BDA and AI have emerged as strategic enablers for KM, DCs, and SCA. Given their complementary roles, this study adopts the integrated construct of BDA-AI to reflect their synergistic contribution: BDA enables data collection, integration, and pattern recognition, while AI supports predictive learning, automation, and adaptive decision-making.

BDA-AI is often conceptualised as both a direct antecedent and moderating mechanism for organisational knowledge and capability development. From the RBV and DCT perspectives, BDA capabilities foster green absorptive capacity and GEO, promoting green innovation (Makhloufi, 2024). In the context of green DCs, BDA not only enhances environmental sensing and reconfiguration capacities but also contributes to agility in sustainable supply chains (Li et al, 2024). Similarly, AI adoption directly improves sustainable performance by promoting green innovation and facilitating knowledge sharing, particularly in high-impact sectors such as healthcare (Al-Balushi et al, 2025).

BDA-AI also enhances GKM systems by improving the capture, integration, and intelligent processing of sustainability-oriented knowledge. Aljehani et al (2024) found that BDA contributes to both KM and green innovation, which together mediate improvements in organisational outcomes. AI facilitates proactive innovation and trust-based KM (Al Halbusi et al, 2025; Abdulmuhsin et al, 2024) and has been shown to moderate the impact of GKM on green human capital and innovation adoption (Khan et al, 2024).

These findings position BDA-AI as a dual enabler in the startup context. Technically, it strengthens knowledge flows and dynamic capability effectiveness, enhancing firms' ability to sense, seize, and reconfigure resources in volatile environments (Warner and Wäger, 2019). Strategically, it amplifies the performance impact of green capabilities. For example, Yu et al (2022) confirmed that BDA moderates the relationship between green DCs and innovation, while integrated frameworks show that BDA-AI improves outcomes in green supply chains, ambidexterity, and sustainable manufacturing (Wang et al, 2025; Rashid and Rasheed, 2022).

For startups, this integration is especially critical. Operating with limited memory and volatile conditions, they benefit from BDA-AI's real-time learning, adaptive capacity, and ability to circumvent traditional growth limitations. These technologies enable rapid resource renewal and strategic agility, positioning startups to seize sustainability opportunities (Nambisan, 2017).

Based on these insights, the following hypotheses are proposed:

H7: BDA-AI positively moderates the relationship between GKM and DCs.

H8: BDA-AI positively moderates the relationship between DCs and SCA.

5. Proposed Conceptual Framework

Based on the proposed hypotheses and grounded in RBV and DCT, this study develops a conceptual framework that illustrates how AI-driven KM fosters sustainability-oriented competitive advantage in startups. As shown in Figure 1, the model integrates six key constructs (GEO, GKM, DCs, BDA-AI, and SCA), and captures their interdependencies.

GEO provides the strategic impetus for green knowledge activities, enhancing dynamic responsiveness and long-term competitiveness. GKM directly contributes to SCA and simultaneously strengthens DCs, mediating the impact of knowledge processes on sustainable outcomes. Meanwhile, BDA-AI serves as a dual enabler,

strengthening the links between GKM and DCs, and between DCs and SCA, by improving agility, insight generation, and resource reconfiguration.

The proposed framework outlines the mechanisms through which startups can strategically leverage AI-driven KM to pursue green innovation and sustainable advantage under conditions of uncertainty and constraint.

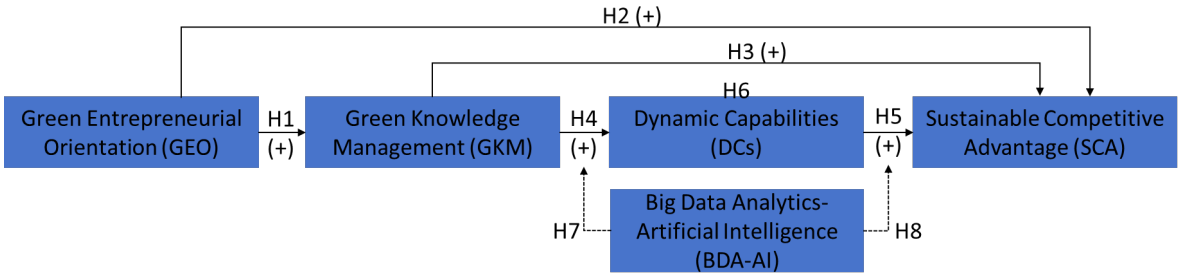


Figure 1: Conceptual Framework of AI-Driven KM for Sustainability in Startups

6. Conclusion

This study explores how AI-driven KM can enhance the sustainability of startups by integrating insights from RBV and DCT. A critical review of recent literature identified six core constructs (GEO, GKM, DCs, BDA-AI, and SCA) and synthesised them into a conceptual framework.

The findings suggest that GEO fosters sustainability-oriented knowledge practices, which enhance dynamic capabilities and support long-term competitive advantage. DCs serve as a vital conduit between green knowledge and performance outcomes, while BDA-AI technologies act as technical and strategic enablers that amplify agility and innovation in startup contexts.

Theoretically, this study contributes to the intersection of green entrepreneurship, KM, and AI by integrating previously fragmented concepts into an integrative framework. It extends the application of RBV and DCT in sustainability-focused startups operating under digitalisation pressures. However, as a preliminary conceptual study, this research primarily serves as a foundational step towards empirical validation. Practically, the proposed model offers guidance for startup founders and policymakers to strategically leverage BDA-AI and knowledge capabilities in pursuit of green growth and long-term advantage.

As a conceptual and literature-based study, it should be regarded as an initial step towards building a more robust empirical understanding of AI-driven KM in startup sustainability. The framework may have overlooked other relevant variables, such as external environmental factors (e.g., policy support or market dynamics), which could also influence the relationships among the core constructs. Future research may apply this framework to specific sectors (e.g., food tech or digital services) to examine contextual nuances and practical implementation. Longitudinal and comparative studies could further illuminate how AI-driven KM capabilities evolve and differ across organisational stages and settings.

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A Systematic Literature Review on GenAI Through the Lens of Corporate Sustainability

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Abstract: Generative artificial intelligence (GenAI) is a subset of AI capable of autonomously producing new content in the form of text, audio, video and code based on previously learned data patterns. As modern organizations face increasing pressure to align with environmental, social, and governance (ESG) objectives, GenAI, due to its enormous potential is reshaping organizational processes, presents an unprecedented opportunity for fostering sustainable practices related knowledge. In this context, this study aims to critically review the existing literature on the topic with the aim of analysing its potential to support social responsibility. Specifically, this Systematic Literature Review (SLR) examines the intersection of GenAI, Knowledge management (KM), and sustainability, emphasizing the role of Green Knowledge Management (GKM), a framework that integrates environmentally conscious knowledge practices into corporate strategy. Through an extensive review of peer-reviewed articles, four key thematic areas emerge: (1) sector-specific application of GenAI for sustainability, (2) Ethical and regulatory concerns on GenAI implementation, (3) GenAI in promoting organizational knowledge and innovation and (4) The role GenAI in corporate social responsibility (CSR). The result of the review indicate that GenAI is increasingly emerging as a catalyst for sustainability. Its role in promoting green innovation and its capacity to facilitate the exchange of knowledge regarding sustainable practices provide crucial support for firms pursuing ESG compliance. Despite these benefits, considerable concerns remain, especially regarding the ethical use of GenAI. This study contributes to the ongoing discussion on the role of GenAI as key enablers of sustainability. By providing a systematization of the research domain, it not only provides a comprehensive understanding of its current applications but also indicates present gaps and opportunities. In addition, it outlines future directions and serves as foundation for further empirical research on the use of GenAI to promote responsible corporate practices.

keywords: Artificial intelligence (AI), Generative AI, Green knowledge management (GKM), Sustainability, Corporate social responsibility (CSR), Systematic literature review (SLR)

1. Introduction

Knowledge is essential to the functioning of organizations and represents a well-established source of competitive advantage in the modern context. The ability to effectively manage both internal and external sources of information often determines whether organizations can successfully achieve their strategic objectives. Knowledge Management (KM) is the discipline concerned with the acquisition, sharing, and application of knowledge within organizational contexts. Numerous studies have demonstrated that well-conducted KM practices have a positive influence on both operational efficiency and innovation performance. In parallel, the increasing consumption of natural resources and the accelerating pace of climate change have intensified pressure from policymakers and public opinion, urging organizations to make sustainable choices regarding their operations. As sustainability becomes a core organizational imperative, the scope of KM has gradually expanded to include knowledge specifically related to environmentally conscious practices. This body of knowledge, known as Green Knowledge Management (GKM), is now recognized as a strategic organizational resource(Sahoo et al., 2023). GKM supports sustainable development by guiding organizations in acquiring, sharing, and applying eco-knowledge. In doing so, it fosters green innovation and contributes to achieving the Sustainable Development Goals (SDGs) (Wu and Gao, 2022). Moreover, since KM is closely tied to firm performance, the adoption of GKM practices has been shown to positively influence organizational environmental outcomes and innovation capacity (Abbas and Khan, 2023). This shift is vital to ensure business competitive advantage guaranteed by the effective use of the knowledge in this dynamic environment. In the last two decade the scientific discussion on artificial intelligence (AI) has reach extraordinary dimension thanks to the inner revolutionary potential of this new technology. With the advent of Machine learning (ML) algorithms, AI-based systems became capable of learn from a previously collected data and improve their outputs. However, only in recent year, with the emergence of deep learning (DL) techniques such as neural networks, generative artificial intelligence (GenAI) has emerged as a specific field within AI domain. GenAI is a technology able to autonomously produce text, video, audio and code starting from patterner learned in previous elaborated data. From a technological standpoint, it is made possible thanks to enabling technologies such as the Internet of Things (IoT), which collects real-world data, and big data infrastructure that supports large-scale processing. One of the most prominent examples of GenAI are Large Language Models (LLMs), which

are logical structures using neural networks and trained on vast quantities of data mainly taken from the web (Raiaan et al., 2024). These models are currently applied across a wide variety of task, from software development to literary composition. Due to its powerful capabilities, GenAI has captured growing interest from many fields, specifically business management experts have considered its application within organizational processes. Specifically, GenAI has emerged as a key enable helping companies in addressing modern context complexities, increasing their competitiveness and efficiency. Given its role in supporting GKM practices, this powerful tool is promising to support organizations in effectively aligning their process and management practices with sustainable development goals (SDGs). By supporting organizations in acquiring, processing and applying sustainability-related knowledge, GenAI can serve as a valuable tool for enhancing sustainable practice. However, there is an urgent need for understanding how to efficiently integrate its use in organizations and the discussion regarding how to use this technology for the best is still on debate. Despite the growing academic interest on the topic, comprehensive systematic reviews focusing on the intersection of GenAI, knowledge management and sustainability-oriented practices remain scarce. While other studies provide a broad overview of the technological capabilities and emerging ethical considerations of GenAI, it does not delve into its implications for corporate sustainability. In this scenario, this work aims at critically review the extant literature in order to offer a novel contribution by exploring how GenAI is not only reshaping organizational processes but also emerging as a catalyst for sustainability and social responsibility. The resulting thematic framing indicates GenAI as a tool for enabling organizations to both create and disseminate sustainability-oriented knowledge.

2. Methodology

A systematic review is a method for identifying and analysing all pertinent literature related to a specific research domain. This methodology is characterised by specific phases that encompass the processes of gathering, organising, and evaluating literature within a review area (Petticrew and Roberts, 2006). Thanks to its scientific rigour, a systematic literature review (SLR) is a rigorous and relevant methodology through which is possible to identify relevant insights which further enhance comprehension, aid in detecting research trends, and highlight new avenues for future research within a specific topic. An SLR provides an empirical foundation that prevents the omission of pivotal articles and mitigates researcher bias (Tranfield et al., 2003). Specifically, the present study employs a methodology structured on a four-step process shown in figure 1.

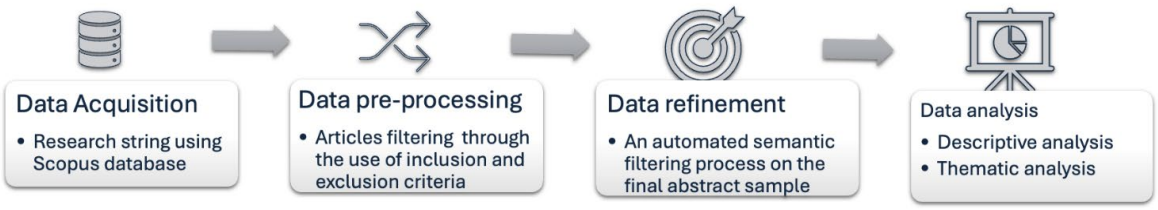


Figure 1: Methodological steps

2.1 Material Search

The data for SLR was collected from the Scopus database, selected due to its comprehensive indexing of peer-reviewed literature across multiple disciplines. The search strategy combined keywords related to sustainability, knowledge and artificial intelligence. Specifically, the following search string was used: (TITLE-ABS-KEY ("sustainability" OR "corporate social responsibility" OR "CSR" OR "ESG") AND TITLE-ABS-KEY ("knowledge" OR “green knowledge”) AND TITLE-ABS-KEY ("Artificial intelligence" OR "AI" OR "LLMs" OR "DL" OR "ML" OR "Generative AI" OR "GenAI")). This query yielded 1657 items.

2.2 Data Pre-Processing

To reduce the dataset to a manageable and analytically robust sample, a multi-stage screening procedure was adopted. This included both automated text analysis and manual validation steps. Both exclusion and inclusion criteria were utilised to enhance the sample quality. As per exclusion criteria, firstly, only peer-reviewed journal articles published in English were included into the final sample (Secundo et al., 2020), the application of this filter reduced the sample to 643 items. Second, with the aim of finding a balance between relevance and completeness, it has been set a threshold for the starting year to 2015. Starting from this year both AI and CSR offered a more meaningful contributions, when sustainability, ESG, CSR and AI maturity started to converge. In addition, an inclusion criterion was introduced to improve the accuracy and validity of the procedure, minimising the risk of excluding any relevant articles within the domain. The study specifically employs snowball sampling,

incorporated highly cited publications from the raw sample that were not part of the primary data collected. This validation criterion allowed the authors to identify and get important papers cited in the literature that were excluded from the chosen databases and keyword search (Shashi et al., 2021). The result produced a total of 553 papers.

2.3 Data Refinement

A subsequent filtering step was employed. For evaluating the abstract eligibility, an automated semantic filtering process was developed using Python. This process involved scanning each abstract for the presence of keywords aligned with the aim of the present work. Abstracts were retained only if they satisfied all three inclusion dimensions and were free from exclusion triggers. This approach enabled the objective reduction of the dataset while ensuring thematic relevance. A codebook, shown in table 2, was used to ensure transparency and replicability of the process.

Table 1: Codebook employed in data analysis phase for automatic filtering the abstracts

Code	Criteria	Definition
IN-1	GenAI Relevance	Mentions of ChatGPT, LLMs, or related generative technologies.
IN-2	Sustainability/CSR Focus	References to CSR, ESG, sustainability, or green knowledge.
IN-3	Organizational Relevance	Includes terms related to knowledge management, innovation, or strategy.
EX-1	Technical-Only Focus	Focuses solely on model training or optimization without societal context.
EX-2	Non-Organizational Domain	Discusses creative arts or entertainment without CSR implications.
EX-3	No Abstract or Unclear	Lacks a sufficient or informative abstract for analysis.

After automatic filtering, all abstract classifications have been manually revised and validated by authors. Specifically, those abstract not classified by the algorithms have been deeply analysed and manually filtered. This process resulted in a total reviewed sample of 135 records containing conceptual or practical insights into the intersection of Generative AI, sustainability and organizational knowledge. These articles were subsequently analysed through thematic analysis methodology and classified into four thematic clusters according with their focus.

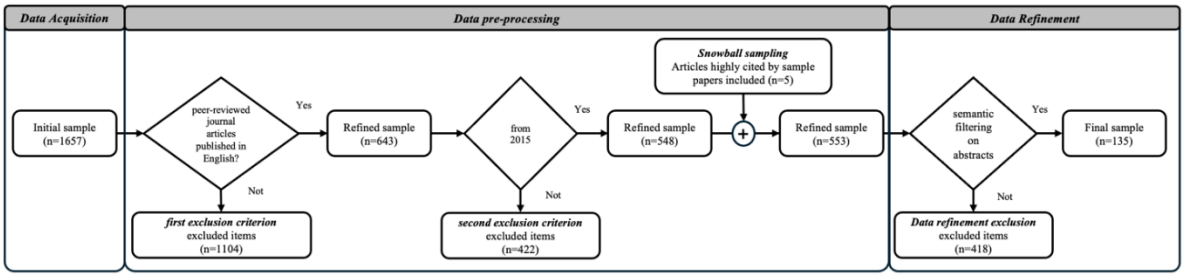


Figure 2: Articles selection process

3. Results

3.1 Descriptive Results

The present section briefly illustrates the descriptive results emerged from the analysis of the sample. Specifically, Figure 2 shows the articles distribution over time. As expected, there is a growing interest on the topic as evidenced by the increasing number of articles over the observation period. Figure 3 highlights papers geographical distribution. Cina and United States lead the ranking with respectively 15 and 12 articles.

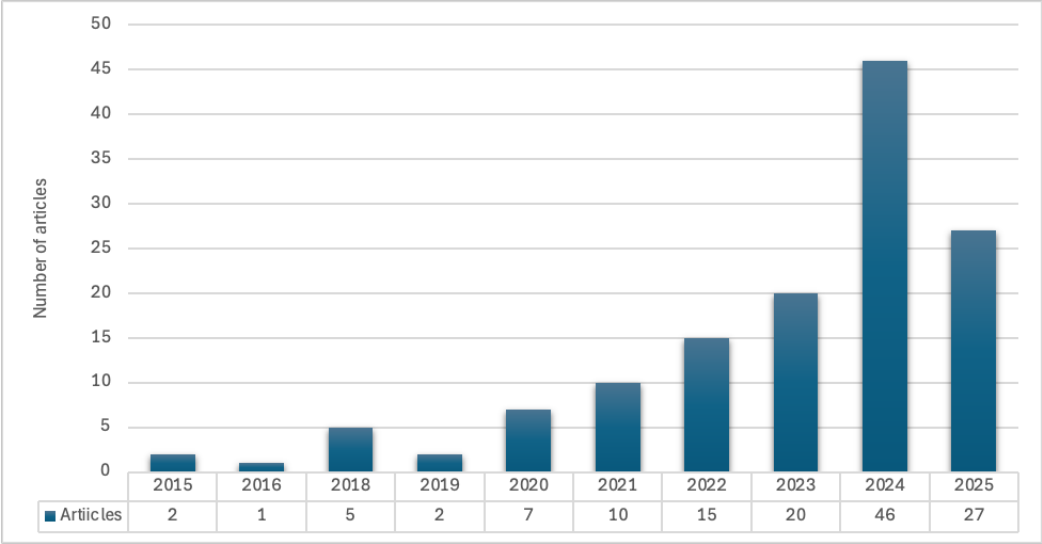


Figure 3: Articles distribution over time

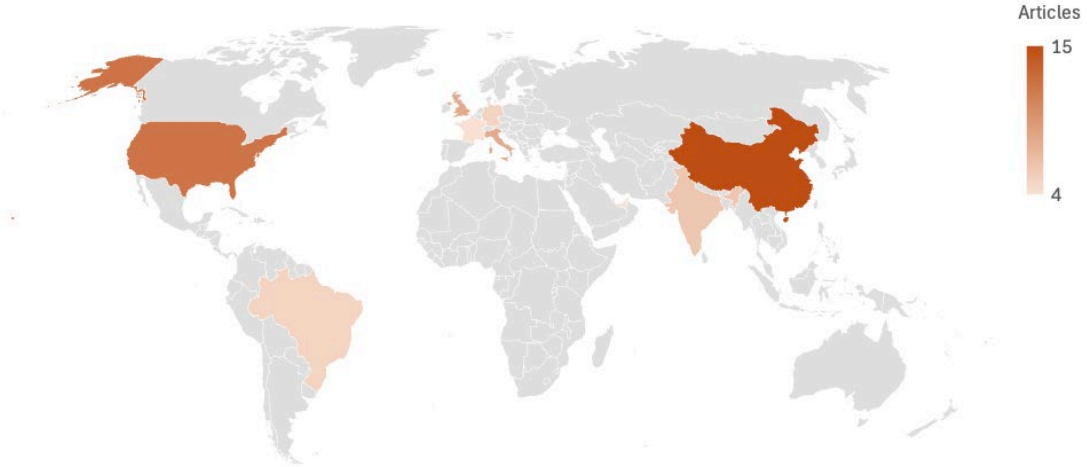


Figure 4: Articles distribution over Countries

Table 2 shows the most relevant contributions in terms of total citations while table 3 summarizes the top 10 contributing journals considering the number of published articles. The sample of 135 articles was published in 93 different source journals indicating a high level of dispersion of the literature across many sources.

Table 2: Most impactful papers in terms of citation received

Paper	DOI	TC
DI VAIO A, 2020, J BUS RES	10.1016/j.jbusres.2020.08.019	628
PHAM A-D, 2020, J CLEAN PROD	10.1016/j.jclepro.2020.121082	246
HOLZINGER A, 2023, NEW BIOTECHNOL	10.1016/j.nbt.2023.02.001	183
AL-SHARAFI MA, 2023, INTERACT LEARN ENVIRON	10.1080/10494820.2022.2075014	93
ABBAS S, 2020, IEEE ACCESS	10.1109/ACCESS.2020.2976452	81
FRANK B, 2021, J CLEAN PROD	10.1016/j.jclepro.2020.125242	76
ALSHAHRANI A, 2023, INT J DATA NETW SCI	10.5267/j.ijdns.2023.6.010	64
EL-ADAWAY I, 2015, J PROF ISSUES ENG EDUC PRACT	10.1061/(ASCE)EI.1943-5541.00208	59
YUN JJ, 2016, SUSTAINABILITY	10.3390/su8080797	58
OUAFIQ EM, 2022, SUSTAINABLE ENERGY TECHNOL ASSESS	10.1016/j.seta.2022.102093	52

Table 3: Top 10 most productive source

Sources	Articles
SUSTAINABILITY (SWITZERLAND)	22
IEEE ACCESS	5
INTERNATIONAL JOURNAL OF DATA AND NETWORK SCIENCE	4
JOURNAL OF CLEANER PRODUCTION	4
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	3
BUSINESS STRATEGY AND THE ENVIRONMENT	2
COMPUTERS AND ELECTRONICS IN AGRICULTURE	2
INTERNATIONAL JOURNAL OF HUMAN-COMPUTER INTERACTION	2
JOURNAL OF ENVIRONMENTAL MANAGEMENT	2
SCIENTIFIC REPORTS	2

3.2 Thematic Analysis

To synthesize the findings from the systematic literature review, the selected articles were classified into four main thematic clusters that reflect the emerging intersections between GenAI, sustainability and corporate responsibility.

Theme 1: sector-specific application of GenAI for sustainability

The integration of Generative AI (GenAI) across various sectors is increasingly transforming business operations, not only enhancing efficiency but also aligning with CSR objectives. This is true in a wide variety of sector. For instance, in communication and digital interactions, chatbots are improving access to public services, particularly in healthcare and public administration (Alia et al., 2024) where these technologies contribute to inclusive access to essential services. Moreover, AI-powered toxic content detection systems enhance digital safety and support businesses in fostering responsible communication environments, without any doubt a key aspect of corporate governance in the digital economy (Babakov et al., 2024). In education, GenAI plays a critical role in democratizing knowledge access. Its use promotes educational equity and helps in bridging educational gaps by offering personalized learning tools which aligns with CSR initiatives focused on social development (Alrayes et al., 2024). This aspect can be particularly beneficial for underprivileged communities (Diab Idris et al., 2024) given that this tools aligning with CSR principles of transparency, accountability, and fairness (Gallent Torres et al., 2023). In healthcare sector, GenAI is being employing in enhancing both patient care, with the use of social chatbots for geriatric care (Blavette et al., 2024), and ethical medical practices through the detection of social determinants of health for improving social well-being (Gabriel et al., 2024). In the retail sector, GenAI enhanced sustainable supply chain management is enabling companies to optimize logistics, thereby reducing waste. Similarly, in tourism GenAI-powered customer service automation is supporting companies in implementing eco-friendly practices (Wang and Zhang, 2024). As underlined by many studies, the effective integration of GenAI within organizations can help in aligning their business strategies with CSR principles. Technological advancements should contribute not only to efficiency but also to corporate responsibility. Despite all the benefits, GenAI adoption forces companies to implement robust governance frameworks to mitigate AI biases and promote transparency in AI decision-making processes. Future research should explore sector-specific framework to help businesses in using GenAI for CSR-driven innovation, ensuring that AI technologies contribute to both corporate success and societal well-being.

Theme 2: Ethical and regulatory concerns on GenAI implementation

The rapid advancements in Generative AI (GenAI) have prompted significant regulatory and governance discussions. From the literature emerges that policymakers and scholars still strive to ensure responsible deployment of these technologies. A key concern in AI governance is the need for strategic redirection in both policy and business practices to balance technological innovation with ethical constraints. Scholars argue that the business environment surrounding AI must be restructured to ensure that AI applications contribute positively to economic and social development, rather than exacerbating inequalities or ethical dilemmas (Etemad, 2023). GenAI emerges as a game-changer for the future. This consideration plays a pivotal role in regulatory discussions. Despite the unprecedented benefits, scholars emphasize the need for regulatory framework that introduce adaptive policy to prevent technology misalignment with social welfare. AI bias,

misinformation and privacy violations (Amador Nelke et al., 2024) are the main issue concerning the risk of using GenAI. For this reason, the integration of GenAI in decision-making processes within corporate structures necessitates clear guidelines. The effective integration of such disruptive technology will make the difference between human using GenAI and human replacement (Heaton et al., 2024). In addition, to the date policymakers are facing the complex challenge of clearly defining GenAI boundaries for its responsible use. Several issues arise, particularly concerning data privacy, intellectual property and accountability in GenAI outputs. Overall, there is an increasing emphasis on ensuring that AI aligns with CSR objectives. The regulatory landscape of GenAI is rapidly evolving, driven by the need to reconcile technological potential with ethical and legal responsibilities. Future research and policymaking should focus on developing dynamic regulatory approaches that keep pace with AI advancements while safeguarding corporate responsibility, fairness, and long-term sustainability.

Theme 3: GenAI in promoting organizational knowledge and innovation

A recurrent theme in the literature is how GenAI support within organization goes beyond the mere task automation acting as a catalyst for radical organizational reinvention. It enhances data-driven decision-making and promote more sustainable operations. In few words, GenAI emerges as powerful driver of both innovation and knowledge transformation. GenAI, with its potential to redefine knowledge production and dissemination, unlocks entirely new pathways of value creation by reducing knowledge fragmentation within organizations (Wu et al., 2024). Some studies further explore this frontier by investigating the possibility to capture and simulate tacit organizational knowledge (Fraile et al., 2023), and the reconfiguration of the entire KM processes with the aim of creating new epistemologies (A Mooradian, 2024). Considering its knowledge dependence, customer engagement is among the domains that benefit the most from GenAI integration. Thanks to digital avatars (Oliveira et al., 2024) and GenAI-powered feedback systems (Leong et al., 2024), this novel technology translates knowledge into interactive experiences and promote CSR by enhancing inclusivity and customer-oriented innovation (Tafesse and Wien, 2024). Many studies highlight GenAI relevance in improving internal knowledge evolution within learning organizations by bridging knowledge gap (Schreiber and Schreiber, 2024) and fostering investment in emerging economies (Sheldon and Kwon, 2023). GenAI seems to be something more than a simply technological advancement. it holds transformative potential to change the way organizations innovate and learn. For this reason, as the literature reveals, those organizations that successfully integrate GenAI within their strategic knowledge systems are better positioned in the complex modern scenario.

Theme 4: The role GenAI in corporate social responsibility

From the reference literature emerge both opportunities and challenges in integrating GenAI's use, and its impact on KM practices, for CSR. Some authors underline the need for a proactive approach to GenAI development. Aseeva (2023), for instance, proposes to embed ethical foresights directly into technological systems design process. This should guarantee its smooth integration with governance frameworks that prioritize long-term societal resilience. Other scholars also underline the environmental impact of AI systems computational cost and carbon footprint (Barbierato and Gatti, 2024). From an industry innovation perspective, many research are exploring how GenAI can contribute in purposefully employing green knowledge to foster more sustainable models of corporate value creation (Eisenreich et al., 2024). This trend could reshape open innovation ecosystems. Improvements in managing the internal and external knowledge regarding sustainable practices with the help of GenAI could represent a crucial tool in promoting green product development and foster new form of eco-innovation. This is particularly true for high impact sectors, such as automation, where GenAI plays a pivotal role in supporting organizational transitions toward sustainable business models (Gómez Gandía et al., 2025), and construction, where GenAI-powered predictive models can accelerate the development and adoption of eco-friendly technologies (Feng et al., 2024). Collectively, these contributions signal the shift from potential to actionable strategies in the GenAI integration for CSR. What clearly emerges from the literature is the imperative to sustain a responsible use of this powerful tool. The optimization of operational efficiencies must align with the broader values of social equity and ethical governance.

4. Discussion

Despite their differences, the four thematic cluster emerged from the review collectively illustrate GenAI's transformative power for modern organizations and its possible role in supporting CSR. Across many sectors, from the healthcare to tourism, GenAI has shown its potential in fostering environmental knowledge sharing. The alignment of its application to ESG goals is seen as both technological and ethical imperative. Particularly, the GenAI's pivotal role besides in its capacity to transform knowledge systems which is highly relevant for those firms striving to innovate sustainably. GenAI produce by analysing large dataset and generating insights that supports eco-innovation is enabling synthesis, generation and dissemination of environmental knowledge. In

this view, it represents a mean to support green-oriented decision-making rather than a mere digital tool. While GenAI integration within organization offer significant benefits, it also introduces many regulatory and ethical issues. Algorithm bias, intellectual property and a lack of transparency in AI decisions could undermine stakeholder trust. For these reasons the introduction of this disruptive technology must be carefully implemented and should be guided by solid regulatory framework proposed by governance structures for ensuring its compliance with societal values.

Future directions

Although the increasing academic interest on GenAI, the result of this review shows that most part of the literature remains conceptual of technologically focused. Few studies provide empirical contributions to the role of GenAI on the SRC. In addition, the metrics for evaluating its impact are still underdeveloped. Main future directions emerged from the gap found in literature have been collected and summarized in the table 4.

Table 4: Future research directions

Future research directions	Description	Research questions
Practical implementation	How to integrate GenAI within organizational knowledge processes is a complex task. Future research could provide a contribution for sector-based framework that guide its strategic integration into sustainability practices	RQ: How can sector-specific frameworks support the strategic implementation of GenAI in sustainability-focused knowledge management?
Cross-functional synergies	Considering GenAI transformative potential on knowledge systems, future directions could investigate on cross-functional synergies across departments to drive responsible innovations.	RQ: In what ways can GenAI facilitate cross-departmental collaboration to enhance responsible innovation within organizations?
Performance indicators	Defining and validating performance indicators for measuring GenAI's contribution to environmental, social and governance outcomes is a must for rigorously demonstrate its importance in CSR practices.	RQ: What are the most effective indicators for evaluating GenAI's impact on environmental, social, and governance performance?
AI governance models	As previously said, the integration of GenAI within organization must be carefully implemented. At organizational level, governance guidelines are absolutely essential in managing the risk while preserving GenAI innovation potential for CSR. Future research could offer precious insight on how to develop regulatory frameworks.	RQ: How can governance models be designed to ensure ethical use of GenAI while promoting innovation aligned with CSR goals?

5. Conclusion

This study offers a comprehensive and timely contribution to the growing discourse on the role of Generative Artificial Intelligence (GenAI) in advancing corporate sustainability through the effectively employment of the green related knowledge. By conducting a Systematic Literature Review (SLR), the research provides a structured synthesis of how GenAI intersects with knowledge management, sustainability goals, and Corporate Social Responsibility (CSR). The findings confirm that GenAI represents a potential catalyst for responsible innovation and green knowledge management across sectors. However, despite its related opportunities, it also introduces several challenges. Developing robust regulatory framework seems to be the key element to balance the desire of embracing its potential and the need of ensuring its alignment with broader human values. Concerning these considerations and in response to the gaps identified in the current literature, this study proposes several areas for future exploration. These include framework development for practical implementation, cross-functional synergies, performance measurement tools and AI governance models tailored to CSR objectives. Ultimately, this review positions GenAI as a crucial element for enhancing green knowledge practices and responsible corporate behaviour.

Ethical declaration: Clearance was not required for the research.

AI declaration: Generative AI tools were not used in the production or analysis of the empirical data. All interpretations and findings are the result of the authors' critical analysis and are not generated by AI.

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AI-Driven Generation of Key Intelligence Topics and Questions: Enhancing the Work of CI Professionals

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Abstract: Competitive Intelligence (CI) is a critically important instrument for monitoring an organization's external environment, providing management with unique insights into markets, competitors, trends, and other entities influencing the organization's strategic position. Simultaneously, it serves as an effective tool for mitigating risks by identifying and interpreting early signals from the competitive landscape, while also uncovering opportunities for capturing competitive advantages. Recent developments in artificial intelligence (AI), particularly the emergence of Large Language Models (LLMs), have opened new possibilities for enhancing Competitive Intelligence (CI) processes. This paper explores the potential of LLMs in addressing specific CI tasks through CI-oriented prompt design. The study specifically focuses on the planning phase, demonstrating how LLMs can support the identification and formulation of Key Intelligence Topics (KITs) and Key Intelligence Questions (KIQs). In addition, the paper discusses the application of LLMs in the data collection phase, emphasizing their role in identifying relevant sources aligned with the direction of the KIQs. The implications of integrating LLMs into CI are substantial; however, this implementation must be approached cautiously to ensure accuracy, reliability, and ethical compliance emphasizing the need for thorough validation and human oversight.

Keywords: Competitive intelligence, Large language models, Prompt engineering, Prompt design, Intelligence cycle

1. Introduction

The hypercompetitive environment exerts increasingly stronger pressure on contemporary organizations across numerous aspects of their operations. Due to technological advancements, particularly in the context of artificial intelligence, organizations are becoming progressively more vulnerable, especially regarding the rational communication of data and information with respect to verification, relevance, and application in decision-making processes. As (Ansoff 1975) notes, management faces information overload that can generate multiple risk factors for businesses or organizations throughout their lifecycle. Currently, verified information with an emphasis on delivery prioritization is just one of multiple factors for companies to gain competitive advantage. What matters significantly is the ability to respond to rapid market changes, including the unprecedented variability of relevant information directly affecting the company. Competitive Intelligence (CI), a traditional system of processes that assists businesses with market environment orientation, provides companies with a tool capable of fully capturing both positive and negative phenomena, leading to opportunity utilization and, conversely, risk aversion or the application of predetermined measures (Ansoff 2019; Gilad 2003). As (Ansoff 2019) adds, transforming direct dangers that a company faces into opportunities has always been the most prioritized capability in the history of the American business spectrum.

(Murphy 2006) returns to the generally accepted fact that CI cannot be related solely to competitors, stating that *"...scope is not limited to researching and assessing other firms and acting to outperform them. It embraces all factors that could endanger or enhance a company's revenues and profits."*

One of the most frequently cited definitions comes from the Society of Competitive Intelligence Professionals (SCIP), which describes CI as "the legal and ethical collection and analysis of information regarding the capabilities, vulnerabilities, and intentions of business competitors... for use in planning and decision-making" (Dishman & Calof 2008). This definition underscores both the ethical dimension of intelligence activities and the decision-oriented nature of CI. (Du Toit 2007) highlights in the context of CI that while *environmental scanning* takes a broad sweep of external trends, CI is more targeted in shaping immediate or near-term strategies through explicit questions and organizational needs. In this sense, CI harnesses methodologies from market research, scenario planning, and business analytics to formulate *forward-looking insights*.

The process increasingly penetrates diverse, often narrowly focused business areas and is also becoming an important tool for the public sector. For example, (Cantonnet et al. 2015) investigated CI activities in small and medium-sized enterprises (SMEs) in the industrial sector, revealing that a company's features and environment significantly influence the development of CI activities. (Safa et al. 2015) studied the application of CI techniques for construction contractor evaluation, demonstrating that CI has potential to improve the process of assessing and selecting contractors through supporting unbiased and auditable decision-making processes. The banking

sector has increasingly adopted CI practices. (Du Toit 2013) compared CI practices between two retail banks in Brazil and South Africa, noting that both banks monitored competition but needed to enhance their analytical capabilities. (Hanif et al. 2022) explored the CI process and strategic performance of the banking sector in Pakistan, finding that all components of the CI process significantly affect banks' strategic performance. They recommended the implementation of formal CI units and awareness programs to improve participation of employees in the CI process.

The hospitality industry has begun to recognize the value of CI. (Köseoglu et al. 2016) examined CI practices in hotels, finding that hotel managers demonstrated a low level of knowledge and awareness of CI, engaging in CI activities primarily for tactical rather than strategic purposes. (Köseoglu et al. 2019) further developed a holistic CI model incorporating all CI efforts at the management level within a hotel organization, identifying disconnection among management levels in coordination of CI practices. In response to the COVID-19 pandemic, (Tulungen et al. 2021) developed a CI approach for establishing an e-tourism strategy, proposing five basic strategies implemented with an e-tourism model and simple management pattern utilizing information technology. Regarding the public sector, we can also mention the defense industry case study conducted by (Barnea 2014) focused on CI in the Israeli defense industry, noting that CI is used intensively in the highly competitive environment of defense products to support decision-making processes.

Developments concerning CI in both academic and corporate environments also confirm the utilization of a wide spectrum of data and information sources in CI. For example, (He et al. 2015) demonstrated how social media analytics can provide valuable competitive intelligence, examining data from two retail chains. (Kim et al. 2016) used social media analytics for CI, comparing iPhone 6 and Galaxy S5 through Twitter data analysis. (Prantl and Prantl 2018) examined CI tools Alexa and SimilarWeb for website traffic data estimation, finding limitations in their accuracy for determining website rankings. Ranjan and (Foropon 2021) explored how Big Data analytics can contribute to building organizational CI, finding that companies prefer a rather centralized informal process and face multiple challenges regarding the use of big data analytics in CI.

The utilization of artificial intelligence in CI processes is likewise evident. Artificial intelligence (AI) and related technologies have transformed how companies approach CI, enabling more efficient data collection, deeper analysis, and more accurate predictions. (Paschen et al. 2021) discuss how AI can be used to automate data collection and analysis, allowing companies to gain insights more quickly and efficiently. Recent studies showed advanced development related to collection phase. For example, (Ju 2024) presents a social media competitive intelligence framework that not only detects brand topics but also predicts customer engagement. (Liu et al. 2021) employ patent analysis and patent mapping methods to study the 5G competition situation, using visualization analysis with AI-driven software. (Stallings et al. 2024) present an approach for classification of data using machine learning that facilitates aggregation and analysis of intelligence information. Their concept proof extends a model for automatic mapping of publicly available budget data. (Lalitha and Gokila 2024) propose a query model to enhance the precision and relevance of search results for corporate users by systematically structuring keywords and utilizing advanced search techniques.

From the literature, it is evident that AI and related technologies are being applied by companies to most phases of the CI lifecycle; however, very little attention is focused on the initial part of CI, namely planning including Key Intelligence Topics (KITs) and Key Intelligence Questions (KIQs) indentifications. The importance of these entities is evident. When examining the process of identifying relevant KITs and subsequently formulating KIQs that shape corporate decision-making (assuming that a competitive intelligence process is in place), it is primarily a matter of constructive dialogue between company management and CI managers (or analysts). These professionals support the organization in addressing three fundamental areas: (1) strategic decision-making and actions, (2) early warning, and (3) comprehensive analysis of key players (Francis 2001; Herring 1999). A detailed initial CI audit can then be used to plan specific activities that help companies better understand their external environment, including identifying both opportunities and risks. Our study addresses this research gap and presents the possibilities of AI regarding the creation of KITs and KIQs as critical components of the initial phase, utilizing prompt engineering and large language models. Simultaneously, we aim to demonstrate effectiveness in preparing intelligence requirements based on real input data from management meetings using AI.

2. Methodology

Our research employs a mixed-method approach focusing on qualitative aspects of defining the initial phases of competitive intelligence driven by large language models (LLMs). We qualitatively evaluate the relevance of key intelligence question identification, including collection phase design with information source suggestions, followed by a quantitative evaluation of similarities among LLM responses.

Despite their underlying architecture of next-token prediction, LLMs exhibit emergent capabilities in structured reasoning, summarization, contextual mapping, and problem decomposition — all of which are central to CI tasks. By framing CI tasks (e.g., KIT/ KIQ development, situational analysis) within clearly defined prompts, LLMs can simulate the analytical heuristics of CI professionals. We acknowledge that LLMs are generative models that produce outputs based on their training data and contextual interpretation capabilities. This study does not aim to demonstrate the substitutability of competitive intelligence professionals; rather, it illustrates how LLMs can augment their internal reasoning processes, expand their strategic analysis capabilities, and reduce time spent on routine, labor-intensive tasks.The study begins with the AI-driven transcription of real-world, publicly available board of directors' meetings from an organization focused on patient care across three large hospital sites. Following this, we developed and tested prompts designed to extract critical problems and consequent evolving needs. The prompt construction process involved determining the industry/domain from the transcribed text, providing initial contextual elements for the LLMs, assigning the role of a competitive intelligence expert, and implementing a chain-of-thought approach divided into specific steps.

The analytical process instructed the models to analyze contextual information from the initial transcript to define organizational objectives, including identification of risks and opportunities. Models were then directed to define broader yet precisely framed challenges as KITs. Subsequently, they were tasked with designing KIQs transformed into Intelligence Requirements, including suggested information sources for collection phases.

We implemented the developed prompt across seven large language models: Claude Sonnet 3.7, DeepSeek R1, Gemini Pro Experimental 2.5, Grok 3, ChatGPT o1, LLaMA 3.3 and Qwen 2.5. For quantitative comparison of the responses, we collected and uploaded all generated outputs into an analysis framework employing cosine similarity measures with Claude Sonnet 3.7. This mathematical technique represents text data as vectors in a multidimensional space and calculates the cosine of the angle between these vectors, resulting in similarity scores ranging from -1 to 1, with higher values indicating greater semantic similarity. By applying this analysis to the collected responses, we quantitatively assessed the degree of convergence or divergence in how different LLMs approached the competitive intelligence tasks, complementing our qualitative evaluation of their performance.

This combined approach allows us to not only evaluate the quality of competitive intelligence insights generated by each model individually but also to systematically compare their outputs to identify patterns of similarity and difference across models, providing valuable insights into the reliability and consistency of LLM-driven competitive intelligence processes.

As part of our evaluation, we aim to compare the efficiency of LLMs in relation to our conceptual approach to the definition of KITs and KIQs. For this task, we employed self-consistency prompting, focusing on the following three qualitative metrics:

- **Precision of Industry/Domain Identification** – the degree to which the model accurately and specifically identified the healthcare context.
- **Relevance of KITs and KIQs** – assessed in terms of relevance, concrete impact, and actionability of the proposed intelligence topics and questions.
- **Sophistication of Information Sources** – the relevance, specificity, and comprehensiveness of the recommended data collection sources.
- **Methodology** – how the models have applied competitive intelligence best practices.

The evaluation metrics—industry/domain precision, KITs/KIQs relevance, source quality, and methodology adherence—reflect structured intelligence principles adopted by the U.S. intelligence community. They align with the Key Intelligence Questions Evaluation Process (KEP), particularly through practices such as domain framing, outside-in thinking, formulation of essential questions for decision-makers, quality of information checks, and the Analysis of Competing Hypotheses (ACH)—all emphasized in official CIA intelligence products (CIA 1979; CIA 1984; Tradecraft Primer 2009). These criteria ensure that LLM outputs are not only linguistically coherent but also analytically rigorous and decision-relevant within the competitive intelligence context. Each metric is evaluated using five levels of consistency with a final overall consistency calculation.

The following prompt was input into the LLMs with system default value of temperature:

> Based on the board meeting records [MEETING], identify the main INDUSTRY/DOMAIN. Then, act as a seasoned competitive intelligence expert specializing in INDUSTRY/DOMAIN and think step-by-step to finalize the Key Intelligence Topics (KITs) and formulate the Key Intelligence Questions (KIQs) for our company’s next strategic moves.

Steps:

1. **Analyze MEETING**
    - Identify the context, problems, risks, opportunities, and overall objectives captured in the board meeting records.
2. **Develop Key Intelligence Topics (KITs)**
    - Based on your analysis, list the most relevant KITs that align with the company's strategic objectives.
3. **Formulate Key Intelligence Questions (KIQs)**
    - For each KIT, propose specific KIQs that will guide research, strategic planning, and decision-making.
4. **Define Intelligence Requirements and Sources**
    - For each KIQ, formalize the intelligence requirements (IR) needed to address it.
    - Suggest both primary and secondary sources where the required data or insights can be gathered.

Output Format

1. **Situational and Critical Commentary**

o For each KIQ, include a brief discussion of:

- Conceptualization: What the KIQ aims to clarify
- Level of Difficulty: How challenging it may be to answer
- Update Frequency: How often the KIQ or its answers should be revisited
- Retrospective Timeframe: The historical data window needed for context

2. **Formatted Table**

o Present a table containing the following columns:

- KIQ
- Defines Information Requirements (IR)
- Suggested Sources

Your response should be concise, well-structured, and actionable, directly linking the insights from MEETING to the company's strategic objectives. When you are ready and understand the instructions, let me know, and I will upload the board meeting transcript.

3. Results

Our quantitative comparison of the seven LLMs' competitive intelligence frameworks performed in Claude Sonnet 3.7. revealed varying degrees of similarity in their approaches to analyzing the healthcare management scenario. Table 1 presents the pairwise similarity scores between all models.

Table 1: Cosine Similarity Matrix of LLM Responses

LLM	Claude Sonnet 3.7	DeepSeek R1 (671B)	Gemini Pro Experimental 2.5	Grok 3	ChatGPT o1	LlaaMA 3.3	Qwen QwQ 32B
Claude Sonnet 3.7	1.000	0.230	0.559	0.489	0.269	0.374	0.156
DeepSeek R1 (671B)	0.230	1.000	0.312	0.393	0.282	0.357	0.326
Gemini Pro Experimental 2.5	0.559	0.312	1.000	0.498	0.225	0.403	0.137
Grok 3	0.489	0.393	0.498	1.000	0.380	0.417	0.230
ChatGPT o1	0.269	0.282	0.225	0.380	1.000	0.125	0.202

LLM	Claude Sonnet 3.7	DeepSeek R1 (671B)	Gemini Pro Experimental 2.5	Grok 3	ChatGPT o1	LlaaMA 3.3	Qwen QwQ 32B
LlaaMA 3.3	0.374	0.357	0.403	0.417	0.125	1.000	0.204
Qwen QwQ 32B	0.156	0.326	0.137	0.230	0.202	0.204	1.000

Our analysis identified Gemini Pro Experimental 2.5 and Claude Sonnet 3.7 (0.6612) as producing the most similar competitive intelligence frameworks, suggesting significant alignment in their analytical approaches. Other highly similar pairs included LLaMA 3.3 and Claude Sonnet 3.7 (0.6348), followed by LLaMA 3.3 and Gemini Pro Experimental 2.5 (0.6031). These three models exhibited substantial content overlap and similar structural approaches. Conversely, Qwen QwQ 32B and Claude Sonnet 3.7 showed the lowest similarity score (0.3509), indicating considerably different analytical approaches. Similarly, Qwen QwQ 32B and Gemini Pro Experimental 2.5 (0.3854), along with Gemini Pro Experimental 2.5 and DeepSeek R1 (0.3853), demonstrated significant divergence in their respective analyses.

The similarity analysis (Table 2) reveals varying degrees of consensus among LLMs in their competitive intelligence approach. Grok demonstrated the highest average similarity (0.401), positioning it as the most representative of the general consensus, with Gemini Pro Experimental 2.5 (0.356) and Claude Sonnet 3.7 (0.346) also showing strong alignment with other models. In contrast, Qwen QwQ 32B and ChatGPT o1 had the lowest average similarity scores, indicating more distinctive approaches. DeepSeek R1 maintained the most consistent similarity across all models (lowest variance), while LlaaMA 3.3, despite middling average similarity, scored highest in centrality, suggesting it represents a middle ground in competitive intelligence frameworks. Qwen QwQ 32B's combination of lowest average similarity and lowest centrality confirms it took the most unique approach among all models analyzed.

Table 2: Average Similarity Scores (Highest to Lowest)

LLM	Average Similarity Score
Grok	0.401
Gemini Pro Experimental 2.5	0.356
Claude Sonnet 3.7	0.346
DeepSeek R1 (671B)	0.317
LlaaMA 3.3	0.313
ChatGPT o1	0.247
Qwen QwQ 32B	0.209

The comparative analysis of LLM outputs (Table 3) revealed distinct strengths across models: Gemini Pro Experimental 2.5 delivered the most comprehensive and detailed framework with specific implementation guidance; ChatGPT o1 demonstrated the strongest operational focus with emphasis on immediate staffing and financial challenges; Claude Sonnet 3.7 maintained the most strategic outlook, particularly regarding system integration and long-term planning; LlaaMA 3.3 presented the most generic approach with broadly formulated KIQs and minimal guidance; DeepSeek R1 and Grok achieved the best balance between immediate operational concerns and longer-term strategic planning; Qwen QwQ 32B offered the most unique perspective by explicitly addressing external market and policy analysis as a separate KIT; while Claude Sonnet 3.7 and Grok showed the strongest prioritization of core issues around workforce, quality, and system integration.

A comparative Table 4 analyzes how the seven LLMs approached situational analysis and source recommendations in their competitive intelligence frameworks. It reveals significant variation in how the LLMs approached these aspects: Gemini Pro Experimental 2.5 provided the most comprehensive situational analysis and most detailed source recommendations, with extensive heath-specific context; Claude 3.7 and ChatGPT o1 both offered strong situational analyses and well-structured source recommendations with good categorization; LLaaMA 3.3 showed the weakest performance in both situational analysis and source recommendations, providing only generic healthcare categories without any specific insights; Most models emphasized the importance of combining internal Trust data with regulatory information and sector-specific resources, though

with varying levels of specificity. This table complements the earlier comparison by focusing specifically on how well each LLM understood the situation and recommended appropriate information sources to address the intelligence needs.

The consistency analysis of seven large language models (LLMs) for competitive intelligence framework development (Table 5) reveals significant performance variations across key metrics including industry/domain precision, KITs/KIQs relevance, source quality, and methodology adherence. Gemini Pro Experimental 2.5 demonstrated exceptional consistency, achieving perfect scores across all dimensions with its comprehensive understanding of the NHS context, highly specific intelligence questions with clear decision-making connections, extensive source recommendations, and systematic methodological approach. Claude 3.7 followed closely with very good overall consistency (4.25/5), showing particular strength in methodology adherence while maintaining strong performance across other metrics. ChatGPT o1 achieved solid consistency (4.0/5) with an operational focus and effective implementation guidance. The middle tier included Grok (3.50/5) and Qwen QwQ (3.25/5), which showed good performance in certain areas but lacked the comprehensive depth of the leading models. DeepSeek R1 demonstrated more variable consistency (2.75/5) with acceptable industry identification but weaker information source quality. LLaaMA 3.3 consistently underperformed across all dimensions (1.50/5), offering generic approaches lacking NHS-specific insights.

To ensure an objective perspective on the self-consistency test results, we conducted a qualitative human verification of individual outputs related to planning within the competitive intelligence process, including the alignment with intelligence requirements and the proposed data and information sources. We can confirm that the Gemini Pro Experimental 2.5 model provided not only a comprehensive perspective deconstructed into distinct topics and questions but also an optimal source foundation with demonstrated expertise. Regarding structure and reasoning from the perspective of utilizing alternative models, we can similarly affirm the relevance of KIQs/KITs including optimal sources, noting that Claude Sonnet 3.7 and ChatGPT performed with highly qualitative responses where the differences were minimal. This quantitative assessment confirms Gemini Pro Experimental 2.5 as the optimal model for healthcare competitive intelligence applications based on its exceptional consistency and depth across all evaluation metrics, with Claude 3.7 and ChatGPT o1 representing strong alternatives with slightly different emphases in their respective frameworks.

4. Limitations and Future Research

This study faces several limiting factors. The most significant constraint lies in the use of a single test dataset—albeit a real-world one—which consists of verbatim transcripts of individual members of a company's management team. Due to the clear identification of each speaker within the meeting transcript, it was possible to structure the document without any significant issues. However, future testing will focus primarily on more complex and less structured recordings, including those with intricate dialogues, frequent speaker changes, and abrupt transitions. Subsequently, we aim to explore real-time transcription followed by immediate input analysis. It's clear that all above-mentioned methods must be conducted with the highest care regarding data protection, specifically personal and sensitive data such as names, contact information, locations, interior elements, and similar.

The overarching objective is the development and conceptualization of a Competitive Intelligence Agentic AI Ecosystem, in which autonomous agents, informed by initial Key Intelligence Topics (KITs) and Key Intelligence Questions (KIQs), will be capable of addressing specific tasks leading to informed decision-making. A notable limitation, already partially acknowledged, is the reliance on a single dataset. This is particularly significant in light of the need to compare different domains and observe how large language models (LLMs) respond to varying types of content.

Table 3: LLM Competitive Intelligence Planning Framework Comparison

LLM	Issue Prioritization	KITs/KIQs Specificity	Impact Prediction	Operational vs. Strategic
Claude 3.7	1) Workforce, 2) Quality/Safety, 3) Integration, 4) Sustainable Improvement	High: Detailed KIQs; Clear timeframes; 8 KIQs/4 KITs	Strong: Links to outcomes; Includes update requirements	Strategic (70/30): Long-term planning; System integration
DeepSeek R1	1) Workforce, 2) CQC Compliance, 3) Staffing Ratios, 4) ICS Alignment, 5) Financial	Medium-High: Targeted KIQs; Concise commentary; 10 KIQs/5 KITs	Moderate: Links to board concerns; Limited impact details	Balanced (50/50): Equal operational/strategic focus

LLM	Issue Prioritization	KITs/KIQs Specificity	Impact Prediction	Operational vs. Strategic
Gemini 2.5	1) Regulatory, 2) Workforce, 3) Clinical Service, 4) Governance, 5) Market Dynamics	Very High: Extensive detail; Comprehensive requirements; 8 KIQs/5 KITs	Strong: Detailed applications; Explicit connections	Strategic-Leaning (60/40): Long-term compliance; Some operational focus
Grok	1) Workforce, 2) Service Delivery, 3) Positioning, 4) Compliance	Medium-High: Concise KIQs; Structured ratings; 8 KIQs/4 KITs	Moderate: Links to planning; Limited application details	Balanced (50/50): Equal immediate/future focus
ChatGPT o1	1) Workforce/Staffing, 2) Quality/Compliance, 3) Market Dynamics, 4) Financial, 5) Culture	High: Clear KIQs; Detailed commentary; 10 KIQs/5 KITs	Strong: "Next Steps" section; Board-level ownership	Operational-Leaning (40/60): Immediate challenges; Real-time needs
LLaaMA 3.3	1) Workforce, 2) Patient Safety, 3) Financial, 4) Governance, 5) Compliance	Low: Generic KIQs; Minimal commentary; 15 KIQs/5 KITs	Weak: General mentions; No timeframes; Generic requirements	Balanced but Generic (50/50): Low specificity overall
Qwen QwQ	1) Workforce, 2) Quality/Compliance, 3) Governance, 4) Market/Policy, 5) Resources	High: Detailed formulation; Clear timeframes; 10 KIQs/5 KITs	Strong: Strategic priorities; Regulatory connections	Strategic-Leaning (60/40): Long-term focus; Some immediate needs

Table 4: LLM Situational Analysis and Source Comparison

LLM	Situational Analysis	Source Relevancy & Specificity	Typical Sources Emphasized
Claude 3.7	High: Detailed health-sector context; Specific regulatory status; Referenced facilities	High: KIQ-specific sources; Balanced primary/secondary mix; Well-categorized	NHS Improvement resources; Clinical audit data; Board evaluations; Peer networking
DeepSeek R1	Medium-High: Workforce focus; Demographic risks; Limited opportunities discussion	Medium: Brief descriptions; Limited differentiation; Partial KIQ coverage	NHS retention pilots; CQC repositories; ICS workforce reports; Annual reports
Gemini 2.5	Very High: Comprehensive context; Specific metrics; Detailed problems/risks/opportunities	Very High: Extensive detailing; Multiple categories; NHS ecosystem-specific	CQC longitudinal analysis; NHS employer resources; Board papers; ICS documents
Grok	High: SWOT-like structure; Post-COVID context; Specific operational metrics	Medium-High: Good specificity; Internal/external mix; Limited application explanation	Internal data; NHS England guidance; HSJ reports; Financial statements
ChatGPT o1	High: Thorough analysis; Well-organized SWOT; Budget pressures; Morale issues	High: Detailed listings; Effective categorization; Data systems and stakeholders	E-roster platforms; CQC reports; Financial forecasts; Staff surveys
LLaaMA 3.3	Low: Generic analysis; Minimal context; Standard categories; Limited NHS-specificity	Low: Generic categories; Non-specific sources; No internal/external distinction	Generic "Trust departments"; Unspecified reports and data sources
Qwen QwQ	Medium-High: Good KIT-level analysis; Specific issues; Clear regulatory context	High: Specific recommendations; Balanced internal/external; Detailed categories	HR reports; NHS workforce intelligence; Dashboard metrics; Financial modeling

Table 5: Self-Consistency Analysis of LLM Responses for Competitive Intelligence

LLM	Industry/Domain Precision	KITs/KIQs Relevance	Source Quality	Methodology	Overall Score
Gemini 2.5	5/5: Comprehensive organization‘s context; Detailed regulatory understanding	5/5: Highly specific KIQs; Clear decision-making links	5/5: Extensive specific sources; Primary/secondary balance	5/5: Strong CI practices; Systematic approach	5.00/5
Claude 3.7	4/5: Clear context; Good regulatory understanding	4/5: Well-structured; Strong conceptualization	4/5: Comprehensive sources; Good categorization	5/5: Strong methodology;	4.25/5

LLM	Industry/Domain Precision	KITs/KIQs Relevance	Source Quality	Methodology	Overall Score
				Professional structure	
ChatGPT o1	4/5: Thorough context; Good operational focus	4/5: Operationally-focused; Clear implementation	4/5: Well-structured sources; Good tool integration	4/5: Good methodology; Effective "Next Steps"	4.00/5
Grok	4/5: Clear identification; Good clinical focus	3/5: Well-balanced; Limited implementation detail	3/5: Appropriate mix; Limited application explanation	4/5: Systematic approach; Some depth limitations	3.50/5
Qwen QwQ	3/5: Good identification; Limited specifics	4/5: Well-organized; Good conceptualization	3/5: Balanced recommendations; Less comprehensive	3/5: Good organization; Some methodology gaps	3.25/5
DeepSeek R1	3/5: Correct focus; Limited details	3/5: Good alignment; Limited implementation	2/5: Brief descriptions; Partial coverage	3/5: Basic structure; Limited integration	2.75/5
LLaaMA 3.3	2/5: Basic identification; Minimal context	1/5: Generic KIQs; Minimal conceptualization	1/5: Vague sources; No NHS-specific context	2/5: Limited application; Significant gaps	1.50/5

5. Conclusion

The presented study aimed to demonstrate the potential of large language models (LLMs) within the competitive intelligence (CI) process, specifically focusing on initial situational analysis and the subsequent formulation of Key Intelligence Topics (KITs) and Key Intelligence Questions (KIQs), including the proposal of relevant data and information sources. For this purpose, seven LLMs were selected: Claude Sonnet 3.7, DeepSeek R1, Gemini Pro Experimental 2.5, Grok 3, ChatGPT o1, LLaMA 3.3, and Qwen 2.5.

A critical component of the study was the construction of the input prompt, which each model used to respond to the transcript of a real-world management meeting within a public-sector organization. The findings suggest that LLMs can contribute effectively to the identification of key organizational challenges and the subsequent formulation of overarching intelligence themes (in the form of KITs), as well as the development of more specific intelligence questions (KIQs).

Moreover, the research offers a comparative analysis of the models in terms of similarity, relevance, and consistency of their responses. Based on the study's findings, the most effective models for CI-related processes, at the time of the research, appear to be Google Gemini Pro Experimental 2.5, Claude Sonnet 3.7, and ChatGPT o1.

Ethics declaration The author declares the study does not include any personal or sensitive data.

AI declaration The use of AI in this paper, particularly large language models, is fully documented in the Methodology section. Furthermore, Claude Sonnet 3.7 and ChatGPT 4o assisted the author in various stages of writing, including proofreading, language refinement, and bibliography formatting. All content was critically reviewed and edited by the author, who takes full responsibility for the final version of the manuscript.

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Unlocking the Business Value of Dark Data: The Importance of Data Governance

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Abstract: Hidden amongst data is dark data; unstructured, unanalysed and typically unused data. Dark data is a complex phenomenon as it is typically difficult to access, lacks meaning without human interpretation, yet could add value and benefit to an organisation. Alternatively, a risk of not activating dark data for an organisation could be inaccurate data used for decision making. Dark data provides the opportunity for building knowledge and in turn, can provide a competitive advantage. Whilst awareness of the value of dark data is increasing, accessing and effectively using this data is not straightforward. Dark data engagement brings with it challenges of how to access this data, how to convert this data for it to be usable and who will be accountable to ensure appropriate use of such data. This paper argues that data governance will be necessary to unlock dark data, control the conversion of dark data to usable data and manage appropriate use of such data. This paper also argues that not unlocking dark data may mean business decision-making may be at risk of not having an accurate base to inform decisions. Appropriate use of dark data aims to maximize benefits for a competitive company, but these organizations will need data governance to control and manage how this data is used. This paper will examine data governance to reduce risks associated with dark data, ensure security and integrity of all data, protect data from misuse, and improve dark data processing.

Keywords: Dark data, Data governance, Quality, Security, Unstructured, Big data

1. Introduction

There is almost no limit to the kinds and amount of data that can now be collected (Eryurek et al., 2021). Statista (cited in Duarte 2024) reported that the latest estimates indicate that throughout 2024, approximately 147 zettabytes of data will be generated encompassing newly created, captured, copied, and consumed information. By the end of 2025, the global volume of data is projected to rise further to 181 zettabytes. The challenge for managers and directors of companies will be to manage this amount of data and reduce the risk of increasingly unused or misusing data. Effective data governance will be the key to addressing this challenge.

A variety of data governance definitions have been presented in recent literature. Currently, there is a lack of consensus for use of a consistent definition of data governance. Some use data governance interchangeably with the term information governance (Black et al., 2023). However, according to Bennett (2017) information governance differs from data governance. Bennett (2017) explains that data governance is a subset of information governance and only refers to data. In comparison, information governance includes considering the context of data which then becomes information. This paper will focus on data governance.

Abraham, vom Brocke & Schneider (2019) undertook a literature review of 145 published papers examining definitions. They provided a definition of data governance based on a cross-functional framework for managing data. Like other authors, Abraham, vom Brocke & Schneider's (2019) definition included a variety of aspects of data governance. Defining data governance commonly includes the notion of control of data (Abraham, vom Brocke & Schneider, 2019; Bennett, 2017). Control is asserted through decisions about rights and accountabilities in managing data (Benfeldt, Persson & Madsen, 2019; Bennett, 2017). Control through authority (Abraham, vom Brocke & Schneider, 2019; Bennett, 2017) often referred to as roles and responsibilities (Benfeldt, Persson & Madsen, 2019;) is the process of determining which people in an organisation will have the decision-making power of data governance (Al-Badi, Tarhini & Khan, 2018; Bennett, 2017). Those with authority alternatively are also accountable (Benfeldt, Persson & Madsen, 2019) for ensuring data governance is implemented and adhered to by others in the organisation.

Accountability for data governance includes conforming to regulations, standards and internal policies (Abraham, vom Brocke & Schneider, 2019; Al-Badi, Tarhini & Khan, 2018; Bennett, 2017, Chukwarah et al., 2024). Internal policies are particularly important for governing human behaviour within an organisation. Human behaviour demonstrating appropriate management and use of data is an expected outcome of positive and effective data governance (Benfeldt, Persson & Madsen, 2019). To determine if accountability for data

governance has been achieved, data governance management should be monitored for compliance to policies and regulations (Abraham, vom Brocke & Schneider, 2019).

2. Shedding a Light on Data

Data that organizations collect is either structured or unstructured in nature where the latter is referred to as dark data (Ajis & Baharin, 2019; Imdad et al., 2020). Structured data can be accessed and analyzed using data mining tools as it is stored in relational databases (Imdad et al., 2020). This data can be categorized as business-critical data being important to the organization or redundant, obsolete and trivial (ROT) data. ROT data has little or no value to an organization as it is either duplicated or once useful but is now no longer required (Imdad et al., 2020).

The alternative data type is unstructured data. It is estimated that unstructured data (dark data) represents an estimated 70% to 90% of all enterprise data (Mesaglio & LeHong, 2024). Unstructured data is increasingly complex and includes instant messaging, short message service text, electronic mail, spreadsheets, XML files, voice, video, and social media interactions (Baker and Sjoberg, 2018; Henderson, 2017) and does not have a pre-defined model or structure (The University of Queensland, 2021; Henderson, 2017). Unstructured data has the characteristics of unstructured information or meaning, making its analysis difficult as the content and data value is buried inside the unstructured data requiring human interpretation (Ajis, Zakaria & Ahmad, 2022; Ajis & Baharin, 2019). The inability to access data puts the accuracy of the current approach used for data analysis at risk, which may lead to poor decision making based on incomplete or incorrect data (Ajis, Zakaria & Ahmad, 2022).

An additional issue with dark data is any negative perceptions and beliefs of those in the company or organization. Dark data may be considered in some organizations as too old to be of value, or of limited value because it is in a format that cannot be accessed with available systems or tools (Edwards et al., cited in Azeroual, Nikiforova & Sha, 2023). Generally, it is not even known whether these data exist (Azeroual, Nikiforova & Sha, 2023). However, Gimpel (cited in Azeroual, Nikiforova & Sha, 2023) says dark data can represent one of an organization's greatest untapped resources, especially when data are increasingly becoming an important asset. Data governance provides the ability build trust in data providing guidance on how data is collected, analyzed, published or used (Eryurek et al., 2021; Ajis & Baharin, 2019).

3. Method

A comprehensive literature review approach was implemented using multiple databases including Science Direct database, Web of Science, Scopus, Proquest and Google Scholar. Key words found in the title and or abstract of published articles were included in the inquiry. Key words used to find the data were “dark data” OR “secondary use of data” OR “big data” OR “metadata” AND “governance” OR “data governance”. Commencing the search for suitable sources, included the criteria of using empirical studies. This criterion was extended to include other types of articles due to dearth of research. Discussion papers, expert opinions and all literature reviews were also included to ensure collection of data about concepts, procedures and strategies useful for contemporary data governance knowledge. At all stages of data collection and extraction, discussions, deliberations and consensus were achieved between both authors to ensure rigour to this inquiry (Paul and Criado, 2020).

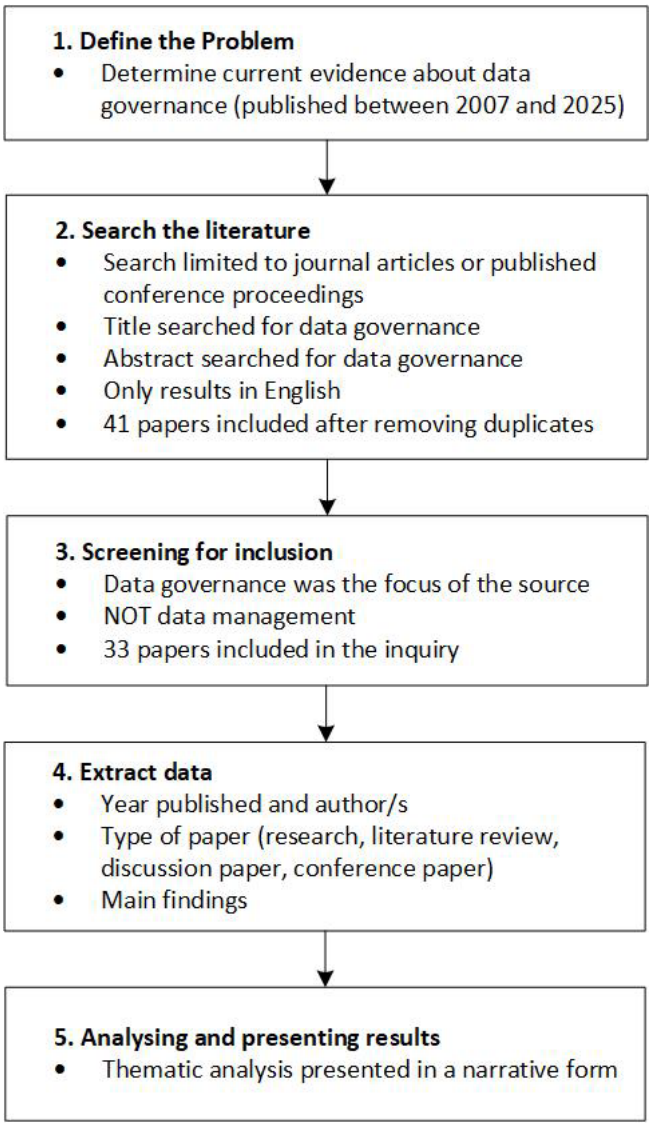


Figure 1: Flow chart of Research Method

4. Findings/Results

This inquiry implemented a comprehensive literature review with a final sample size of 33 published articles included in this study. This inquiry examined governance for secondary data (dark data). Key concepts identified that were important to data governance of dark data were data quality, data security, and data access.

5. Discussion

The viewpoint that data is a valuable resource has grown increasingly prevalent among business and Information Technology (IT) executives. Dark data is now seen as a business opportunity for further use of data, however there are challenges to work with dark data. Ashbel (2021) states that data governance, data compliance, and cost-efficient storage are three such challenges. Data governance is a set of policies and practices that an organization can establish to support their data management (Almeida, 2021) creating clear visibility into an organisation's stored data. Policies and procedures that govern data management will help eliminate inconsistencies from dark data (Azeroual, Nikiforova & Sha, 2023) and improve data quality, thus helping to reduce data management costs (Ashbel, 2021).

6. Data Quality

Data quality is key to effective decision making (Azeroual, Nikiforova & Sha, 2023; Black et al., 2023; Chukwurah et al., 2024; Gunawong, 2023). High-quality data can generate insights, promote knowledge and

contribute to business outcomes (Chukwurah et al., 2024). Alternatively, duplicated and other deficient data content, typically hidden in dark data can lead to poor data quality, creating inaccurate data leading to ill-informed decisions, loss of competitive strength and at worse, reputation damage (Azeroual, Nikiforova & Sha, 2023; Ajis & Baharin, 2019).

Contributing to data quality issues have been highlighted in the literature such as massive volumes and variety of data, high velocity, and various automatically generated data (Azeroual, Nikiforova & Sha, 2023). Poor data can be inconsistent, inaccurate, incorrect, or incomplete (Azeroual, Nikiforova & Sha, 2023; Gunawong, 2023) which usually also leads to the existence of duplicates, which in turn constitute data contamination (Azeroual, Nikiforova & Sha, 2023). Logically, dark data and duplicates, given their nature, need to be considered from different perspectives. Not only technological solutions are needed that would reveal poor- or low-quality data, but also organizational and cultural changes related to data management and governance within the organization will be necessary for increasing future use of dark data (Azeroual, Nikiforova & Sha, 2023).

As the volume of data continues to grow, further compounded by multiple sources of data, this will lead to increased storage costs to an organisation (Ajis & Baharin, 2019). This situation also increases duplication and along with non-unique data degrades data quality, resulting in inefficient and inaccurate data-based decisions (Azeroual, Nikiforova & Sha, 2023).

To mitigate the risks of poor data quality and to implement a proactive solution, data governance should commence with developing a data quality strategy (e.g., Abraham, vom Brocke & Schneider, 2019; European Foundation for Quality Management, 2011), including identifying roles and responsibilities definitions, and the reason for data quality management processes (e.g., Abraham, vom Brocke & Schneider, 2019; Malik 2013). The management of data quality should extend to data quality assessment (Azeroual, Nikiforova & Sha, 2023), the definition of data quality metrics (e.g., Abraham, vom Brocke & Schneider, 2019; Brous, Janssen & Vilminko-Heikkinen, 2016) and consistent measurement of data quality levels (e.g., Abraham, vom Brocke & Schneider, 2019; Azeroual, Nikiforova & Sha, 2023; Henderson 2017). The data quality strategy should consider how to achieve accurate, timely, complete and credible data (Gunawong, 2023). This governance strategy should also include how to manage and promptly address any data quality issues (Abraham, vom Brocke & Schneider, 2019; Henderson 2017) in a timely manner (Brous & Janssen, 2020).

Data governance establishes data management processes which can manage data quality (Azeroual, Nikiforova & Sha, 2023; Brous & Janssen, 2020). Azeroual, Nikiforova & Sha, (2023) suggesting data governance developing policies with transparent procedures to ensure quality assurance and management processes (e.g., data cleansing) and employment of Artificial Intelligence. Such procedures are designed to improve understanding of the data to use them more effectively and efficiently. Data governance is therefore able to address the challenge of data quality that is inconsistent, inaccurate, incorrect, or incomplete reversing this situation to achieve data accuracy, availability, completeness, consistency, and timeliness of data (Abraham, vom Brocke & Schneider, 2019; Azeroual, Nikiforova & Sha, 2023).

7. Data Security and Data Access

Data security is the practice of safeguarding organizational information against theft, cyberattacks, and data breaches due to unauthorized access (Wong & Norbaini, 2024). Dark data typically has widespread duplicated content without explicit oversight which weakens security (Ajis & Baharin, 2019). Data sharing is increasing both internally and externally to enhance transparency, inclusivity and productivity (Chukwurah et al., 2024). With the use of big data, hackers have multiple potential entry points leading to leaked data, lost, stolen, or breached dark data. To stop intruders from accessing or stealing data, security measures must be in place at all sites where sensitive data is stored (Wong & Norbaini, 2024). If security is not controlled damaged reputations as well as loss of competitive advantage for the organization can result (Ajis & Baharin, 2019). Data governance to enhance security is essential for protecting the company's data.

Protecting the company's data is an evolving process requiring the organisation to be agile as changes in IT and data requirements continue to occur. Contemporary business strategies to enhance productivity include examples like streamlining IT systems for greater transparency, end-user ease and sharing data. Sharing data occurs both internally between company departments as well as with external users such as third-party organisations. With the modern trend of increasing expectations for data management to remain agile, securing systems and in particular protecting data has become more complicated and requiring sound data governance.

Security measures must be incorporated into a data governance strategy to guarantee that no one has more access than is necessary to perform their duties, even at the data field level (Khatri and Brown, 2010; Wong & Norbaini, 2024). The early work of Khatri and Brown (2010) continues to be relevant when they argued that a data governance framework was essential to address data security, which included data access. Data governance should commence with risk analysis to identify data needs for different business departments ensuring the 'need for access' (e.g. Abraham, vom Brocke & Schneider, 2019; Khatri and Brown, 2010) to protect confidentiality and privacy. The need for access includes identifying who, when, how, and what access is permitted as well as who will be responsible for ensuring these guidelines are met (Azeroual, Nikiforova & Sha, 2023). Such data governance establishes the right of access and accountability for the process for securing the data, starting when data is created, and transferred between digital systems to where and to whom has the authority to access this data (both internally and externally) (Wong & Norbaini, 2024).

Data governance should align with laws and regulations. Appropriate security controls should abide by laws and regulations like the General Data Protection Regulation (GDPR) and the California Privacy Rights Act (CPRA) (Wong & Norbaini, 2024). By adhering to laws and regulations companies avoid non-compliance, enhance data quality, and reduce the risk of data being breached (Chukwurah et al., 2024). Regulations provide the foundation for policies, as compliance is essential. Complying to laws and regulations provides guiding principles that should be incorporated when writing and updating organisation's policies and procedures as well as monitoring for auditing purposes. This includes examining the use of policies and reported data issues and response to such issues (Abraham, vom Brocke & Schneider, 2019; Brous & Janssen, 2020; Palczewska et al. 2013).

A dependable and uniform structure provided by clearly articulated policies and procedures for handling and using data is the desired outcome from data governance policies (e.g. Abraham, vom Brocke & Schneider, 2019; Khatri and Brown, 2010; Wong & Norbaini, 2024). Policies for data governance aims to guarantee data security, accuracy, access and consistency of handling the data (Brous & Janssen, 2020; Wong & Norbaini, 2024).

Those authoring policies should aim for transparency of expectations for accessing and handling data appropriately both within the organisation and with external stakeholders (Chukwurah et al., 2024; Wong & Norbaini, 2024). Data governance through policies should apply to all facet of data management across the data lifecycle. This includes production including data quality; storage; upkeep; usage including access and appropriate use; and disposal of data (e.g. Eryurek et al., 2021; Wong & Norbaini, 2024).

Further detail required in data governance policies when establishing data security controls in data governance (Abraham, vom Brocke & Schneider, 2019; Tallon, Ramirez & Short, 2014) should include data security roles (e.g. Abraham, vom Brocke & Schneider, 2019; Khatri and Brown, 2010) and applying industry and government standards (e.g. Abraham, vom Brocke & Schneider, 2019; Khatri and Brown, 2010). Finally, the data governance policy for data access should outline the organisation's response plan if data is accessed without authorisation or used inappropriately (Wong & Norbaini, 2024).

Timely addressing data breaches starts with clear procedures of what one should do to minimise possible hazards or an actual breach (Chukwurah et al., 2024; Wong & Norbaini, 2024). Certainly, companies that use data governance to implement risk management, put security measures in place and continue to monitor and identify any potential or actual breach will ensure that sensitive data is protected by lowering the risk of data breaches (Chukwurah et al., 2024; Wong & Norbaini, 2024). A strong data governance framework should specify what should be done to minimize harm and stop similar incidents in the future. Reports should be expected as part of the governance approach showing accountability (Chukwurah et al, 2024) and action to avoid further data management issues.

8. The Key to Successful Data Governance

Successful implementation of data governance frameworks depends on interrelated sets of factors. The underpinning factors commence with developing transparent and robust data governance policies (Ajis & Baharin, 2019) and customising the governance framework for things like big data (Kim and Cho, 2018). Addressing specific technological demands such as tailored quality standards and big data algorithms (Chandra et al. (2023) means that governance provides a purposeful and useful framework for managing the data. Along with solid quality data improvement, integrity and security controls are essential (Henriques et al. 2021). Security controls should include ensuring competencies in data privacy (Henriques et al. 2021) such as avoiding leaks of personal information (Kim & Cho, 2018). Other integrated factors that complement foundational

factors are data governance aligning with business goals, organizational structure, human and culture. Technical implementation factors all influence success of data governance.

Sound data governance considers how people impact on implementation of the governance framework and the resultant data management. The first organisational structure, human and culture factor to consider is employee perceptions of the value of using dark data and the trust in the resultant data driven decision (Alhassan, Sammon & Daly, 2019; Ajis & Baharin, 2019). Organisational factors need to provide guidelines of when and who should be clearly identified as the owner and user of the data in the governance framework (Brous & Janssen, 2020). When considering such detail, one should not forget to engage stakeholders in the process of developing a governance framework. Stakeholders are likely to be people both internal and external to the company. Data governance is likely to impact on both parties.

9. Conclusion

Increased productivity and positive business outcomes can be gained by organisations searching out dark data and optimising data use. Regardless of the benefits of using dark data, inaction to use data may be detrimental to a company working with incomplete datasets. As other companies become more efficient with data use, productivity is gained through the use of unused data resulting in greater accuracy of data. Those companies who are embracing dark data are likely to have a competitive edge. Others yet to embrace dark data will need solid data governance to assist with the conversion of dark data to useful data and gain quality datasets. When handling and using dark data, the original providers of the data (consumers, participants) should be protected, and data secured to protect the company. Data is used by people and as such organisational structure and culture factors are key to robust data governance. Dark data can potentially be a hidden gem and should be unlocked; but cannot be mined appropriately without data governance.

Ethics declaration: I did not need an ethical clearance for the research referred to in this paper.

AI declaration: I did not use an AI tool in the development of this paper.

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The Role of Doctors During Apprenticeships and Medical Residents in Knowledge Transfer in Teaching Hospitals

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Abstract: In the era of the knowledge economy, knowledge is the most important asset of an organization. Teaching hospitals are medical entities that provide healthcare services to patients. The specialized medical staff not only provides medical care, but also educates future healthcare professionals, while also conducts clinical research and supports the advancement of medical technologies. Knowledge transfer in teaching hospitals is essential to their growth and serves as a key operational goal. Future healthcare professionals undertaking apprenticeships and placements in teaching hospitals not only contribute to knowledge transfer, but also play a strategic role in addressing current and future challenges facing the healthcare system. The aim of this paper is to identify knowledge-sharing processes within teaching hospitals as part of the medical staff education system. The following research question was posed: Is the education of doctors during apprenticeships and residents an element of the knowledge transfer strategies of teaching hospitals? The analyses indicate that the training of doctors during apprenticeships and residency is central to the mission and strategy of teaching hospitals, particularly in terms of knowledge transfer and the development of intellectual capital. The analyses are professional by nature, conducted from the perspective of a certified auditor and long-term researcher of the operational challenges of hospitals as healthcare institutions. The reflections presented in this paper offer an important perspective on the conditions required for the development of teaching hospitals as institutions with intellectual capital capable of addressing global health challenges. The paper continues the author's previous research on the development of intellectual capital among staff in Polish teaching hospitals.

Keywords: Knowledge transfer, Doctors during apprenticeships, Medical residents**, I**ntellectual potential of hospital employees

1. Introduction

Human resources are the most valuable intangible asset of any healthcare organisation. In recent years, it has become evident that developing and effectively managing human capital and its associated knowledge is crucial. The rising average age of medical staff and their departure from the workforce may compromise the effective functioning of healthcare institutions and the efficiency of the entire health system. The significance of this issue was clearly illustrated during the COVID-19 pandemic. Thus, a key challenge for the healthcare sector is the education of the next generation of medical professionals. In this educational process, teaching hospitals play a leading role as institutions closely cooperating with medical universities. As specified in legislation, the responsibilities of teaching hospitals include not only the provision of healthcare services and health promotion, but also the following:

- conducting teaching and research activities,
- educating medical professionals,
- carrying out health-related tasks and implementing health programs,
- executing assignments commissioned by scientific institutions, social organisations, local authorities and other bodies,
- providing consultancy, expert opinions, and reference services to other entities (Law of 15 April 2011).

The founding bodies of teaching hospitals are most often medical universities. They oversee compliance with legal regulations, internal statutes, and organisational policies, as well as the purposefulness, cost-effectiveness, and reliability of the hospital's core functions. The tasks of preparing individuals for medical professions and providing continuing education are embedded in the statutes, which form the legal foundation for hospital operations. The statutes of a teaching hospital are adopted by its founding institution. Detailed rules regarding training in medical professions, together with the provision of health services and health promotion, along with access to necessary training infrastructure, are defined in agreements between teaching hospitals and medical universities.

2. Doctors During Apprenticeships and Residents in the Medical Education System

The framework for practising the medical profession and the sources of funding for doctors' work are regulated by law. Key legislative acts include:

- the Act of 5 December 1996 relating to the professions of physicians and dentists,

- the Act of 8 June 2017 relating to the method of determining the minimum basic salary of certain employees working in medical entities,
- the Act of 15 April 2011 relating to medical activity.

These legal acts define the rules governing medical practice, education, licensing, professional accountability, working hours, and remuneration, including how the lowest salaries in medical institutions are calculated.

The practice of the medical profession involves providing healthcare services by individuals with appropriate qualifications, confirmed by relevant documentation, including health assessments, disease diagnosis and prevention, treatment and rehabilitation, medical consultations, while also issuing medical opinions and certificates. The law also recognises medical education as part of medical practice. Physicians are required to engage in ongoing professional development, including postgraduate training, which encompasses both apprenticeships and specialized education. The postgraduate apprenticeship focuses on improving practical skills and deepening theoretical knowledge in specific medical fields. This apprenticeship must last no less than 12 months. It is carried out under a fixed-term employment contract dedicated to vocational training. During apprenticeship a doctor operates under the supervision of a specialized physician. The organisation, funding, and provision of conditions for postgraduate apprenticeships fall under the responsibility of the voivodeship marshal as part of governmental administration. Funding for the postgraduate apprenticeship is provided to the voivodeship marshal by the competent voivodeship governor based on a formal agreement between them. These funds are then transferred to the institution hosting the apprenticeship. The content of the postgraduate apprenticeship programme is defined by the Minister of Health.

A doctor may undergo specialized training in residency mode, which includes on-call medical duties specified in the specialized training program, under an employment contract with the training provider, for the duration necessary to complete all components of the program. This duration is set out in the official specialized training programme. The programme is reviewed at least every five years and updated as needed based on advancements in medical science by a panel of experts. The specialized programme must be approved by the Minister of Health. Residency positions are awarded and financed by the Minister of Health using state budget resources under the Minister's control (Law of 5 December 1996, Article 16j). Residency funding covers both salaries and social security contributions. Remuneration levels for various specializations within residency training are set by the Minister of Health. The doctor undergoing specialized training is supervised by a designated physician, known as the head of specialization.

Basic salary levels for apprentices and residents are also determined by the Minister of Health. According to the Act of 8 June 2017 relating to the method for determining minimum remuneration in medical entities, as of 1 July 2024, the salary for doctors in postgraduate apprenticeships will be PLN 6,798—an amount calculated by multiplying the job factor for apprentices (0.95) by the average gross monthly wage in the national economy for 2023 (PLN 7,155.48).

The Act of 15 April 2011 relating to Medical Activity sets out, among other things, the principles for conducting therapeutic activities, the rules for the functioning of healthcare entities, working time standards, and guidelines for monitoring both therapeutic activities and entities that provide them, including the execution of educational and research tasks. A healthcare entity established or operated by a medical university is required not only to provide medical care but also to fulfil obligations related to undergraduate and postgraduate education in the medical professions. It is also obliged to provide the university with access to organisational units and resources necessary for training.

As the aforementioned legal provisions illustrate, the rules for educating doctors during apprenticeships and residents are clearly defined: ranging from programme content, through remuneration frameworks, to the structure of the educational process. Since funding for the education of trainees and resident doctors involves public resources, its use is subject to oversight and accountability. Healthcare providers involved in education must account for such funding separately and disclose it in their financial statements.

The analysis of healthcare practice and the relevant literature reveals several challenges related to human capital management. Key negative trends contributing to staffing shortages and high turnover in healthcare institutions include:

- limited financial resources of healthcare providers,
- Numerous ongoing organisational and systemic reforms in healthcare,
- rising operational costs associated with maintaining the operational readiness for providing healthcare services (inflation, energy, pandemics),

- the long and highly formalized nature of medical education and continuous training,
- shortages in specific medical specializations,
- globalization and privatization of health services.

If human capital is acknowledged as the most critical factor in the effective operation and development of healthcare entities, then the education and upskilling of medical staff, particularly the younger generation, should be a top priority in all such organisations. This is especially true for teaching hospitals, which work in close partnership with medical schools at various stages of training. The complexity of medical education, its structured nature, the multi-level career path, while also the potential held by medical students all justify the conclusion that the training of doctors is an integral part of a broader talent management strategy. An overview of the definitions of talent presented in Table 1, including those used in the health services sector, may serve to confirm the validity of considering doctors during apprenticeships and residents as individuals with talent.

Table 1: Selected definitions of talent

Author	Definitions of talent
Kaczmarska A., Sienkiewicz Ł., 2005	Individuals with key skills, abilities, and even a gift.
Silzer, R., Dowell, B., 2010	Talent refers to those individuals and groups with the strategic competencies that enable a company to achieve its short and long-term goals. They exhibit the competencies that will add the most value to customers and in doing so, help to differentiate the organization from its competition.
Tansley C., 2011	A complex amalgam of employees' skills, knowledge, cognitive ability, and potential. Talent in an individual needs to be recognised as a complex and dynamic mix of such key characteristics.
Jędrych E., 2013	Talent is defined as a high-potential employee who contributes to the organization's value and enhances its current and future competitive position.
Cannon J.A., McGee R., 2015	Innate predispositions that determine individual success, competencies recognised and valued by organisations, and the initiation of activities aimed at discovering and developing exceptional qualities and skills.
Taha V. A., 2015	Talented people are considered the strategic asset of the organizations, and ability to identify, recruit, retain and deploy these employees is a prerequisite for sustainable competitive advantage and success.
Stuss M., 2021	Talent is shaped by ability, achievement, competence, adopted ideas, potential, while also the degree of commitment.

Source: Author's self-study based on literature.

Implementing Talent Management strategies for the health services organizations positively impacts the organization itself, the personnel, and the patients-beneficiaries (Mitosis, 2021) G. Ogden (2010, p. 80) is convinced that despite the "shrunken" budget, it is necessary to invest in developing talent because "healthcare organizations without the right processes in place to identify and develop talent will struggle to perform and compete at a high level in the new healthcare economy".

3. Teaching Hospitals as a Knowledge-Sharing Entity - Methodology of the Research

The aim of this paper is to identify knowledge-sharing processes within teaching hospitals as part of the medical staff education system. The conclusions were drawn based on available financial data from the financial statements of teaching hospitals, outlining the funding of education for doctors during apprenticeships and residents, relevant legal acts, and publicly available information on hospital websites.

The following research question was formulated: "Is the education of doctors during apprenticeships and residents an element of the knowledge transfer strategies of teaching hospitals?"

The research process included the following steps:

- analysis of legislation on the rules for the training of doctors, including trainees and residents,
- collection of financial statement data from the National Court Register (selected data from profit and loss accounts, explanatory notes, and other disclosures),

- compilation and selection of data illustrating costs and revenues related to the education of doctors during apprenticeships and residents, subsidies received for this purpose, and the number of doctors during apprenticeships and residents in the analysed period,
- application of selected structural and dynamic indicators to describe the relationship between total hospital revenues and revenues from educational subsidies, along with expert analysis of these financial relationships,
- identification of the role of human resources and intellectual capital in teaching hospitals in the education of future medical professionals and the processes of knowledge creation and transfer (based on literature and website reviews, while also synthesis),
- review of conclusions from selected research areas previously conducted by the author on the financial statements of hospitals and the intellectual capital of teaching hospital staff,
- conclusion of the study.

Clinical hospitals distinguish themselves among healthcare providers not only by the scope of specialized services they offer, but also by their significant roles in training medical professionals, conducting research and teaching, and fulfilling consultative, expert, while also other duties delegated by academic institutions, local authorities, or government bodies, hence their selection as the subject of this study.

There are numerous public rankings of healthcare providers, including teaching hospitals. One such ranking compiled a list of the 30 healthcare providers with the highest revenue from medical services. From this list, the 10 largest teaching hospitals were selected. (Jarosz, 2023) Clinical hospitals' operations are financed with public funds. The broader the scope of their activities, the greater the revenues generated from contracts with the National Health Fund and the Ministry of Finance. The selection of clinical hospitals with the highest revenues from the sale of medical services for the study reflects their recognition as the most important healthcare institutions in the training of medical personnel.

4. Practical Aspects of Knowledge Transfer in Polish teaching Hospitals - Results

The education of doctors during apprenticeships and residents is included in the operational scope of the hospitals analysed. The three stated missions of the teaching hospitals are particularly noteworthy:

- "Treating effectively, teaching well, and serving science",
- "We treat and educate with passion",
- "We save lives, we treat the sick, we teach the next generation",
- "The mission of the University Clinical Hospital is to provide health services at the highest level and to promote health, in conjunction with teaching and scientific research activities."

The missions of the remaining teaching hospitals analysed generally refer to the supreme value of human life and health.

In their statutes, teaching hospitals emphasize that one of their key objectives is, among other things: "the provision of health services and health promotion in conjunction with teaching and research activities," and their tasks include: "participation in the preparation of individuals for medical professions and the continuing development of professionals in medicine, nursing, and other healthcare fields." In these areas, the hospitals also express a willingness to collaborate with both domestic and international healthcare institutions, while also to educate and improve the skills of medical personnel.

Financial data was also collected from financial statements, particularly the income statement and accompanying explanatory notes for the years 2022 and 2023. The focus was on revenue from healthcare services, funds received for the education (salaries) of doctors during apprenticeships and residents, and the number of future medical professionals being trained. The relationship between these figures reflects the extent of the hospital's involvement in educational processes.

Information regarding the financing of medical education is disclosed in the financial statements of healthcare entities, particularly in the explanatory notes. These include data such as:

- the revenue structure of the medical facility,
- accrued income, and
- average annual employment, broken down into professional groups.

The level of detail in reporting on the training of doctors during apprenticeships and residencies varied across financial statements. Some teaching hospitals provided thorough descriptions, while others offered only limited

information. The relationships between the value of subsidies for training doctors during apprenticeships and residents and total income from operations are presented in Table 2.

Table 2: Funding for doctors during apprenticeships and residents

Hospital	Total revenue (thousands of PLN)		Subsidies for the training of doctors during apprenticeships and residencies (thousands of PLN)		Percentage of education grants in revenue (%)		Increase in value of grants (%)
	2023	2022	2023	2022	2023	2022	2023/2022
1	1,790,475	1,368,160	68,864	39,274	4	3	75
2	1,777,409	1,351,530	97,129	82,708	5	6	17
3	1,549,185	1,174,597	84,040	60,498	5	5	39
4	1,374,247	1,127,011	88,297	74,103	6	7	19
5	871,785	690,183	57,296	39,909	7	6	44
6	692,090	540,677	53,442	43,816	8	8	22
7	661,600	527,284	30,618	25,763	5	5	19
8	593,424	544,113	20,913	14,660	4	3	43
9	471,413	405,859	21,641	17,629	5	4	23
10	455,780	384,798	31,006	21,542	7	6	44

Source: Author's self-study based on financial statements of teaching hospitals

As the data on the scale of funding allocated to the training of doctors during apprenticeships and residents shows, it remains below 8% in both periods. A positive development is the 75% increase in funding at the teaching hospital with the highest level of sales revenue. In the analysed years, the share of funding for doctors during apprenticeships and residents in total income remained at a similar level, with growth ranging from 17% to 75% between periods. Of the ten teaching hospitals examined, only four provided detailed figures on the number of doctors during apprenticeships and residents in the explanatory notes to their financial statements. The proportion of trainees and resident doctors in 2023 at these teaching hospitals ranged from 10% to 14% of the total staff.

Revenue from the sale of healthcare services at teaching hospitals is financed through contracts with the National Health Fund (the payer) and through grants and subsidies from the Ministry of Health. Public funding of these activities creates a clear obligation to support the education of doctors as a critical resource within the healthcare system. The number of students in the field of medical and health sciences increased by 14% between 2019 and 2022, reaching 196,600 in 2022 and 202,800 in 2023 (a 3% increase). In 2022, students in this field accounted for 16% of the total student population. The increase in student numbers in medical and health sciences is likely to translate into a rise in the number of doctors during apprenticeships and residents in the coming years. (Report 2023)

5. Costs and Benefits of Training Doctors During Apprenticeships and Residency. Discussion on Results and Implications for Practice

Health systems worldwide are facing the major challenge of addressing complex population health needs. Key challenges include:

- ageing populations,

- globalization, pandemics,
- sustainable development tasks,
- the adoption of artificial intelligence in healthcare,
- robotization and emerging technologies.

It is essential that young, capable, and open-minded individuals choose careers as doctors, nurses and other healthcare professionals. Without investment in the education of young medical professionals, meaningful progress in medicine becomes difficult to achieve. The analyses presented in this paper show that teaching hospitals, as institutions closely connected to medical schools, are aware of these challenges. There is a clear need to intensify efforts in this area. Globalization has accelerated the pace of change, and therefore, activities related to the education of future medical professionals must also be accelerated. Greater investment in the resources needed to develop the sector's intellectual capital is equally necessary. Given the ongoing demographic decline, this will be a significant challenge. As the COVID-19 pandemic demonstrated, the long-term cost-benefit analysis clearly supports the conclusion that the benefits of strengthening education for doctors during apprenticeships and residents outweigh the costs. (Chluska, 2022)

Financial statements serve as a key source of information for stakeholders and informed decision-making processes. It is expected that by providing more comprehensive information about the education of future medical professionals, both medical universities and teaching hospitals will improve public communication and encourage future applicants to pursue medical careers. As shown in the author's previous research, the missions and strategies of teaching hospitals and their founding institutions (medical universities) indicate a strong alignment in the areas of intellectual capacity development and knowledge transfer. This contributes to a comprehensive approach to knowledge transfer strategy.

6. Conclusions and Future Directions

The analyses presented in this paper continue the author's ongoing appeal to strengthen and enhance the intellectual potential of teaching hospitals and medical universities as a foundation for healthcare transformation strategies in response to the challenges of the 21st century (Chluska, 2024). Recognising the role of the financial statements of teaching hospitals as a primary means of communicating with the public and stakeholders led to the conclusion that the current regulations regarding the disclosure of operational revenue, including education-related grants and employment data by professional groups, are implemented by the hospitals analysed at an average level of detail. It should be proposed that given the challenges faced by teaching hospitals in training and upskilling their medical personnel, such disclosures become more comprehensive and precise. Summarizing the findings in relation to the research question posed, it may be concluded that the education of doctors during apprenticeships and residents is part of the knowledge transfer strategies of teaching hospitals, albeit it requires further enhancement and better communication of results to stakeholders, including decision-makers in the healthcare sector. These activities are also in line with public expectations for transparency regarding the implementation of sustainable development goals. While teaching hospitals are not formally required to produce sustainability reports, it is the author's view that the current components of financial statements, particularly the explanatory notes, may serve as a platform for disclosures related to human capital development and enhancement, including the intellectual capital of doctors during apprenticeships and residents. The education of current and future medical personnel not only fulfills the goals of sustainable development on a global scale but also constitutes an obligation arising from coordinating international efforts to prevent pandemics and other global health threats. The globalization of health risks requires strategic actions at the global level.

Ethics declaration: No ethical permission was required to conduct the research. I conducted the research independently, based on the data available in the National Court Register. The data is public.

AI declaration: I declare that I have not used AI resources or tools.

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Sharing is Where the Heart is: A Mediation-Moderation Model of Trust and Generosity Influence on Knowledge Sharing in NPOs

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Abstract: Knowledge sharing plays a crucial role in the success of organizations, including those relying on the goodwill of their social actors, such as nonprofit organizations (NPOs). While knowledge-based management practices have been adopted in various types of NPOs, research still lacks a comprehensive understanding of the factors driving knowledge sharing, particularly the role of prosocial motivations. Trust, generosity, and team cohesion are recognized as key determinants of knowledge-sharing behavior, yet their interactions and combined effects in NPOs remain insufficiently explored. Following a research design grounded in Social Exchange Theory, this work examines how trust, generosity, and team cohesion contribute to knowledge sharing within Portuguese NPOs using a mediation-moderation model approach. Using survey data and structural equation modelling, we investigate how generosity and team cohesion mediate and moderate the relationship between trust and knowledge sharing. Our findings indicate that trust has a strong, positive impact on generosity and team cohesion, reinforcing its foundational role in knowledge-sharing dynamics. Furthermore, both generosity and team cohesion are positively associated with knowledge sharing. Notably, team cohesion plays a dual role by mediating and moderating the relationship between trust and knowledge sharing, amplifying its effects. Generosity, however, exhibits a more complex influence, serving as a positive mediator while also acting as a negative moderator in this relationship. These results highlight the nuanced interplay between trust, generosity, and team cohesion in shaping knowledge-sharing behaviors within NPOs. By uncovering such dynamics, this study contributes with valuable insights for both scholars and nonprofit managers, offering a deeper understanding of the mechanisms that foster effective knowledge-sharing environments in NPOs. The findings emphasize the importance of cultivating trust and team cohesion while managing the dual effects of generosity to optimize knowledge-sharing practices in nonprofit organizations. Our results show trust, team cohesion and generosity influencing KS in NPOs as not seen before, however, the present study is not free from limitations, such as the sample size, and the elimination of some variable items throughout the statistical analysis phase. We are aware that results apply to the specific context of Portuguese NPOs, therefore we invite colleagues to replicate the model in other geographies and, thus, test for national culture effects.

Keywords: Non-profit organizations, Trust, Team cohesion, Generosity, Knowledge sharing

1. Introduction

Knowledge is essential for all organizations (Davidavičienė et al., 2020; Santhose & Lawrence, 2023) such as firms and NPOs. NPOs aim at socioeconomic development, integrating business practices on knowledge-based management, and with concerns about expectations and achieving superior performance (Langmann et al., 2021; Latif & Williams, 2017). The success and level of competitiveness of organizations are associated with critical factors such as knowledge sharing (KS) (Syed-Ikhsan & Rowland, 2004). However, KS does not happen spontaneously, although it is part of organizational life, requiring effort between the parties (Jia et al., 2023). Knowledge emerges and is put into practice in social environments through interactions (Rooney, 2015), culminating in trust (Curado & Vieira, 2019). Trust influences the adoption of generous behaviors (Anand & Walsh, 2016; Glanville et al., 2016), it increases cohesion between team members (Paul et al., 2016) and has a positive and significant impact on KS (Chedid et al., 2020; Mei et al., 2024). Trust among employees facilitates the development of work in teams (Kumi & Copestake, 2022). Generosity promotes strong connections between individuals (Anand & Walsh, 2016), cohesion between team members (Yang & Lin, 2022) and KS (Albinsson et al., 2019; Dwidienawati & Abdinagoro, 2018). Team cohesion influences relationships among team members (Lu & Fan, 2017), increases the willingness to help each other, and share knowledge (O'Reilly & Caldwell, 1985; Xue et al., 2011), all part of being generous and benefiting to third parties (Glanville et al., 2016; Dwidienawati & Abdinagoro, 2018; Dwidienawati et al., 2018). Teams are central points for organizational structure, highlighting their relevant role to the organization's strategy, as well as for KS (Davidavičienė et al., 2020). Therefore, it is essential that NPOs focus on promoting conditions that facilitate KS in their teams (Toner & Martins, 2022). Literature and research on KS in the context of teamwork and within NPOs is scarce and limited (Toner & Martins, 2022), especially in Portuguese NPOs (Curado et al., 2023). Further research is required to determine

whether generosity and team cohesion mediate or moderate the relationship between trust and KS in specific NPOs. Literature on KS antecedents shows contradictory results (Zhao & Detlor, 2023) thus contributing to a research gap. **Therefore, we question the role of trust, team cohesion and generosity in influencing KS in Portuguese NPOs.**

In this study we address such gap by exploring the contribution of trust, generosity and team cohesion for KS in Portuguese NPOs, supported by the Social Exchange Theory (Blau, 1964). We use a linear structural equation modelling analysis approach using survey data to understand the relationships between trust, team cohesion and KS. Due to the previously discussed complexities, we then conducted a mediation-moderation analysis to explore further specific effects that can better support the research goals, aimed at in-depth theoretical and practical contributions.

2. Literature review

2.1 Trust

Trust has aroused greater interest in literature, attracting much attention on the role of trust in KS (Yuan et al., 2024). The willingness to share knowledge is higher when mutual benefits are anticipated (Michalová & Maršíková, 2023). Trust only develops if there is reciprocity between the parties in the exchange process (Urbonavicius et al., 2021). Trust concerns an individual's expectation regarding their initial exchange behavior, based on the deduction of positive intentions towards the other party, in a situation of uncertainty and risk (Molm et al.,2000). Such a perspective proposes trust is relevant to improve collaboration between teams in the organizational contexts (Noerchoidah et al., 2022). Therefore, it is imperative that team members cooperate, through sharing knowledge (Gonzalez & De Melo, 2021), in benefit of all parties (Syed-Ikhsan & Rowland, 2004). Trust is promoted by reciprocity (Leung et al., 2019), as well as being a fundamental indicator of KS between individuals (Capestro et al., 2024; Curado et al., 2025). Additionally, trust can be seen as a process through which behaviors are consolidated or weakened (Burke et al., 2007). Thus, trust is a strong premise for KS (Jinyang, 2015). Therefore, we propose:

Hypothesis 1 (H1): Trust is positively and significantly related to KS.

Trust is a fundamental element for practicing generous behaviors (Glanville et al., 2016). It is through trust that team members can overcome individual uncertainties and vulnerabilities (Rosendaal & Bijlsma-Frankema, 2015), replacing them with concern and affection (Chua, 2003). The more trust there is among employees, the greater the adoption of generous behaviors, such as graciousness and mutual assistance (Anand & Walsh, 2016; Glanville et al., 2016). Generosity means giving more than what is necessary (Rooney, 2015). Anand and Walsh (2016) classify salary increases, benefit packages and reward systems as generous acts carried out by employers, in return for the participation of their subordinates in achieving organizational goals. Thus, generosity is said to be beneficial for both parties involved (Anand & Walsh, 2016; Dwidienawati & Abdinagoro, 2018). Therefore, we propose:

Hypothesis 2 (H2): Trust is positively and significantly related to generosity.

NPOs benefit from informal networks, trust-based personal relationships among employees are important to facilitate development of work in teams (Kumi & Copestake, 2022). McEvily and colleagues (2003) mention that the topic of interdependence between individuals within teams is one of the greatest organizational challenges. Trust can exist at team level (Burke et al., 2007), facilitating cohesion between team members (Mayer et al., 1995). There is evidence of a positive influence of trust on team cohesion (Paul et al., 2016), with trust implying reciprocity (Noerchoidah et al., 2022). Thus, it is essential that organizations focus on applying strategies that aim to promote team cohesion (Wei et al., 2022). Since trust generates mutual identification, shared values and social exchanges, it contributes to the development of shared bonds among team members. Hence, trust in teammates is positively related to team cohesion (Kim & Ko, 2021), so, we propose:

Hypothesis 3 (H3): Trust is positively and significantly related to team cohesion.

2.2 Team Cohesion

Team cohesion regards a group phenomenon (Rovio et al., 2009) that comprises the perceptions of team members (Graupensperger et al., 2019). Team cohesion reflects the value that the individuals attribute to the sense of identification, highlighting the potential need to respond to the team's approval or disapproval (Hackman & Knowlden, 2014). Team cohesion, when high, can be associated with normative influences, as well as increased team performance (Rovio et al., 2009). KS is influenced by perceived social pressure (Hackman &

Knowlden, 2014) therefore, team members interactions and pressures play an influence in KS (Ng, 2020). Teamwork among co-workers positively influences NPO's cooperation in such a way as they outperform the non-collaborative NPOs in terms of productivity. Thus, cooperation shapes NPO staff performance (Oberai et al., 2023). Team cohesion is one of the team's defining characteristics (Wojciechowska-Dzięcielak, 2020). It plays a significant role in the relationships established between team members (Lu & Fan, 2017). It is through cohesion that team members tend to increase their willingness to help each other and share knowledge (Xue et al., 2011). In teams with high levels of cohesion there is a greater willingness to share knowledge due to pressure and trust established between its members (O'Reilly & Caldwell, 1985). Therefore, we propose:

Hypothesis 4 (H4): Team Cohesion is positively and significantly related to KS.

2.3 Generosity

Generosity regards an individual attitude or an action that goes beyond the call of duty (Rooney, 2015; Dwidienawati et al., 2018). It may be demonstrated by volunteering (Glanville et al., 2016). In recent years, studies related to generosity have been neglected in literature (Anand & Walsh, 2016). Anand and Walsh (2016) state that concepts such as philanthropy, volunteering and altruism refer to generosity. The effectiveness of teams depends on employees' willingness to share information, fostering cooperation. Generosity boosts employees' intrinsic motivation, and it is contagious; thus, the generosity of a few inspires replication of such behavior by others and creates a culture of kindness that provides numerous benefits (Stanley et al., 2023). Generous acts promote benefits to third parties (Glanville et al., 2016; Dwidienawati & Abdinagoro, 2018; Dwidienawati et al., 2018). However, Collet and Morrissey (2007) question the unilaterality of generosity; by sharing their knowledge, individuals hope that, in the future, their team members will reciprocate in the same way (Jinyang, 2015). There is a positive impact of generosity on KS (Albinsson et al., 2019; Dwidienawati & Abdinagoro, 2018). However, individuals do not always act generously due to empathy or altruism, but rather with the intention of enhancing their career status within of the organization (Michalová & Maršíková, 2023). Generous individuals benefit from giving (Collet & Morrissey, 2007). Considering that generosity is a positive attitude towards others, which involves an individual evaluation of the situation (Febriyana & Ridho, 2024; Lazăr et al., 2022), the better the assessment of the behavior, the greater the intention to practice it. Since generosity positively influences KS in profitable settings (Yu et al., 2024), we propose that it happens likewise in NPOs:

Hypothesis 5 (H5): Generosity is positively and significantly related to KS.

2.4 Knowledge Sharing

KS regards a set of behaviors, which include helping others. Even though it directly affects organizational results, KS is and extra-role behavior (Islam & Tariq, 2018). KS is crucial (Jinyang, 2015) for obtaining competitive advantage in organizations (Wojciechowska-Dzięcielak, 2020; Santhose & Lawrence, 2023). KS is important for team processes (Tung & Chang, 2011) however, it does not emerge spontaneously, but through mutual relationships (Chua, 2003) based on trust. It is hard achieving a compete balance between expectations, interests and objectives, making the issue of trust complex to manage (McEvily et al., 2003). A strong team cohesion is reflecting quality and quantity of its interactions (Lu & Fan, 2017) and plays an influence in KS (Ng, 2020). Thus, we propose:

Hypothesis 6 and Hypothesis 7: Team cohesion mediates (H6) and moderates (H7) the effect trust has on KS.

Trust is essential for acting generously (Anand & Walsh, 2016; Glanville et al., 2016) and overcoming individual uncertainties and vulnerabilities (Rosendaal & Bijlsma-Frankema, 2015). Being generous means willingness to give without expecting anything in return therefore, generosity has a positive impact on KS (Albinsson et al., 2019; Dwidienawati & Abdinagoro, 2018). However, considering SET, when an individual invests in a relationship, it is expected that the other party will reward them (Kim & Kim, 2021). Reciprocity aims for mutual support and trust, discouraging counterproductive behaviors, (Leung et al., 2019). Accordingly, the willingness to share knowledge is also higher when individuals anticipate reciprocity (Jeong et al., 2024; Michalová & Maršíková, 2023). Thus, we propose:

Hypothesis 8 and Hypothesis 9: Generosity mediates (H8) and moderates (H9) the effect trust has on KS.

Figure 1 represents our research model.

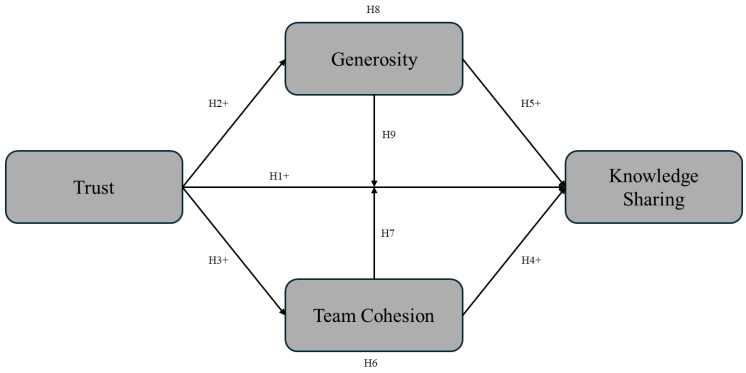


Figure 1: Research model

3. Research Method

This study follows a deductive approach and adopts a quantitative methodology using a cross-sectional survey of Portuguese NPOs. NPOs can encompass non-political and non-governmental organizations, through which no profit is made, holding responsibility for their stakeholders (Latif & Williams, 2017). The role and importance of NPOs has become increasingly evident, both nationally and globally (Latif & Williams, 2017). Data collection was carried out through a questionnaire survey prepared using the online platform Qualtrics. Data collection took place during the Spring of 2024. The KS scale is from Huang (2009) comprising 4 items. The team cohesion scale is from Wendt and colleagues (2009), consisting of 9 items. The generosity scale is from Carmeli et al. (2014) gathering 6 items. The trust scale is from Chow and Chan (2008) composed of 3 items.

This study uses a sample of 222 respondents of Portuguese NPOs. The sample, regarding these NPOs, was extracted using public databases provided by the Calouste Gulbenkian Foundation (2015), the Portuguese Environment Agency and the ONG.PT. Sample descriptives on NPOs indicate that there is a greater number of female individuals (72.1%), with the majority of the sample aged between 35 and 44 (27%) and 45 and 54 years old (33%). Most respondents have been practicing volunteering activities for 15 or more years (55%), accumulating them with another professional activity (55%).

To test the hypotheses in this study, we use a partial least squares (PLS) structural equation modelling (SEM) analysis, considering its ability to assess small and medium data samples (Chin, 2010). According to Wu and Hu (2012), the sample should be ten times the number of indicators of the most complex construct, or ten times the number of antecedents linked to an endogenous construct (team cohesion comprises 9 items). Given our sample size (n=222), the necessary conditions for conducting a PLS analysis are satisfied. PLS allows for an empirical assessment that combines a measurement model and a structural model (Hair et al., 2011), associating each construct with the items that measure it (Cepeda-Carrion et al., 2019). We used IBM SPSS (Statistical Package for Social Sciences) and SmartPLS 4.0 to run the analyses.

4. Results and Discussion

The initial measurement model evaluates the group of items that best represents each scale (Soh et al., 2017), considering each load value should be greater than 0.5 (Chin, 2010). Thus, 1 item from the team cohesion scale (TC1) and 2 items from the generosity scale (G3, G6) were eliminated. Subsequently, the reliability of the constructs was analyzed using Cronbach's Alpha and Composite Reliability, all of which meet or close to the minimum threshold (0.7) (Hair et al., 2011). Regarding convergent validity, it was assessed using the average variance extracted (AVE), confirming that all constructs have a value greater than 0.5 (Hair et al., 2011). Multicollinearity was also deemed a reduced threat, since factor inflation value is lower than 3 (Hair et al., 2019) or a 5 (Hair et al., 2011).

Evaluation of our research model was developed using the non-parametric bootstrapping approach (Chin, 2010), with a view to determining and precision of path coefficients, as well as testing hypotheses (Soh et al., 2017). Regarding the measure of model fit to the original data (R^2) and the internal measure of consistency between the original and cross-validation predicted data (Q^2), findings also show that the model predictive quality is above the recommended thresholds (Hair et al., 2011). The model fit to the original data shows high consistency levels for KS as the main dependent variable ($R^2 = 0.449$) with approximately 45% of its data variation explained by the model. Regarding the cross-validation prediction, findings show that all items in the model have predictive validity, ensuring further consistency ($Q^2 = [0.039; 0.506] > 0$). Table 1 presents and confirms the positive and

significant relationships for the significant threshold (p< 0.01 and p< 0.05). In agreement with the results obtained, there is evidence supporting that trust is positively and significantly related to KS (β=0.287, p< 0.05) generosity (β=0.0.524, p< 0.05) and team cohesion (β=0.800, p< 0.05). There is a positive relationship between generosity and KS (β=0.261 p< 0.05) and between team cohesion and KS (β= 0.224, p<0.05). Table 2 also provides an overview of the correlation information between variables.

Table 1: Path coefficients and p-values for the structural model

Relationship	β	T-test	p-value	Confidence interval (95%)	Hypothesis
Trust -> Knowledge sharing	0.224	2.122	0.034	[0.012; 0.425]	H1 (Supported)
Trust -> Generosity	0.524	8.727	0.000	[0.401; 0.633]	H2 (Supported)
Trust -> Team cohesion	0.800	35.190	0.000	[0.750; 0.839]	H3 (Supported)
Team cohesion -> Knowledge sharing	0.287	3.034	0.002	[0.110; 0.482]	H4 (Supported)
Generosity -> Knowledge sharing	0.261	4.501	0.000	[0.132; 0.362]	H5 (Supported)

Table 2: HTMT ratio with correlations

	Team cohesion	Trust	Generosity	Knowledge Sharing	Generosity x Trust	Team Cohesion x Trust
Team cohesion						
Conf	**0.885**					
Gen	0.627	**0.688**				
Partilha	0.606	0.664	**0.718**			
Generosity x Trust	0.231	0.414	0.369	**0.418**		
Team Cohesion x Trust	0.558	0.626	0.277	0.260	**0.510**	

Note: Correlations between variables are displayed on bold. "X" states the ration between variables under the moderation test.

The subsequent mediation-moderation analysis reveals contrasting results. The initial indirect specific effects pertaining to the role of team cohesion as both a mediator (H6) and moderator (H7) of the relationship between trust and KS show significant effects are significant (p<0.05). Therefore, trust exerts a positive effect to feelings of team cohesion that, in turn, also lead to KSs (β = 0.230; p < 0.05) (H6). Similarly, the stronger the feelings of team cohesion, the stronger the direct relationship between trust and KS is perceived (β = 0.184; p < 0.05) (H7). Nevertheless, contrasting evidence exists in the mediation-moderation role of generosity in the relationship between trust and KS (H8 and H9). Results show that, while generosity is a positive mediator between trust and KS (β = 0.137; p < 0.05), generosity is also a negative moderator of the direct relationship between trust and KS (β = -0.183; p < 0.05). Therefore, trust fosters a positive influence on generosity that, in turn, positively influences KS (H8). Nevertheless, high generosity exerts an influence between trust and KS, reducing the strength of such direct relationship (H9).

Results confirm the hypothesized relationships in this study. Trust is positive and significantly related to KS, supporting Hypothesis 1. Such evidence corroborates previous extensive literature across different settings (Yeboah, 2023) and extends it to the limited research on NPOs. Trust is the social support of relationships; thus it influences social exchange behaviors (Jinyang, 2015) in this case of behaviors of KS in the domain of NPOs. The positive and significant relationship between trust and generosity was also supported, confirming Hypothesis 2. This relationship corroborates the rationale that identifies the adoption of acts of generosity is fostered by the level of trust between individuals (Glanville et al., 2016). Hypothesis 3 was likewise confirmed, demonstrating evidence of a positive and significant relationship between trust and team cohesion. Trust is the basis for maintaining social exchange processes (Mitterer & Mitterer, 2023) and therefore contributing to team cohesion. High levels of cohesion are associated with trust established between its members (O'Reilly & Caldwell, 1985), namely within NPOs teams. Team cohesion positively and significantly influences KS, corroborating Hypothesis 4. Team cohesion builds on a sense of identification (Wojciechowska-Dzięcielak, 2020) that leads to extra-role behaviors (Maksum et al., 2020), like KS (Islam & Tariq, 2018), which are very relevant for NPOs. Results

demonstrate empirical evidence of a positive and significant relationship between generosity and KS, confirming Hypothesis 5. Individuals can benefit more than they lose from shared resources (Hatamleh et al., 2023). Thus, KS is an act of generosity, particularly relevant in knowledge-intensive organizations like NPOs (Holzer et al., 2016). In support of Hypotheses 6, team cohesion keeps the relationships among team members (Lu & Fan, 2017) leading them to share knowledge (Xue et al., 2011). In teams with high levels of cohesion there is a greater willingness to share knowledge due to pressure and trust established between its members (O'Reilly & Caldwell, 1985). Regarding Hypothesis 8 the evidence is very clear. The greater the trust, the greater the adoption of generous behaviors among individuals (Anand & Walsh, 2016; Glanville et al., 2016), because generosity involves a positive attitude towards others (Febriyana & Ridho, 2024; Lazăr et al., 2022) impacting on KS (Albinsson et al., 2019; Dwidienawati & Abdinagoro, 2018). Therefore, team cohesion and generosity, the greater the influence of trust on KS in NPOs (Oberai et al., 2023; Stanley et al., 2023). The results obtained from the moderation testing show that there is a positive moderation effect of team cohesion (supporting Hypothesis 7). Consistent with results from Hypotheses 6 testing, team cohesion plays a relevant role in the relationship between trust and KS. Team members interactions and social pressure influence KS (Ng, 2020). Mutual trust among team members emerges from social exchanges (Kim & Kim, 2021) through interdependent relationships (Urbonavicius et al., 2021) tending to be more positive and lasting in cohesive teams (Cohen et al., 2013; Maksum et al., 2020). Therefore, such evidence is only natural, yet important to occur in NPOs. Regarding Hypothesis 9 the evidence is not supportive, but rather interesting by unveiling psychological mechanisms. We can identify a valid parallel rationale. Altruism, being a trait closely related to generosity, has been found to reduce the positive association between trust and KS (Wu et al., 2009). This indicates that while altruism (and by extension, generosity) generally promotes KS, it might also alter the dynamics of how trust influences this process. Regarding relational dynamics, the relationship between trust and KS can be complex and influenced by various factors. For instance, integrity-based trust was found to have a negative effect on knowledge-seeking behavior in some contexts (Mohammed & Kamalanabhan, 2020). Such complexity suggests that different forms of trust and relational factors can interact in unexpected ways. Finally, the negative moderation may be due to complex interactions. Given that altruism can reduce the positive impact of trust on KS (Wu et al. 2009) it is plausible that generosity might also have complex interactions with trust. Previous research suggests that when individuals share knowledge purely out of altruism (a concept that presents behavioral similarities to generosity) a culture of complacency with knowledge might exist (cf. Sedighi et al., 2016; Yu et al., 2024). Such findings might posit an alternative route of psychosocial phenomena that can overcome the need for trust to achieve KS due to an altruistic status quo in NPOs – that of by default expectations of generosity among its members. We argue that generosity could potentially shift the focus from trust-based motivations to other forms of social exchange, thereby altering the direct impact of trust on KS.

5. Conclusions, Limitations and Future Research

This study uses the support of the social exchange theory to understand the relationships between trust, generosity, and team cohesion, and their impacts on KS among team members of Portuguese NPOs. Trust has the capacity to positively and significantly influence generosity and team cohesion, and the three have a positive relationship with KS. Our results show trust, team cohesion and generosity influencing KS in NPOs as not seen before. The present study is not free from limitations, such as the small sample size, possible due to the questionnaire response time. The elimination of some variable items throughout the statistical work may have biased the research results obtained. Results apply to the specific context of Portuguese NPOs, therefore we invite colleagues to replicate the model in other geographies and thus test for national culture effects. The transversality of data collection does not allow us to study the evolution of relationships between the variables; thus, we suggest future longitudinal developments to understand the dynamics of the model.

Ethics Statement: The research project was submitted to the Ethics Committee of ISEG – Lisbon School of Economics and Management, being in full compliance with ISEG's principles and rules regarding research ethics (Opinion 11/2024)

AI Statement: No AI or LLM tools were used in the draft or during data analysis procedures of the current work.

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Enhancing Knowledge Management and Strategic Foresight through Information and Communication Technologies

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Abstract: Knowledge Management (KM) and Strategic Foresight (SF) are essential for organizational growth, particularly in today's environment shaped by Information and Communication Technologies (ICT). This study conducts a literature review to investigate the effective integration of KM and SF practices with ICT. It addresses two key research questions: How can KM practices be incorporated into SF processes? How can ICT enhance the management of future-oriented knowledge through SF? The increasing complexity of organizational environments and the challenges posed by information overload and future scenario forecasting highlight the importance of this research. ICT serves as a crucial enabler, utilizing tools such as Big Data analytics, Artificial Intelligence (AI), and the Internet of Things (IoT) to optimize KM and SF practices. However, the integration of these technologies encounters significant barriers that require further exploration. The primary objective of this study is to map the current integration of ICT within KM and SF, emphasizing opportunities, limitations, and the potential contributions of AI to these processes. Utilizing a Rapid Review methodology, which streamlines the systematic review process to provide timely insights, the research involved searches in the Scopus database and a snowballing technique, resulting in an analysis of 12 selected articles. Findings indicate that ICT can significantly improve the efficiency and effectiveness of KM and SF processes, particularly in scenario-building and strategic decision-making. The study identifies specific tools and methods, such as collective knowledge systems and IoT frameworks, that organizations can adopt to enhance these practices. Future research should expand on this groundwork by including larger samples and practical studies to validate the proposed hypotheses. This study aims to encourage organizations to adopt ICT-based solutions, fostering sustainable competitive advantages in dynamic business environments.

Keywords: Knowledge management, Strategic foresight, Information and communication technologies, Future-Oriented knowledge management, Rapid review

1. Introduction

In today's dynamic business environment, Knowledge Management (KM) has emerged as an essential instrument for driving growth and innovation (Hijazin et al., 2023). Its importance lies in its ability to exploit and utilize organizational knowledge for strategic decision-making and competitive advantage (Vágner and Bencsik, 2022). However, Implementing KM systems is not quite simple. It presents many difficulties related to problems like information overload, maintenance workload, and how it affects the organization's ability to learn and develop new ideas over time (Hahn and Subramani, 2000). These challenges must be carefully managed to ensure the KM systems work well and last longer.

Implementing the use of Strategic Foresight is another complex topic that organizations have to look through. Many challenges make looking ahead and planning for the future difficult (Wayland, 2015). Industries constantly change, and predicting what will happen outside our control is hard. Traditional strategic management tools often need help to keep pace with structural changes, leaving decision-makers uncertain and ambiguous. As companies struggle with the complexities of KM systems and Strategic Foresight, Information and Communication Technology (ICT) can help make these processes less painful and more accurate (Da Silva et al., 2023). The rapid evolution of ICT has opened new frontiers for enhancing KM practices, with researchers increasingly turning to Artificial Intelligence (AI) for superior insights and outcomes. However, despite its potential, integrating ICT systems into KM processes still needs to be explored (Hahn and Subramani, 2000). With advanced data analytics, machine learning algorithms, and predictive modeling techniques, ICT can empower strategic foresight efforts by providing deeper insights, identifying patterns, and forecasting potential

outcomes more accurately (Wayland, 2015). Embracing ICT as a knowledge and strategic enabler is essential for enhancing the efficacy and resilience of KM process and Strategic Foresight in an ever-changing world.

This work comprehensively explores ICT systems within various domains. We have two main objectives: to reveal the current state-of-the-art literature and to demonstrate ICT's potential in enhancing both KM processes and Strategic Foresight. While existing research has widely examined KM itself (Iskandar et al., 2017), our goal is to integrate ICT into it, thus revealing new opportunities for organizational growth and innovation. This research offers insights for both researchers and managers and is a valuable help in navigating this evolving area of KM. Through a Rapid Review methodology (Cartaxo et al., 2018), we aim to provide practical insights to push organizations toward a future of sustainable success.

Following this introduction, the work is organized as follows: Section 2 provides the background with the necessary content to support this research. Section 3 presents the methodology used in the literature review, and Section 4 describes its results, presenting the answers to the research questions. In Section 5, the results are discussed. Finally, in Section 6, we present our conclusions.

2. Theoretical Background

In this section, we will briefly give some insights on the main subjects of this work: KM and Strategic Foresight.

2.1 Knowledge Management

KM has been widely introduced in academia by Nonaka and Takeuchi, who presented the SECI model for knowledge creation and conversion (Abdillah et al., 2024). This model distinguishes between tacit (unarticulated, non-verbalized, and intuitive) and explicit (articulated, specified by writing, drawing, among others) knowledge and illustrates the ways of knowledge transformation: Socialization (tacit to tacit knowledge, e.g., a chat between colleagues), Externalization (tacit to explicit knowledge, e.g., formalizing a body of knowledge in the form of a document or audiovisual media), Internalization (explicit to tacit knowledge, e.g., translating theory into practical activity), and Combination (explicit to explicit knowledge, e.g., combining, merging existing ideas) (Da Silva et al., 2023). With the increasing utilization of ICT systems, the KM process has become easier and more accurate (Tajudeen et al., 2022). These systems include a wide array of hardware, software, and networks that enable the collection, storage, processing, and dissemination of data and information.

2.2 Strategic Foresight

Futures Research is an interdisciplinary field that uses various methods to explore possible, plausible, and preferable futures (Da Silva et al., 2023). Its activities include the analysis of technology futures and impacts, aiming to formulate and test potential and desirable futures to facilitate decision-making, including analyzing how these conditions may change. Another important aspect of the information gathered from future studies is the increasing need for protection and security, which can be done with ICT (Tajudeen et al., 2022). Communication technology systems are crucial in safeguarding sensitive information through robust security measures, ensuring data integrity, confidentiality, and availability.

Recent research has begun to clarify how KM, Strategic Foresight, and ICT interact and reinforce one another. Existing literature indicates a dynamic interplay where KM processes enable organizations to capture and systematically use insights from Strategic Foresight activities. At the same time, ICT provides essential infrastructure and analytical capabilities to support these practices. Notably, frameworks have been proposed to illustrate how these three areas mutually enhance each other, promoting more informed and responsive strategic decision-making in rapidly changing environments. Additionally, empirical studies have highlighted the role of ICT in integrating internal and external knowledge sources, thus streamlining the translation of foresight into actionable knowledge.

3. Methodology

This section describes how we conducted the literature review. In this work, we used the Rapid Review methodology (Cartaxo et al., 2018), a form of literature review that simplifies the process of a traditional systematic review to produce scientific evidence in a timely manner.

Adopting the Rapid Review methodology is particularly suitable for this study as it allows for the rapid and rigorous synthesis of relevant literature within tight deadlines typical of conference-driven research. This method streamlines specific phases of the traditional systematic review by narrowing the search scope, utilizing focused inclusion criteria, and enabling faster data extraction without compromising scientific rigor.

Consequently, it provides timely insights into integrating ICT, KM, and Strategic Foresight, crucial for practitioners and researchers aiming for prompt and evidence-based decision-making.

Rapid Reviews are a condensed form of Systematic Literature Reviews (SLRs) designed to collect evidence more quickly (Tricco et al., 2015). Unlike SLRs, which may take months or even years, RRs are typically completed in weeks. They achieve this speed by narrowing the research scope, allowing a single researcher to select studies, and sometimes skipping specific rigorous steps found in SLRs, such as synthesizing results or reviewing a broad range of databases (Tricco et al., 2015).

Despite these shortcuts, RRs still adhere to a predefined protocol to ensure academic rigor. Because RR research questions are defined upfront, the process is more efficient and allows for targeted search terms and specific data extraction. This efficiency makes RRs a valuable tool when a faster turnaround is needed in evidence-based research (Khangura et al., 2012).

3.1 Research Questions and Search Process

In order to conduct a thorough review of the literature, we have identified our objectives and followed a protocol that outlines our research methodology. To address gaps in the existing literature, we have formulated two research questions (RQs) that will investigate how recent publications (from 2017 onwards) have characterized the application of ICT systems and KM techniques in the process of Strategic Foresight: how can KM practices effectively integrate into Strategic Foresight processes? (RQ1) How can ICTs be applied to manage knowledge about the future obtained during Strategic Foresight? (RQ2).

We defined the search string by combining terms relevant to the research questions, as presented in Table 1. These terms were in English, and we tested different combinations of keywords to see the range of results they produced. The searches were conducted in the Scopus database, focusing on articles published since 2017.

Table 1: Search string

TITLE ((“knowledge management” OR km) AND ((future* AND (stud* OR research)) OR (technolog* AND forecast*) OR (foresight))) OR KEY ((“knowledge management” OR km) AND ((future* AND (stud* OR research)) OR (technolog* AND forecast*) OR (foresight))) AND PUBYEAR > 2016 AND PUBYEAR < 2024 AND (LIMIT-TO (DOCTYPE , “ar”) OR LIMIT-TO (DOCTYPE, “cp”)) AND (LIMIT-TO(LANGUAGE, “English”))

We will also incorporate articles identified through snowballing techniques, specifically focusing on literature review articles found in the original search in Scopus. When conducting systematic literature studies, researchers often use a technique called snowballing. This technique involves using the references cited in a paper (backward snowballing) or the papers that have cited the paper (forward snowballing) to identify additional relevant sources (Wohlin, 2014). By using this approach, researchers can expand their search beyond traditional database searches and leverage existing literature connections. Snowballing is particularly useful for extending systematic literature studies because new studies often cite previously relevant papers or systematic studies already conducted in the area (Wohlin, 2014).

3.2 Selection of Studies and Quality Verification

The first step for selecting articles for this Rapid Review involved using the search string defined in Table 1 in the Scopus database. This search returned 172 documents. The filtering process of the articles is shown in Figure 1.

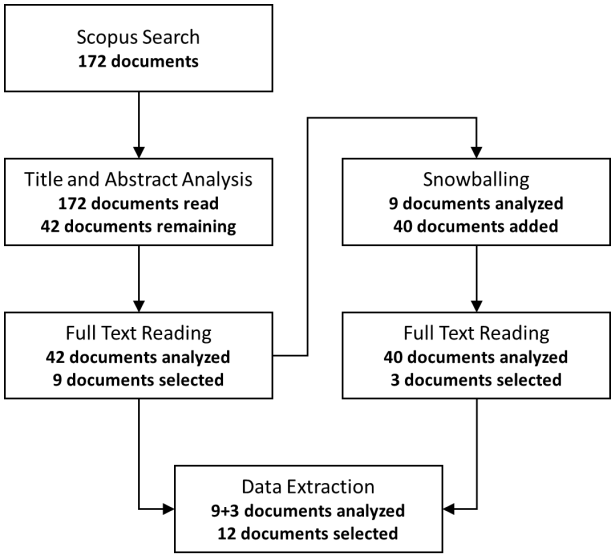


Figure 1: Rapid Review execution

Throughout the entire search process, the following exclusion criteria were used: studies that won't help answer at least one research question, studies written in languages different from English, studies published before 2017, studies not published in peer-reviewed journals or conferences, and studies unavailable for the complete reading step, usually due to some paywall.

From the 172 publications initially gathered in the Scopus search, we analyzed the titles and abstracts with the inclusion criteria, leaving only 42 remaining and 130 documents excluded. We thoroughly read these articles and excluded 33 documents, leaving only nine articles remaining. Then, we used these 9 articles as a source of the snowballing process. The snowballing process considered all the exclusion criteria mentioned and gathered an additional 40 documents. Then, we thoroughly read this new set of 40 documents, excluding 37 and keeping 3. Ultimately, we select 12 articles for data extraction (3 from the snowballing processes plus the other 9 used to gather documents for it) in this review. It is worth mentioning that we excluded 12 articles in the complete reading process due to the lack of access.

3.3 Data Extraction and Analysis

To gather all pertinent information from the selected articles, we employed a data extraction form. We retrieve data from the selected articles, addressing the aspects outlined in the form. Throughout this process, we aimed to determine whether the articles presented KM techniques and established a link between Communication Technology and KM. Additionally, we explored ways to integrate these techniques into the technological foresight process and how communication technology could manage future knowledge obtained in this technological forecasting process. The list of the 12 selected articles and the research questions each article answers is presented in Table 2.

4. Results

This section answers the research questions below, which have been formulated based on the selected articles and the information extracted so far.

4.1 RQ1 - How can KM Practices Effectively Integrate into the Strategic Foresight Process?

The articles selected to answer this first RQ were observed to have a similar approach. Of the 12 articles that came to the final stage of analysis, 8 addressed some relevant points for this topic. They spoke about using KM systems in the foresight process in every particular.

For example, Iandolo et al. (2021) used Collective Knowledge Systems in the Strategic Foresight process of predicting Black Swans, a sudden event with significant impact, frequently justified in hindsight despite its initial unexpectedness. Senaratne et al. (2021) brought to discussion the use of Social Network Analysis to identify knowledge flow, which can be used for companies to understand better how customers relate to each other and, therefore, use this information as leverage for designing new products, what Senaratne also named as Knowledge Network Analysis.

Using a similar approach, Da Silva et al. (2023), Hijazin et al. (2023), and Nascimento et al. (2021) developed the concept of knowledge capture and knowledge feedback serving as essential methods of identifying, organizing, storing, and transferring information obtained from a Strategic Foresight process leading to a better scenario building. Junior et al. (2019) suggest using a SWOT (Strengths, Weaknesses, Opportunities, and Threats) matrix in Strategic Foresight to ensure more effective use of the explicit knowledge obtained through future analysis and contribute to decision-making. Jari & Theresa (2017) use the triangulation logic systematic approach in foresight studies, which is used to expose meaningful information that has remained undiscovered in the data collection process.

Table 2: List of the selected articles

Title	Year	Author	RQs Answered
Identifying Knowledge Management Processes in Futures Research	2023	Da Silva et al.	RQ1
Moderating the Synergies between Business Intelligence and Strategic Foresight: Navigating Uncertainty for Future Success through Knowledge Management	2023	Hijazin et al.	RQ1 & RQ2
Integration of Industry 4.0 technologies and Knowledge Management Systems for Operational Performance improvement	2022	Lista & Tortorella	RQ2
The relationship between the Internet of Things and knowledge management in smart ecosystem development	2021	Ikeda et al.	RQ2
Combining Big Data and Artificial Intelligence for Managing Collective Knowledge in Unpredictable Environment—Insights from the Chinese Case in Facing COVID-19	2021	Iandolo et al.	RQ1 & RQ2
Dynamic interactions among knowledge management, strategic foresight and emerging Technologies	2021	Nascimento et al.	RQ1 & RQ2
Current trends and future directions in knowledge management in construction research using social network analysis	2021	Senaratne et al.	RQ1 & RQ2
Foresight and knowledge management. New developments in theory and practice.	2019	Bootz et al.	RQ1
A UNISON framework for knowledge management of university-industry collaboration and an illustration	2019	Hu et al.	RQ1
Approaching future-oriented technology analysis strategies in knowledge management processes	2019	Junior et al.	RQ1
The Internet of Things: Building a knowledge management system for open innovation and knowledge management capacity.	2018	Santoro et al.	RQ2
Knowledge management and triangulation logic in the foresight research and analyses in business process management	2017	Jari & Theresa	RQ1

Bootz et al. (2019) emphasize the link between KM and Strategic Foresight, highlighting this connection's central role in driving organizations' difficulties. They reinforce how KM practices are essential in generating technological innovation and sustaining competitive advantage in a scenario characterized by rapid knowledge obsolescence and constant innovation demands. Moreover, they argue that foresight – initially focused on cognitive anticipation – has evolved into a field of decision-making and action, focusing on better integration with strategy to prepare minds for change. The authors suggest that integrating thinking and action requires a deeper consideration of the cognitive elements in foresight processes.

Hu et al. (2019) emphasize how important it is for higher education institutions to use technology to manage knowledge effectively. By using ICT tools and platforms, universities can systematically collect, store, share, and disseminate valuable knowledge assets. The UNISON Decision Analysis Framework, combined with auxiliary management mechanisms and the plan–do–check–act (PDCA) cycle, exemplifies how ICT infrastructure can optimize decision-making and enhance productivity. Furthermore, the implementation of online learning platforms, cloud databases, and technology licensing mechanisms demonstrates a commitment to utilizing ICT for knowledge transfer and innovation among university employees and students.

4.2 RQ2 - How can ICTs be Applied to Manage Knowledge About the future Obtained During Strategic Foresight?

From the 11 pre-selected articles, 7 had relevant thoughts to answer the RQ2. Almost unanimously, the articles used Big Data or IoT. Hijazin et al. (2023) use Business Intelligence (BI) systems to provide a framework for utilizing acquired data to support the decision-making process in unpredictable environments, which facilitates building new scenarios. It also shows the correlation between BI and Strategic Foresight, offering an excellent mechanism for increasing companies' capacity to discern potential risks and opportunities. It also shows the powerful connection between BI and KM, highlighting how it could be crucial for organizations to transfer and integrate information. Senaratne et al. (2021) discussed applying Big Data analytics to improve interactions and enhance clusterization with Social Network Analysis. This approach enables the study of customer behavior using knowledge flow.

On the other hand, Nascimento et al. (2021) used a more generic methodology, calling these tools "emerging technologies," which can gather a whole amount of scenarios. He describes it as implying that these technologies impact both KM and Strategic Foresight, enabling a better decision-making process and showing that companies that develop these connections can achieve sustainable competitive advantage. With thorough research, Iandolo et al. (2021) explored the dynamics of utilizing Big Data and AI for collective knowledge applications. Adopting these instruments can help organizations improve their knowledge absorption capacity and combine it in innovative paths for future studies.

Going in the other direction, Santoro et al. (2018) make good use of the Internet of Things (IoT) phenomenon to develop a conceptual model proposing implementations of IoT with KM systems involving the exploration of ICT. This contributes to innovation management, which can increase business development and enable the implementation of disruptive ICTs in several processes, including Strategic Foresight. Ikeda et al. (2021) associated IoT and KM architecture to generate real-time collective knowledge, enabling the company's ecosystem to function in an interconnected and collaborative way. These IoT-associated applications, which are joined with Big Data, can manage information gathered from Strategic Foresight processes and help predict upcoming events.

Lista & Tortorella (2022) discussed the usage of KM combined with Industry 4.0 technologies, which are primarily about IoT enablers. They emphasize that Industry 4.0 plays a role in generating new knowledge during the design process. This concept can be applied to Strategic Foresight, using this fast knowledge acquisition to enhance event prediction.

Integrating the findings presented in sections 4.1 and 4.2 makes it clear that Knowledge Management and ICT play complementary roles in enhancing Strategic Foresight processes. The studies collectively suggest a coherent narrative: KM practices structure the identification, capture, and sharing of foresight-generated knowledge, while ICT provides robust analytical tools and platforms essential for managing and applying this knowledge effectively. Integrating Big Data analytics, Artificial Intelligence, and the Internet of Things into KM systems creates a powerful mechanism that transforms strategic foresight into actionable insights. Consequently, these technologies optimize internal knowledge processes and enable organizations to anticipate market changes and innovate proactively, thus bridging theoretical insights with practical organizational capabilities.

5. Discussion

Based on the results obtained, this section will discuss the most relevant topics for the future use of ICT in KM and Strategic Foresight processes.

5.1 What are the Opportunities for Expanding the use of ICT in KM and Strategic Foresight Processes?

Organizations can expand their ICT systems in KM and Strategic Foresight processes through several key steps. Firstly, they must evaluate their existing capabilities and pinpoint areas where ICT solutions can improve their KM and Strategic Foresight practices. Organizations might need to improve their ICT infrastructure, which could involve actions like investing in cloud computing and analytics platforms (Brandtner and Mates, 2021). AI and machine learning technologies are crucial for developing KM and Strategic Foresight processes, enabling organizations to analyze trends, mine data, and extract valuable insights. Integrating collaborative tools such as project management software and virtual collaboration platforms makes knowledge sharing and teamwork more accessible among employees (Brandtner and Mates, 2021). It's worth mentioning that companies should also invest in human-machine collaboration and Large Language Models (LLMs) to have an even greater improvement in KM and Strategic Foresight research processes, making the most of what AI can give.

5.2 What are the Limitations of the ICT Implementation in KM and Strategic Foresight Processes?

While ICT systems offer significant potential for enhancing KM and Strategic Foresight processes, we acknowledge a few limitations. Firstly, high implementation costs can become a barrier, especially for smaller organizations with limited budgets or in developing countries (Zhang and Huang, 2020). The complexity of ICT systems and the need for specialized workers to effectively utilize them also bring challenges. Many organizations may lack the necessary in-house talent or experience to fully leverage the capabilities of ICT systems in KM and Strategic Foresight (Zhang and Huang, 2020). Also, dependence on ICT systems can generate vulnerabilities such as cybersecurity threats and data privacy concerns, requiring defenses to mitigate risks, which will generate more money investments. In addition, the rapid pace of technological change may cause ICT investments to be obsolete within a short time, necessitating continuous updates and upgrades to maintain relevance.

5.3 The use of AI in KM and Strategic Foresight Processes

The literature reviewed reveals clear commonalities and contrasts in how AI supports KM and Strategic Foresight processes. Commonly, researchers emphasize AI's capability to enhance data analytics, pattern recognition, and predictive modeling, significantly improving organizations' abilities to anticipate future trends and capture strategic insights. However, there is also a notable contrast. While some studies emphasize AI's role primarily in automating knowledge storage and retrieval, others highlight its proactive application in generating innovative knowledge and enabling dynamic organizational learning. Thus, the synthesis of these perspectives suggests AI serves a dual role—both as a sophisticated repository manager and a proactive agent facilitating strategic innovation and adaptability.

Additionally, AI boosts the storage and retrieval of explicit knowledge by organizing and summarizing information from various sources, such as legal precedents or enterprise communication channels. Also, AI supports knowledge applications by providing faster access to relevant information and offering more intuitive interfaces, such as chatbots, for interacting with knowledge repositories, and that helps foresight by enabling organizations to harness the power of data-driven insights for informed decision-making and innovation (Jarrahi et al., 2023).

Other researchers have also addressed some insights on those questions. Yepes & López (2021) state that building on previous knowledge transforms beliefs and patterns, from which they conclude that the more capabilities an organization has, the greater its adaptation to technological changes will be. On the same page, Da Silva et al. (2023) say that organizations that manage their knowledge tend to perform better in Futures Research activities than those that don't because much of the necessary knowledge is already identified and explicit and that Futures Research can help identify, create, acquire, store, transfer, and use organizational knowledge, generating feedback to improve KM processes.

Speaking of ICT, Hijazin et al. (2023) discuss the amalgamation of BI and Strategic Foresight offers organizations a powerful mechanism for enhancing their capacity to grasp their current situation comprehensively, discern potential risks and opportunities, and make well-informed decisions that seamlessly align with long-term strategic goals. Their work also developed the hypothesis that KM plays an essential role in moderating the relationship between BI and Strategic Foresight as it serves as the foundation for Strategic Foresight initiatives by efficiently capturing, organizing, and managing information and also contributing to maintaining a long-term orientation by preserving institutional memory and providing support for strategic planning, while Senaratne et al. (2021), studied the relationship between KM and Social Network Analysis, and after reviewing more than 13,000 articles, brought up the concept of Knowledge Network Analysis technique, which is an extension of the Social Network Analysis with the implementation of Big Data analytics. Nascimento et al. (2021) also validate by introducing how emerging technologies can impact the usage of KM and Strategic Foresight. They say that such technologies can enable better decision-making, performance, and success for companies based on KM and strategic foresight as they can allow an upgrade in the very functions of Strategic Foresight and KM.

6. Conclusion

While this review highlights important insights from existing research, our analysis underscores the need for a more precise articulation of how Knowledge Management, Strategic Foresight, and ICT integration uniquely contribute to organizational advantage. From our viewpoint, the effective combination of these domains provides organizations with enhanced capability to anticipate future scenarios and leverage foresight-derived knowledge systematically through robust technological tools. Our structured synthesis emphasizes this

integrated approach as essential for organizations that sustain innovation, adaptability, and strategic responsiveness in rapidly evolving environments.

Integrating ICTs into KM and Strategic Foresight processes presents a promising avenue for organizations seeking to tackle the complexities of today's dynamic business environment. ICT systems can use advanced data analytics, AI, and predictive modeling techniques to enhance the effectiveness and endurance of KM and Strategic Foresight practices.

This work aimed to find the state-of-art literature on KM and Strategic Foresight united with ICT implications through a Rapid Review. The results obtained from the analysis clarify the effective integration of KM practices into the Strategic Foresight process and the application of ICTs in managing future knowledge. The findings reveal a common perspective among the selected articles, showcasing various methodologies and tools utilized to enhance KM within the context of technological foresight. Researchers have demonstrated innovative approaches to using information for better decision-making and scenario-building, from exploring collective knowledge systems to utilizing Big Data analytics and IoT. These insights highlight the importance of exploiting emerging technologies and methodologies to navigate the complexities of the future landscape effectively. By embracing these advancements, organizations can enhance their capacity to anticipate risks, identify opportunities, and achieve sustainable competitive advantages in an ever-evolving business environment.

This review makes contributions to integrating KM, Strategic Foresight, and ICT within organizational contexts. Firstly, it provides an up-to-date synthesis of existing literature, offering insights into the current state-of-the-art of this field of study. Furthermore, the review showcases different research approaches for enhancing KM and Strategic Foresight practices by identifying methodologies and tools, such as collective knowledge systems, Big Data analytics, and IoT. Our goal is to be useful for researchers when researching this relationship, to have answers to initial questions regarding ICT integration, and to gather the latest studied information on academia.

Unfortunately, we had some limitations during the work process. First, we highlight the scarcity of articles for the review. Only 12 articles made it through the final analysis on using ICT to improve KM and Strategic Foresight. Another limitation related to the first is the lack of practical studies to test a central hypothesis, with a broader range of studies and a comprehensive use of ICT utilization.

Although the RR has provided valuable insights into the use of ICT for KM and Strategic Foresight, there is an intrinsic limitation to this approach. RRs, by nature, have a constrained time frame, leading to a potentially limited scope and incomplete quality assessment. To address this limitation, future research should undertake a more comprehensive literature review, incorporating a broader range of sources, to explore other aspects of ICT applications in KM and Strategic Foresight. This would offer a deeper and more nuanced understanding, contributing to more robust strategic planning and decision-making.

We aim to provide a valuable resource for organizations that rely on KM or Strategic Foresight and are considering implementing new ICTs to improve their operational processes and boost efficiency. We have examined various studies and analyzed how different ICT tools can be integrated into KM and foresight practices. By doing so, we offer insights that can guide organizations in their technology adoption journey, helping them understand which technologies are most effective for their specific needs and how to implement them to maximize benefits. Whether organizations want to enhance collaboration, streamline workflows, or facilitate better data analysis, our work provides a foundational understanding that organizations can build upon. Ultimately, this will encourage more organizations to embrace ICT solutions, leading to improved decision-making and strategic outcomes.

Ethics Declaration: Ethical clearance was not required for the development of this research.

AI Declaration: AI tools such as Grammarly and ChatGPT were used solely for language revision. The authors' analysis and interpretations are their own.

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AI for Knowledge-Driven Business Decisions: Capabilities and Constraints

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Abstract: This paper presents experimental research evaluating the capability of generative artificial intelligence (GenAI) chatbots to assist business executives in their decision-making processes. With the growing prominence of large language models such as ChatGPT and Perplexity, there is significant interest in their potential for knowledge management (KM) and decision support, but empirical evidence is still lacking. This study conducted over 210 experiments using approximately 900 prompts to assess the performance of ChatGPT and Perplexity across various business decision tasks, including marketing analysis, work shift optimization, sentiment analysis, review of company financial and strategic documentation, and product marketing evaluation. The outputs generated by the chatbots were compared with traditional decision support methods, human expert analysis, and benchmarking data. The results indicate that GenAI chatbots can streamline processes by collecting, interpreting, and synthesizing data into actionable insights. Nevertheless, limitations were identified in handling complex file formats, response variability based on context framing, and the necessity for human validation of outputs. A comparative analysis of ChatGPT and Perplexity revealed distinct differences: ChatGPT demonstrated overall reliability but struggled with tabular data, whereas Perplexity provided more substantive yet occasionally less accurate responses. The findings suggest that GenAI chatbots could enhance decision efficiency through rapid analysis, but a collaborative human-AI model remains advisable to validate outputs and iteratively refine queries. Our study underscores the potential of GenAI for KM in guiding decisions while highlighting the need for further research on evaluation methods, integration with business intelligence tools, and the development of user guidelines for the responsible adoption of this technology.

Keywords: Applied knowledge management, Business decision making, Chatbots, Experiments, GenAI

1. Introduction

In recent years, artificial intelligence (AI) powered by large language models (LLMs) has gained considerable traction in both public and organizational contexts. Intuitive interfaces, natural language interaction capabilities, and cost-efficiency have positioned it as a promising technology for knowledge management (KM) applications (Alavi et al. 2024; Jarrahi et al. 2023; Kirchner et al. 2024; Nakash and Bolisani, 2024; Storey, 2025). These systems are increasingly viewed as potential decision-support instruments for business managers, owing to features such as multidimensional data analysis, interactive prompting, complex question answering, and the ability to synthesize new knowledge through the recombination of existing information (Shrestha et al. 2019). However, despite their growing visibility and adoption, there remains limited clarity regarding the actual efficacy of such systems in handling complex, domain-specific knowledge and facilitating high-quality managerial decision-making.

While current literature acknowledges the theoretical potential of generative AI (GenAI) for augmenting knowledge-based decisions, much of the discourse remains conceptual, technical, or anecdotal in nature (Duan et al. 2019). Empirical studies assessing the performance of GenAI systems under realistic conditions, particularly in business decision-making scenarios, are scarce. Moreover, the capabilities of these tools can vary widely depending on task complexity, domain specificity, and quality of training data (Stray, 2021). These uncertainties are further compounded by concerns about reliability, transparency, and algorithmic bias, which may undermine trust in AI-generated outputs (Arrieta et al. 2020; Gichoya et al. 2023).

This study addresses these gaps and aims to empirically assess whether and how generative AI chatbots can support business decision-making processes, particularly in knowledge-intensive contexts. While generative models have been praised for their potential in knowledge management, there is still a lack of systematic experimental studies evaluating their performance under real-world conditions. Specifically, the following research questions guided the investigation:

RQ1: How effective are GenAI chatbots in executing business-relevant analytical tasks?

RQ2: How do chatbot-generated results compare to those produced by traditional decision-support methods and human experts?

RQ3: What are the specific strengths and limitations of different GenAI systems (e.g., ChatGPT and Perplexity) in real decision scenarios?

RQ4: What methodological considerations are necessary to ensure a reliable and responsible use of GenAI tools in business environments?

These questions were addressed through a series of experiments simulating typical business situations, as detailed in the following sections. By comparing GenAI outputs to traditional knowledge processing approaches, the research provides a grounded assessment of current AI capabilities and outlines critical issues for their responsible integration in managerial contexts. The study further explores the critical role of human expertise in ensuring the effective utilization of GenAI for decision-making, which is one of the major contemporary challenges in its application to business and management (Kolbjørnsrud et al. 2016).

2. Revolutionizing Business with GenAI

Recent advancements in GenAI have enabled these systems to perform routine tasks such as data classification and reorganization. Their capabilities extend to creating text, composing music, and generating digital art, which has attracted significant attention and prompted independent experimentation by consumers and families. This widespread interest has led stakeholders to consider the impact of GenAI on business and society, often without a comprehensive understanding of its implications (Cano-Marin, 2024; Feuerriegel et al. 2024; Kanbach et al. 2024). Although GenAI technologies still represent a limited portion of overall AI investments, funding for these innovations is growing rapidly. In the first five months of 2023 alone, investments reached $12 billion, with an average annual growth rate of 74% between 2017 and 2022, compared to 29% for AI overall (McKinsey and Company, 2023). The potential revenue from GenAI could reach approximately $1.1 trillion by 2028, up from $45 billion in 2024 (Morgan Stanley Research, 2025).

GenAI has garnered global attention for its potential to transform knowledge-based work across various sectors and business functions (Agrawal et al., 2022). Areas such as sales, marketing, customer operations, and software development could be revolutionized through performance improvements and role optimization. Among the numerous business functions impacted, some stand out for the value generated relative to functional costs. According to McKinsey's analysis, four business functions could represent approximately 75% of the total annual value from GenAI use cases: customer operations, marketing and sales, software engineering, and research and development (R&D). Benefits include automating customer service, creating personalized content and advertisements, accelerating coding and documentation, and generating innovative research hypotheses and designs (McKinsey and Company, 2023).

Beyond functional value, GenAI has the potential to transform organizational KM systems. Its natural language capabilities enable conversational querying to retrieve archived information, allowing employees rapid access to relevant knowledge for informed decisions and strategies (Kolbjørnsrud et al., 2016). In 2012, knowledge workers spent 20% of their time (one workday per week) searching for and gathering information (McKinsey Global Institute, 2012) and according to empirical evidence collected during COVID-19, some workers now spend up to one and a half working days per week on these tasks (Nakash and Bouhnik, 2024).

If GenAI could assume this task, it could significantly boost efficiency and productivity. Moreover, as a "virtual expert," GenAI can analyze vast company data in natural language and interact iteratively with users to refine and personalize searches, offering scalability far beyond dedicated expert teams (Shrestha et al., 2019). Operational benefits include synthesizing reports and data for decision support, answering operational questions without manual database searches, retrieving historical project knowledge, and assisting with consistent, accurate internal document drafting.

These examples underscore GenAI's potential to revolutionize corporate KM by reducing information retrieval time and costs while enhancing operational efficiency organization-wide. However, despite rising interest, there is insufficient empirical evidence regarding the real effectiveness of these tools in supporting managerial decision-making. Recent studies (Cillo and Rubera, 2024; Csaszar et al. 2024; Soni, 2023) have begun analyzing the potential and impact of GenAI on business decisions, but there is a consensus that specific experiments must be conducted to understand the true effectiveness of these technologies, particularly from the perspective of potential users in real-life situations.

3. Research Outline

This study outlines a series of experiments designed to simulate real-world business decision scenarios, reflecting typical business situations. The methodology proceeded as follows.

A: Selection of Realistic Experiments

A series of experiments were selected based on their relevance to business management and potential applications of GenAI. Some scenarios involve quantitative analysis, others require information categorization, and some entail qualitative analysis:

- Simulation of Marketing Models
- Optimization of Work Shifts
- Sentiment Analysis
- Analysis of Company Financial and Strategic Documentation
- Marketing Evaluation of a Product Family

B: Identification of Generative Chatbots

Selecting appropriate generative chatbots posed several challenges. First, technologies evolve fast, and new versions of chatbots are being continuously introduced, with new algorithms and analytic tools. Second, standard criteria to assess and compare chatbot performances are not yet available. Therefore, it was decided to adopt a mixed approach including quantitative and subjective assessments, and also indications from professional experts. These criteria included: the GPQA Diamond applied to chatbots (applied, for instance, in framework like BenchmarkAggregator); the Massive Multitask Language Understanding (MMLU) benchmark; MATH, a MATH comprehensive evaluation tool to assess mathematical reasoning of GenAI) models; Multilingual Grade School Math (MGSM) benchmark; the LMArena score developed by Chatbot Arena; the Olympic Arena benchmark measurement. These measurement methods are still experimental, and each provides a specific perspective. Therefore, an overall view of all these measurements was taken. A third issue is that we had some specific restrictions regarding the access to certain chatbots especially in their “premium” versions, which limited the possible choice. In the end, it was decided to use these tools and versions: ChatGPT Plus and Perplexity Pro that, at least at the time of our study (December 2024) showed the best combination of scores.

C: Selection of Assessment Approaches

Given the lack of standard methods to evaluate quality and effectiveness of GenAI systems in decision-making contexts, two approaches were adopted. One approach involved comparing chatbot results with those obtained using existing decision-making analytical tools. For instance, in marketing-related experiments, input data and benchmarking results were derived from Enginius, a software that performs marketing analysis with predefined models. Thus, chatbot results were compared to those a manager might obtain using traditional decision support systems. In other cases, subjective analysis was performed, such as comparing chatbot analyses of financial and strategic documentation with manual analyses or professional reports of the same documents.

D: Conducting Experiments

For each experiment, a series of prompts were compiled for the two chatbots, and data files were input in various formats.

4. Experiments and Results

4.1 Marketing Analysis

This section details an experiment aimed at comparing the effectiveness of GenAI chatbots with a specialized marketing platform called Enginius. The objective is to evaluate how these solutions interpret marketing data and transform it into useful and accurate outputs. Three models from the Enginius platform were selected: the GE-McKinsey Matrix, Segmentation Analysis, and Network Analysis. For each model, a structured approach was followed, providing key information and an Excel file containing the initial data necessary to address the problem. The process was replicated using Word and PDF files to verify the models' ability to handle different document formats. The analysis of the GE-McKinsey Matrix involved calculating and representing the x and y coordinates for each product family within the matrix, considering evaluation data, weight perspectives, and market shares. ChatGPT achieved 100% accuracy on PDF and Word formats in both languages when calculating

x and y, correctly recognizing scores and applying normalization. Perplexity showed mixed performance, initially struggling with data interpretation but improving with advanced search modes on Excel files.

For Segmentation Analysis, the objective was to identify the optimal number of segments using hierarchical clustering criteria and assign respondents to their respective clusters. Both ChatGPT and Perplexity performed well in determining the number of segments and assigning respondents, but faced challenges in synthesizing data from different sources, with ChatGPT's advanced model (o1) being the only one to achieve maximum accuracy.

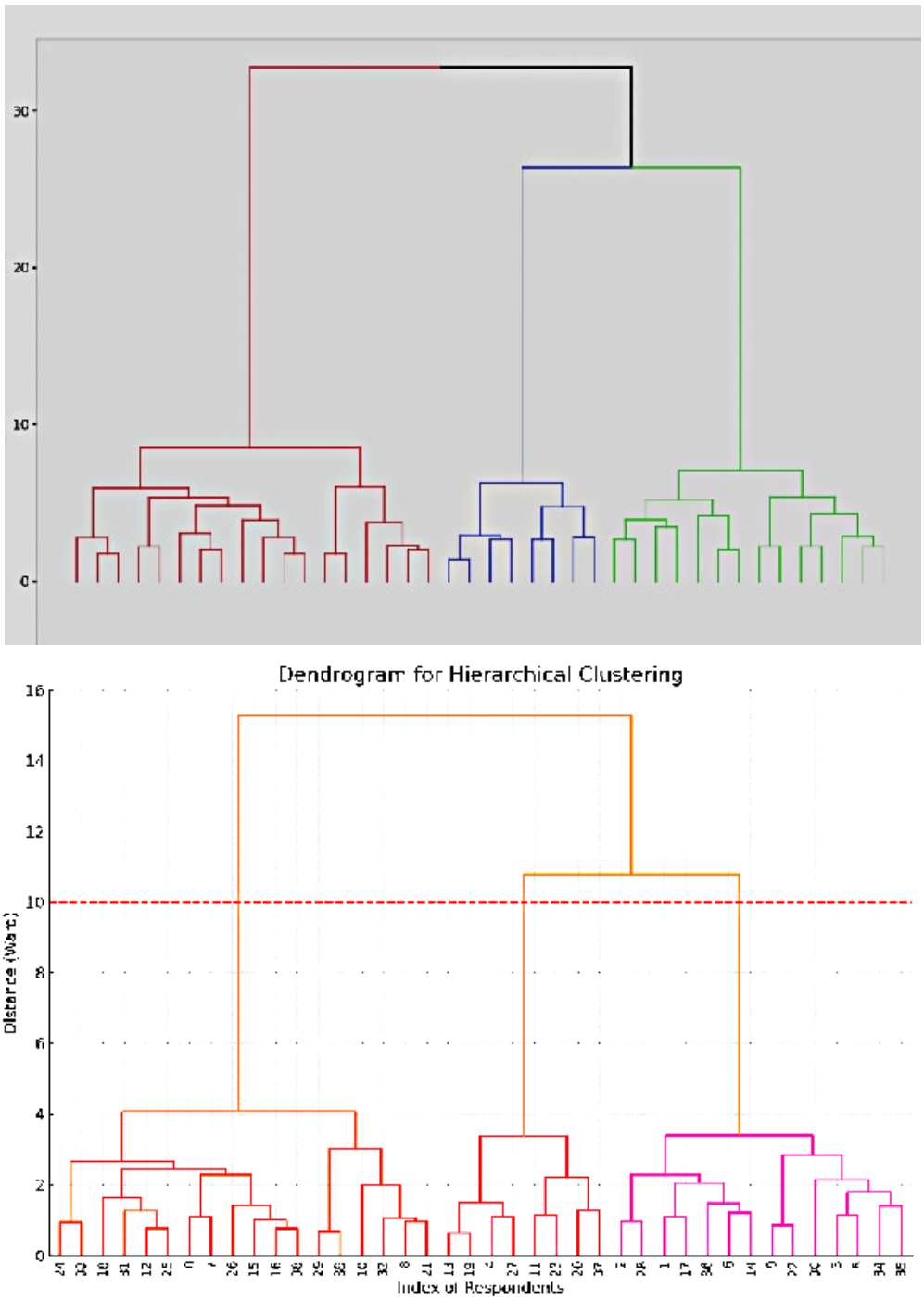


Figure 1: Comparison between dendrogram produced by Enginius (top) and Chatbot (bottom)

A task assigned to AI was the calculation of the optimal number of segments, through the graphical representation of a dendrogram. This visualization provides the business analyst with an immediate visual aid to identify the most appropriate number of segments to adopt (Figure 1). The Network Analysis involved calculating metrics such as degree and closeness centrality for each node in a network of 152 nodes. ChatGPT

excelled with Excel files, accurately calculating metrics and providing graphical representations and statistical summaries. However, it struggled with PDF and Word formats due to difficulties in extracting and interpreting the data matrix correctly. Perplexity was unable to calculate network metrics or provide satisfactory graphical representations in any case.

Overall, the experiments highlight the potential of GenAI chatbots in supporting business decision-making processes, particularly in the initial analysis phases. However, they also emphasize the need for rigorous methodological control, especially when dealing with complex data integration or probabilistic estimates.

4.2 Optimization of Work Shifts

This section describes an experiment aimed at evaluating the effectiveness of GenAI chatbots in optimizing the scheduling of operators in an inbound customer service contact center. The contact center, assumed to manage a company in the water sector, operates with unique toll-free numbers. The experiment utilized an Excel file containing historical work schedules from previous weeks, including operators' experience levels (Coordinator, Lead, Senior, Junior).

The GenAI systems were tasked with predicting and assigning shifts for the "current week" based on the provided information and adhering to precise operational rules, such as shift durations, preferred and less preferred time slots, evening shift rotation, coordinator and lead operator schedules, fair rotation among operators, operating hours, continuous coverage, and call flow peaks. The results were evaluated using both subjective and objective criteria, leveraging the personal experience of one of the paper's authors as a shift scheduler in a similar contact center. The evaluation considered adherence to operational rules, optimization of hourly coverage, fairness of rotations, and overall applicability and reliability. Essentially, the chatbots' results were benchmarked against those that a human manager would have obtained through personal analysis.

The analysis highlights the challenges AI models face in simultaneously applying complex rules when data contains numerous variables. While ChatGPT and Perplexity demonstrated good graphical representation capabilities, they struggled to adhere strictly to stringent constraints, such as preferred time slots and fair rotation. The experiment underscores the need for a "human-assisted" approach in such scenarios, where chatbots can provide baseline solutions or useful visualizations, but human intervention remains crucial for fully reliable results. In other words, human managers can use the systems as "assistants" but must then evaluate their results and, by interacting with the chatbots using different prompts, correct mistakes and inconsistencies to ultimately achieve satisfactory outcomes.

4.3 Sentiment Analysis

This section describes an experiment aimed at examining the behavior of GenAI systems when subjected to a large dataset. Specifically, the study focuses on the analysis of 4,225 comments extracted from Instagram posts about the unveiling of the Ferrari F80, a new supercar revealed on October 17, 2024. Despite the enthusiasm of experts and enthusiasts, the model received several criticisms, mainly regarding three aspects: the controversial design, the transition from a V12 or V8 engine to a V6 hybrid, and the excessive price tag of four million dollars.

The comments were pre-processed by removing those containing only emojis and translating them into English to ensure more accurate analysis. These were provided to the GenAI systems in three different formats (Excel, Word, and PDF) to verify any differences in results based on the input type. The systems were tasked with classifying the comments based on tone (positive, negative, or neutral) and generating a summary table. Additionally, they were asked to create a word cloud to identify the most frequent words and conduct a valence analysis to identify the most commonly used positive, negative, or neutral terms. This approach aimed to provide an overview of users' perceptions and reactions toward the Ferrari F80 for an initial qualitative comparison with the previously described criticisms.

The results of this study were compared with two types of analyses conducted using the Enginius platform: a sentiment analysis on a customized set of comments and an overall sentiment analysis on Instagram using the #ferrarif80 hashtag. Furthermore, a separate evaluation method was developed to directly compare the classification proposed by the chatbots with a human evaluation of a randomly selected sample of 99 comments. These comments were manually analyzed, classifying both the tone (positive, neutral, or negative) and the expressed emotions (anger, anticipation, disgust, fear, joy, and sadness). Figure 2 presents an example of tone and emotion analysis, comparing the results of a manually conducted and an AI-generated assessment.

The evaluation of the results revealed strengths and weaknesses of both ChatGPT and Perplexity. ChatGPT, in the GPT-4o version, excelled at graphical representation, creating clear and intuitive visualizations, sometimes even better than those offered by specialized software. However, its actual analysis capabilities presented many shortcomings, with often unreliable results unless using advanced models like o1 or o3-mini high. Perplexity, on the other hand, showed greater solidity in the overall analysis, providing more coherent results compared to the reference data. However, as the volume of data to be examined increased, the model tended to lose precision, with some gaps in interpreting more complex information.

ID	COMMENT	TONE ANALYSIS	EMOTION ANALYSIS
9	Have you tried the car? No no one has and I fully know this car will be hella fast because of v6 hybrid...	POSITIVE	TRUST
51	Awesome	POSITIVE	JOY
62	Beauty 💀 💀 💀 💀 💀	POSITIVE	JOY
77	Downgrade	NEGATIVE	DISGUST (ANGER)
94	It looks weird but I'll never be able to buy one anyway.	NEUTRAL	SADNESS (ANTICIPATION)
99	V6 hybrid? Well, at least is powerful and beautiful.	NEUTRAL	ANTICIPATION (SURPRISE or JOY)
113	When LaFerrari was launched, it was criticised for design...	NEUTRAL	TRUST
122	Hey Ferrari...why you hiding your tiny engine at the back? 😂 no glass cover?	NEGATIVE	ANGER (DISGUST)
129	idk, it honestly looks dope	POSITIVE	JOY

Comment ID	Comment	Sentiment	Emotion
9	Have you tried the car? No no one has and i fully know this car will be hella fast because of v6 hybrid...	Positive	Trust
51	Awesome	Positive	Joy
62	Beauty 😜 😜 😜 😜 😜	Positive	Joy
77	Downgrade	Negative	Disgust
94	It looks weird but I'll never be able to buy one anyway.	Neutral	Sadness
99	V6 hybrid? Well, at least is powerfull and beautiful.	Neutral	Surprise
113	When laferrari was launched, it was criticised for design...	Neutral	Trust
122	Hey Ferrari...why you hiding your tiny engine at the back? 😂 no glass cover?	Negative	Disgust
129	idk, it honestly looks dope	Positive	Joy

Figure 2: Comparison of tone and emotion analyses (manual assessment – top; chatbot-generated – bottom)

Additional attempts were made to improve the accuracy of the analyses provided by the chatbots, including the use of a reference database and a detailed description of the factors negatively influencing people's perceptions. While these efforts yielded some improvements, particularly for Perplexity, the overall performance remained limited, highlighting the need for further advancements in GenAI models to handle complex sentiment analysis tasks effectively.

4.4 Analysis of a Company's Financial and Strategic Documentation

The fourth experiment aimed to explore the potential of GenAI tools in analyzing a diverse set of heterogeneous and not necessarily directly related documents. Specifically, the investigation focused on the documentation of Piaggio & C., a historic Italian manufacturer of two and three-wheeled motor vehicles. The analyzed material was collected from the company's official website and includes press releases, conference call transcripts and presentations, codes of ethics, interim management reports, corporate governance reports, remuneration policies, financial statements, and non-financial declarations.

The analysis aimed to deepen the understanding of how AI technologies can interpret and leverage complex and varied information. The chatbots were tasked with assuming the role of expert financial analysts to assess the company's health. The analyses focused on financial ratios, key points from shareholder meetings, non-financial performance indicators and ESG policies, identification of risks and opportunities, future strategies and objectives, and an overall assessment of the company's health with a focus on potential future crises.

The accuracy of GenAI chatbots was evaluated using a combination of quantitative and qualitative methods, including comparison with historical data from specialized databases and direct review made by expert analysts. The evaluation of the results revealed both strengths and weaknesses of the two chatbots, ChatGPT and Perplexity. ChatGPT excelled in calculation accuracy and the development of extended and structured analyses, also offering targeted operational suggestions for improving internal management and corporate strategy. Perplexity, while adopting a more concise and sometimes less rigorous approach in the numerical part, proved equally reliable in identifying key themes and contributed additional insights.

Overall, both models provided responses in line with the expectations of human analysis, highlighting risks and opportunities (such as volatility in global markets, electrification, and premium branding strategies), as well as major warning signs (e.g., a possible slowdown in sales in some geographic areas or high levels of debt). This convergence of results suggests that chatbots can complement and, in part, accelerate the work of analysts and consultants, allowing them to focus on strategic insights rather than the operations of collecting and synthesizing information. However, a problem arises from the lack of a standard way to evaluate the assessments provided by the system, and without cross-checking by human decision-makers, there may be a risk of blindly trusting the system.

Looking ahead, it is conceivable that GenAI tools will evolve further, improving numerical precision and refining the ability to integrate information from multiple documentary sources. This could translate into greater effectiveness in identifying emerging trends, anticipating risks, and proposing operational solutions for companies, making AI a key element in the decision-making process.

4.5 Marketing Evaluation of a Product Family

The primary objective of this final analysis is to understand how GenAI chatbots respond to the strategic analysis of a product family. Specifically, the investigation focuses on comparing technical specifications, informative documents, and web pages of a specific line of devices for cyclists—the Garmin Edge line, an advanced technological product line developed by Garmin, a leading company in the fitness and outdoor technology sector. The analysis was conducted in both Italian and English to evaluate the differences in the response capabilities of AI systems based on language. The products under investigation are Garmin Edge 540, 840, and 1050, all consumer products (GPS cycling computers).

This type of analysis is strategic and innovative in nature for decision-making. It enables marketing managers to understand how the products differ from each other and from the competition, highlighting distinctive features that could represent a competitive advantage. The objective of this marketing analysis is also to identify strategies to improve market competitiveness through proposals for technological innovation and targeted positioning. Additionally, the analysis explores development opportunities for each model, considering emerging trends in the relevant sector and the specific needs of different customer segments. Finally, it aims to identify the most effective strategies to differentiate from the competition in terms of innovation, pricing, and related services to strengthen the company's market position.

The chatbots were tasked with developing:

- A SWOT analysis for each model, identifying strengths, weaknesses, opportunities, and threats.
- A comparison with main competitors, identifying direct and indirect competitors and analyzing their offerings in terms of technology, price, features, and services.

- Industry benchmarking, comparing the technical specifications of Garmin models with market leaders to highlight competitive advantages.
- Technological advantages, exploring the technologies integrated into each model compared to alternatives on the market.
- Innovation proposals, suggesting technological improvements for each model.
- Risk analysis and mitigation strategies, identifying potential technological, market, and regulatory risks that could impact sales or reputation.

To verify the accuracy of the results, it is essential to adopt a structured approach that considers various critical aspects, such as completeness, relevance, and quality of the responses. The evaluation of the results shows that both ChatGPT and Perplexity are capable of successfully carrying out the analysis of a product family, starting from a detailed description, as in this case through user manuals. ChatGPT stands out for the quality of its representations and a greater propensity to suggest mitigation strategies or technological improvements. Perplexity obtains equally valid results, often with a comparable level of technical detail; however, the graphic component (such as tables and layouts) is sometimes less accurate and appealing compared to ChatGPT.

As an illustrative example, Figure 3 shows how chatbots can accurately perform a sector-specific analysis focused on the technical aspects of the devices under examination, integrating information extracted from the provided documentation with insights gathered through online research.

Feature	Garmin Edge 1050	Garmin Edge 840	Garmin Edge 540	Wahoo ELEMNT Roam
Display Type	3.5" Color Touchscreen	2.6" Color Touchscreen	2.6" Color Non-Touch	2.7" Color Non-Touch
Resolution	282 × 470 px	246 × 322 px	246 × 322 px	240 × 400 px
GPS Type	Multi-band GNSS (GPS, Galileo)	Multi-band GNSS	Multi-band GNSS	GPS, GLONASS, Galileo
Battery Life	Up to 20h (45h with battery saver)	Up to 26h (42h with battery saver)	Up to 26h (42h with battery saver)	Up to 17h
Storage	32GB Internal	16GB Internal	16GB Internal	No Internal (Cloud Sync)
Wi-Fi	✅	✅	✅	✅
Bluetooth & ANT+	✅	✅	✅	✅
LTE	❌	❌	❌	❌
Navigation	Turn-by-turn, ClimbPro, Trailforks, Heatmaps	Turn-by-turn, ClimbPro, Trailforks	Turn-by-turn, ClimbPro, Trailforks	Turn-by-turn, Breadcrumb Navigation
Smart Features	Garmin Pay, Music, Phone Notifications	Phone Notifications, Strava Sync	Phone Notifications, Strava Sync	Phone Notifications, Strava Live Segments
Safety Features	Incident Detection, LiveTrack, GroupRide, Emergency Contacts	Incident Detection, LiveTrack, GroupRide	Incident Detection, LiveTrack, GroupRide	LiveTrack, Crash Detection
Power Meter Support	✅	✅	✅	✅
ClimbPro Feature	✅	✅	✅	❌
Indoor Trainer Support	✅ (Smart Trainer Control)	✅	✅	✅
Weight	160g	85g	80g	93g
Price Range	$750 - $850	$500 - $650	$430 - $540	$400 - $500

Figure 3: Example of competition analysis generated by chatbots (technical features of the examined devices)

Overall, both chatbots confirm their effectiveness as tools for business analysis, capable of collecting and reworking information from multiple sources, offering comprehensive summaries and strategic insights useful for the development of new products, significantly reducing the workload of human analysts.

5. Conclusion

This research focused on use and effectiveness of generative chatbots within business contexts, with particular attention to their potential for business analysis and decision support. As the referenced literature, while emphasizing the growing interest in GenAI, highlights the lack of concrete application guidelines to assist companies in adopting these technologies, this paper aims to offer an initial contribution in this direction, presenting a study that addresses both practical and methodological aspects.

The results highlight that GenAI tools, such as ChatGPT and Perplexity, can significantly streamline processes, simplify information management, and make strategic analyses more timely (see research question RQ1 in the Introduction). The evidence collected demonstrates the ability of these chatbots to support companies in collecting and interpreting data, thereby providing useful insights to guide decisions and complement traditional and human-based analysis (as per RQ2).

However, critical issues remain unresolved, particularly the difficulty in managing certain file formats, the variability of responses based on the specific context (when this context is not fully explained to the system), and the need for constant human intervention to validate the outputs produced by AI (RQ3). This necessitates users' ability to input appropriate prompts, interact with the system to refine questions and data inputs, and interpret the results. In other words, while chatbots are intended to assist managers in their decisions, human action cannot be entirely replaced, and new capabilities are required to use these systems effectively.

A significant aspect of the study was the comparison between ChatGPT and Perplexity, which revealed notable differences in their approach to data and accuracy of results. This comparison is particularly important given the variety of technologies and tools available on the market, each with distinct performances and characteristics. In our case, ChatGPT demonstrated excellent processing and overall reliability, although it faced challenges with complex tabular data. Perplexity, on the other hand, provided more detailed answers but showed some limitations in accuracy.

From an operational perspective, the results suggest that the use of generative chatbots could lead to greater efficiency in decision-making processes, thanks to the speed of analysis and the ability to support decisions. To maximize the benefits, a collaborative model in which AI is supported by professionals who validate and interpret the system's outputs still appears advisable (RQ4).

The implications of this research for theory include advancing our understanding of AI's role in KM and decision support, while for practice, it provides insights into the practical applications and limitations of GenAI tools in business contexts, and underscores the importance of developing user guidelines and best practices for the effective and responsible adoption of GenAI technologies.

Looking to the future, there are numerous areas for development. Improvements in reading structured formats, the creation of shared methodologies for evaluating chatbot performance, and integration with other business intelligence tools are just a few. Additionally, future research could explore the ethical implications of AI in decision-making, the development of more robust frameworks for AI-human collaboration, and the impact of AI on organizational culture and employee roles.

The paper has some limitations that should be considered. First, the study was based on a structured experimental plan that included over 210 different experiments and approximately 900 prompts but, due to length constraints, only a summary is provided in this paper. Second, further experiments should be conducted with different cases and business applications. Third, the replication of experiments may suffer from the subjective intervention of researchers, who might use different variations of prompts to interact with the chatbots. Additionally, part of the assessment criteria used to evaluate results are subjective in nature, which may introduce biases. Nonetheless, we believe this exploration can provide valuable insights and pave the way for new lines of research on how chatbots can contribute to producing a useful knowledge base for business decisions, a critical topic in KM literature.

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AI Declaration: GenAI Chatbots (ChatGPT and Perplexity) were used to conduct the experiments that are integral part of the empirical study. A GenAI chatbot (Lucrez-IA), developed by the University of Padova, was used to check English of some specific sentences.

Ethics Declaration: No ethical clearance was required for this study.

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Knowledge Audit in HEIs: A Framework for its Strategic Management

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Abstract: In the knowledge era, Higher Education Institutions (HEIs) are recognized as knowledge-intensive organizations whose sustainability and capacity for transformation depend largely on how they manage not only academic and scientific knowledge but also the organizational knowledge that emerges from their internal practices. However, most HEIs focus their efforts on knowledge derived from teaching and research functions, leaving aside the strategic management of the knowledge produced, stored, and applied in administrative, operational, and relational domains. This disconnection limits the potential of organizational knowledge as a source of differentiation, innovation, and dynamic capabilities. This article proposes a systemic approach to knowledge audits in HEIs, aimed at closing the gap between academic and organizational knowledge. The study follows a qualitative and propositional methodology structured in three phases: a critical literature review, an empirical analysis of eight cases from knowledge-intensive organizations, and the design of a strategic management framework for systemic knowledge audits. The framework includes seven interconnected components: (1) characterization of knowledge in relation to institutional strategy; (2) multi-level inventory of core, tactical, operational, and relational knowledge; (3) diagnosis of risks such as leakage, obsolescence, and knowledge gaps; (4) development of knowledge and risk maps; (5) governance structures for knowledge management; (6) design of intervention routes; and (7) monitoring, evaluation, and continuous improvement. The model advances knowledge audit practices by integrating strategic alignment, risk management, and organizational learning into a unified framework. Unlike traditional audits focused solely on inventories or compliance, it adopts a systemic and sociomaterial perspective (Schatzki, 2016); (Tsoukas, 2000), recognizing knowledge as an emergent, distributed, and context-dependent phenomenon shaped by practices, technologies, and structures. It provides actionable tools to identify, protect, and mobilize critical knowledge, supporting institutional planning, self-assessment, and innovation. Findings from the case analysis revealed governance weaknesses, fragmented flows, and poor linkage between KM and strategy. In response, the framework offers both conceptual depth and practical application, positioning knowledge audits as reflective organizational interventions (Czarniawska, 2003) and reinforcing the role of knowledge as a lever for sustainability, resilience, and strategic transformation in HEIs.

Keywords: Knowledge audit, Higher education institutions (HEIs), Knowledge management, Strategic alignment, Sociomaterial perspective, Knowledge governance

1. Introduction

Since the late 20th century, knowledge has been established as a fundamental resource for economic and social development, giving rise to what is now known as the knowledge era (Drucker, 1993). By their very nature, universities are recognized as knowledge-intensive organizations due to their core activities in teaching, research, and outreach (García-Vega and Vicente-Chirivella, 2020; Ortega y Gasset, 2001). However, this emphasis on academic and scientific knowledge has created a gap in organizational knowledge, which emerges from administrative, strategic, and operational practices.

This dissociation has hindered the ability of Higher Education Institutions (HEIs) to manage organizational knowledge as a strategic asset, essential for differentiation, sustainability, and the development of dynamic capabilities (Davenport and Prusak, 1998; Nonaka and Takeuchi, 1994; Teece, 2007). From a contemporary perspective, knowledge should be understood as an emergent and socio-material phenomenon, shaped by interaction networks among people, technologies, and structures (Diez-Gaviria, 2023; Orlikowski, 2007; Schatzki, 2016), where heterarchical relationships and shared practices generate organizational meaning (Cilliers, 2005; Tsoukas, 2000).

Given this scenario, a reflective and dialogic organizational intervention is necessary (Czarniawska, 2003) to redefine organizational knowledge and enhance its management. A knowledge audit with a systemic approach is proposed as a key tool in this process, enabling the identification, diagnosis, and mapping of knowledge in HEIs while fostering institutional learning and strategic adaptation (Nonaka, Toyama and Hirata, 2018; Probst, Raub and Romhardt, 2001). Accordingly, this article presents a systemic knowledge audit methodology, structured in five chapters, which address the initial problematization, the proposed methodology, and the conclusions.

2. Background

The concept of organizational knowledge has evolved significantly in recent decades, shifting from traditional approaches centered on codification and information storage to perspectives that recognize it as an emergent, dynamic, and contextual phenomenon. This section presents the main theoretical foundations that support this study.

2.1 Knowledge Audit (KA)

The success of knowledge management (KM) initiatives largely depends on the organization's ability to systematically assess its intellectual assets, knowledge flows, and contextual factors that facilitate or hinder their use. Hylton (2002) warns that inadequate diagnostics are a major cause of failure in KM strategies, as they obstruct the identification of existing knowledge, its circulation, and critical gaps. Similarly, Liebowitz *et al.*, (2000) highlight that a well-designed audit enables organizations to recognize both available and missing knowledge, determine who needs it, and identify how it can be strategically utilized.

Structured models, such as Iazzolino and Pietrantonio´s (2017) integration of the Balanced Scorecard with intellectual capital and Perez-Soltero *et al.* (2007) process-oriented approach, provide frameworks for evaluating both the "stock" and "flow" of knowledge while aligning it with institutional objectives.

2.2 Knowledge Risks

These risks arise from events or conditions that negatively impact the creation, retention, transfer, and application of knowledge, limiting an organization's ability to innovate, adapt, and generate value (Liebowitz *et al.*, 2000). Factors such as staff turnover, technological obsolescence, process fragmentation, and the absence of mechanisms for documenting and sharing learning increase an organization the vulnerability to knowledge loss or deterioration (Burnett, Illingworth and Webster, 2004).

In this context, KA also serves a preventive function. It helps identify blockages, redundancies, and critical gaps in knowledge flows, enabling targeted interventions to ensure continuity and optimal utilization. According to Burnett, Illingworth and Webster (2004), these processes not only expose risks but also support the development of strategies to mitigate their impact, thereby strengthening organizational resilience.

2.3 Critical Knowledge

Critical knowledge refers to the set of knowledge whose loss, deterioration, or inaccessibility would significantly compromise an organization's performance and sustainability. This type of knowledge is directly linked to strategic processes, key competencies, environmental relations, and specialized functions (Perez-Soltero *et al.*, 2007).

A systemic approach is required to assess not only the content but also its location, usage dynamics, and dependence on the organizational context. Identifying critical knowledge enables institutions to prioritize actions for its conservation, transfer, and renewal, ensuring that the most valuable assets remain accessible at the right time and place to maximize their impact.

3. Methodology

A qualitative approach was adopted, structured into three interrelated phases: literature review, comparative empirical analysis, and methodological design. The first phase was a review of 46 articles indexed in Scopus on organizational KA in HEIs. In the second phase, documented case studies from knowledge-intensive organizations were analyzed. Finally, a systemic audit methodological proposal adapted to HEIs was developed.

4. Results

The progression through the three phases enabled the consolidation of a robust theoretical framework and the identification of application patterns, recurring challenges, and best practices that informed the final design. The main findings are presented below, organized according to each phase:

4.1 Phase 1. Conceptual Foundations and Theoretical Background

This phase consisted of a structured literature review conducted in the Scopus database, guided by the PRISMA technique (Moher *et al.*, 2009) to ensure methodological transparency. The search equation combined the terms: (knowledge auditing OR knowledge mapping OR knowledge diagnosis) AND (HEI) AND (knowledge

management), applied to titles, abstracts, and keywords. The time frame was set from 1995 to 2025 to capture both foundational and current contributions. Inclusion criteria considered peer-reviewed journal articles, theoretical analyses, and applied studies explicitly addressing knowledge audits in organizational or educational settings. Exclusion criteria ruled out conference abstracts without full text, theses, and unrelated topics.

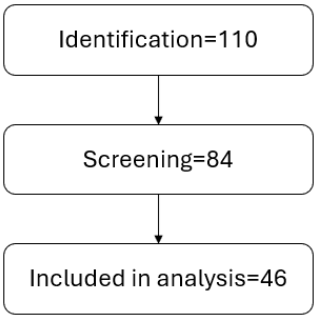


Figure 1: PRISMA flow diagram for the literature review process

The selection process followed three PRISMA stages—identification, screening, and eligibility—resulting in 46 articles for full review (see Figure 1). This corpus allowed for the identification of four dominant perspectives on knowledge audits—strategic alignment, KM optimization, continuous improvement, and knowledge availability—and five methodological approaches, from operational audits to systemic models aligned with institutional strategy. These findings laid the groundwork for the framework developed in this study.

4.1.1 Knowledge audit: A construct with multiple perspectives

KA has been analyzed from multiple perspectives, each emphasizing its significance for organizational management, continuous improvement, and the strategic utilization of knowledge. These perspectives are outlined below.

- Strategic perspective

From a strategic approach, KA is regarded as process-oriented to evaluate and manage critical knowledge assets that contribute to achieving organizational objectives. This approach highlights the identification of essential knowledge resources to support effective decision-making (Kumar, Singhal and Kansal, 2022). It is also described as a method for identifying strengths and weaknesses to facilitate the strategic use of knowledge (Pirnau *et al.*, 2022). Additionally, it involves assessing existing assets and their relevance to strategic goals (Wu Y. and Senoo D., 2010). Thus, the strategic perspective focuses on the evaluation, availability, and application of critical knowledge assets in alignment with organizational strategy.

- KM perspective

This perspective ensures that knowledge is systematically managed and aligned with institutional strategic objectives (Shahmoradi, Karami and Nejad, 2016). It is described as a process that allows identifying weaknesses and strengths in KM (Dante and Ponjuán, 2021; Ponjuán, 2018), as well as its efficiency and adequacy for strategic development (Carreño and Escobar, 2019; Pirnau et al., 2022;). Accordingly, this perspective underscores the structured identification, organization, and implementation of knowledge processes.

- Continuous improvement perspective

KA is also understood as a mechanism for fostering continuous improvements. This perspective emphasizes the need for ongoing diagnostics (Adesina, 2024) to identify critical areas (Shek, Lee and Cheung, 2009) and implement corrective actions (Dahlan, Abdullah and Wahiddin, 2016). It highlights the importance of periodic evaluations and structure enhancements that contribute to the continuous development of organizational capacity.

- Organizational perspective and knowledge availability

This approach is characterized by the identification, classification, storage, and accessibility of knowledge (Gu *et al.*, 2011; Natividad, Bennet and Vatananan-Thesenvitz, 2023; Puerta-Ramírez and Giraldo-García, 2024), ensuring that it is available for appropriate use in decision-making (Marr, Schiuma and Neely, 2004; Skok and

Goldstein, 2007). This emphasizes the importance of having effective systems in place to structure knowledge and ensure access to it.

The review of these perspectives shows that KA is a complex process that must be understood and applied comprehensively. Each perspective provides essential elements that allow understanding the state of organizational knowledge, identifying its limitations, and proposing improvement paths to ensure its availability and adequacy for the fulfillment of strategic objectives. Thus, the adoption of a model that considers these integrated views, besides being pertinent, is necessary, especially in knowledge-intensive organizations.

4.1.2 Methodological models of KA: from operational to strategic

The methodologies used in KA can be classified into five main approaches each emphasizing different aspects of MK. These approaches are described below.

- Operational aspects

Methodologies belonging to this group are mainly focused on identifying activities, procedures, and techniques used to collect, organize, and functionally use knowledge (Kim *et al.*, 2014; Marr, Schiuma and Neely, 2004; Shek, Lee and Cheung, 2009). The main purpose is to optimize internal processes and ensure that knowledge is managed efficiently from a technical and operational point of view (Nieto and Bolaños, 2010). This approach is useful in the implementation of organizational knowledge systems and in the evaluation of established procedures.

- Knowledge inventory

The purpose of this type of audit is to ensure that relevant knowledge is clearly identified and adequately stored so that it can be accessed by those who need it (Natividad, Bennet and Vatananan-Thesenvitz, 2023; Unamuno, 2009). These methodologies usually focus on activities such as collecting information, structuring knowledge databases, and reporting on existing assets (Ara and Kumar Das, 2021; Gu *et al.*, 2011) . Although this approach is useful to ensure the availability of knowledge, it is limited to the operational aspect of its management, without necessarily relating it to organizational strategy.

- Risk diagnosis

This type of audit seeks to mitigate possible negative impacts by identifying gaps, weaknesses, or failures in organizational knowledge. The purpose of this approach is to ensure that the organization has mechanisms in place to identify critical areas of knowledge that require immediate attention (Acevedo-Correa *et al.*, 2020), to prevent these from becoming potential threats to the organization (Adesina, 2024; Durst and Leyer, 2014). Methodologies based on risk diagnosis include systematic processes to detect problems and formulate corrective action plans (Cannavacciuolo *et al.*, 2017L; Dante and Ponjuán, 2021; Jalalimanesh, Yaghoubi and Homayounvala, 2012).

- Strategy as an end

Methodologies belonging to this approach usually involve a systematic process that includes the identification of knowledge resources and processes (Shahmoradi, Karami and Nejad, 2016), the evaluation of internal and external factors that influence organizational knowledge (Gavrilova, Kudryavtsev and Alkanova, 2023), the assessment of current practices and the identification of areas for improvement (Carreño and Escobar, 2019) that can impact the strategic performance of the organization (Dante and Ponjuán, 2021; Kuznetsova, Gavrilova and Alkanova, 2024). This type of audit focuses on how available knowledge contributes to the achievement of specific strategic objectives (Dahlan, Abdullah and Wahiddin, 2016; Piri *et al.*, 2020; Shek, Lee and Cheung, 2009). The value of this approach lies in its ability to provide a diagnosis that translates into useful inputs for organizational strategy (Angel Sosa, 2024), ensuring that knowledge is managed and applied in a manner consistent with strategic objectives.

- KA with a systemic approach: from and for the strategy

The methodologies that belong to this group state that organizational knowledge must be understood, managed, and evaluated based on the strategic objectives, ensuring that its management is consistent with the direction (Puerta-Ramírez and Giraldo-García, 2024). From this perspective, KA becomes a continuous cycle (Backhaus *et al.*, 2006) that starts with the strategic definition, identifies and organizes critical knowledge assets, and then provides relevant information to feedback on the strategy and ensure its sustainability (Pirnau

et al., 2022; Skok and Goldstein, 2007). The importance of this approach lies in its ability to provide a comprehensive methodological model, particularly relevant for HEIs, where knowledge is the fundamental resource for their operation and sustainability over time.

The systemic approach is essential for the effectiveness of KA, especially in HEIs, since it allows for aligning organizational knowledge with institutional strategy. By taking the strategy as a starting point, the knowledge that is truly valuable for meeting organizational objectives is identified, and by considering it also as a point of arrival, the audit results strengthen and provide feedback on the strategy. This approach recognizes that knowledge should not only be an input, but a structural component of the strategy, which is even more relevant in HEIs, where knowledge is the main asset. Integrating both elements allows decisions to be made based on clear diagnoses, ensuring the sustainability, innovation, and relevance of these institutions in complex and competitive environments.

4.2 Phase 2: Case Analysis and Empirical Contrasts

The second phase consisted of an empirical validation of the systemic audit components identified in the literature review, through the analysis of eight cases from knowledge-intensive Colombian organizations. A convenience sampling strategy was used, selecting institutions with declared KM practices aligned with organizational strategy, previously involved in research or consultancy on KM.

The cases, from sectors such as higher education, vocational training, and public administration, provided evidence through documents and interviews of active KM integration with strategic planning, self-evaluation, or quality management. Data collection included institutional documents and semi-structured interviews with key actors. The goal was not generalization, but contrast and contextual validation of categories from Phase 1.

A comparative matrix (Table 1) synthesized key variables analyzed.

Table1 : Summary of empirical analysis

Code	Auditing practices	Risks	Governance
A	Inventory and criticality matrix	Staff attrition, obsolescence	Informal knowledge leader
B	Surveys and interviews	Gaps and flow barriers	No defined structure
C	Interviews with key experts	Leakage, low circulation	Ad-hoc Committee
D	Documentary diagnosis	Regulatory obsolescence	Informal coordination
E	Narrative audit with a practical approach	Leakage, critical dependence	Functional area with indirect responsibility
F	Critical knowledge matrix	Barriers by functional silos	Formal role in KM
G	Interviews and triangulation	Leakage and low transmission	Cross-cutting team
H	Review of critical processes	Digital obsolescence	KM strategy defined

The analysis confirmed that the organizations studied are knowledge-intensive (Diez-Gaviria, 2023), although their approaches to KM and its strategic integration vary significantly. Practices such as inventories, interviews, and diagnostic assessments were common; however, few institutions had robust systems for updating, protecting, or mobilizing critical knowledge. Frequently observed risks included knowledge leakage, regulatory or technological obsolescence, and internal knowledge flow barriers, often addressed through tools like criticality matrices or process mapping.

In terms of governance, informality prevailed, with only a few organizations having formal KM roles or defined strategies. These findings underscore the importance of conceiving KA as reflective and systemic organizational interventions (Czarniawska, 2003), oriented toward re-signifying knowledge, enhancing dynamic capabilities, and guiding strategic transformation.

4.3 Phase 3: Design of a Systemic Audit Proposal for HEIs

As a result of the theoretical review and empirical analysis in knowledge-intensive organizations, a strategic management framework for KA is proposed that seeks to articulate organizational knowledge with institutional strategy, especially in complex contexts such as the university. Based on a systemic and collectivist perspective of knowledge (Schatzki, 2016; Tsoukas, 2000), the model recognizes knowledge as an emergent, relational, and dynamic construction (Cilliers, 2005; Diez-Gaviria, 2023), and proposes the audit as a reflexive intervention capable of generating organizational transformation (Czarniawska, 2003). This framework has six

interconnected components that guide diagnosis, planning, and strategic action around knowledge. This framework has six interconnected components that guide diagnosis, planning, and strategic action around knowledge. This model goes beyond operational inventories or descriptive audits by integrating strategic alignment, risk mapping, and governance into a cohesive system. It is particularly designed to address the complexity of HEIs, enabling both diagnosis and decision-making aligned with institutional development, as illustrated in Figure 2.

4.3.1 Characterization of organizational knowledge

This first component seeks to identify and describe the relevant knowledge of the organization concerning its institutional strategy. To this end, it is based on an integrated reading that considers both the knowledge derived from the substantive pillars -teaching, research, and social projection the knowledge that emerges from the mission and support areas. The distributed, tacit, explicit, and situated nature of knowledge is recognized, as well as its dynamic nature in terms of the relationships between people, technologies, structures, and norms.

4.3.2 Knowledge inventory

The inventory classifies and records organizational knowledge in four categories: core knowledge (essential to the institutional mission), tactical knowledge (key to intermediate decision-making), operational knowledge (related to process execution), and relational knowledge (derived from interaction with stakeholders). These categories can be organized into two levels: one linked to macro-processes or strategic domains, and the other related to sub-processes, functions, or individual competencies. In addition, the inventory contemplates the identification of sources of knowledge, both dynamic (human) and static (documentary or technological), concerning organizational processes.

4.3.3 Diagnosis of knowledge

The diagnosis identifies four risks that may affect the sustainability, availability, or quality of organizational knowledge; the risk of obsolescence refers to the loss of validity due to regulatory, technological, or contextual changes; the risk of leakage is associated with staff turnover or loss of institutional memory; flow barriers represent difficulties in accessing, using or mobilizing knowledge; while gaps refer to the difference between required and available knowledge. This diagnosis allows for establishing criticality levels according to the probability of occurrence and potential impact and constitutes a key input for decision-making.

4.3.4 Knowledge maps and risk maps

Based on inventory and diagnosis, knowledge maps are generated that visualize the distribution, concentration, and relationships between the different types of knowledge in the different areas or departments of the HEIs. Likewise, risk maps are built to locate critical nodes, vulnerable areas, and knowledge gaps. These maps favor strategic reflection and the planning of improvement actions.

4.3.5 Knowledge governance and intervention path

The proposed framework highlights the importance of establishing solid knowledge governance, based on defined roles and responsibilities, inter-area coordination mechanisms, and institutional policies that regulate access, protection, and valuation of knowledge, promoting distributed and collaborative leadership following heterarchical networks (Diez-Gaviria, 2023). Based on the characterization, inventory, and diagnosis of knowledge, an intervention route is designed that prioritizes gaps and opportunities, contemplates short-, medium-, and long-term actions focused on culture, processes, people, and technology, and integrates knowledge with development, self-evaluation, or accreditation plans. This route seeks to mobilize knowledge to generate value, strengthen organizational learning, and develop dynamic capabilities (Teece, 2007).

4.3.6 Monitoring, evaluation, and continuous improvement

Finally, the framework incorporates a monitoring and evaluation system that makes it possible to: a) establish maturity and KM indicators; d) follow up on the implementation of the intervention path; and c) promote continuous improvement cycles based on evidence. This component ensures the sustainability of the model and its alignment with the institutional strategy, allowing for adjustments in response to changes in the environment or new priorities.

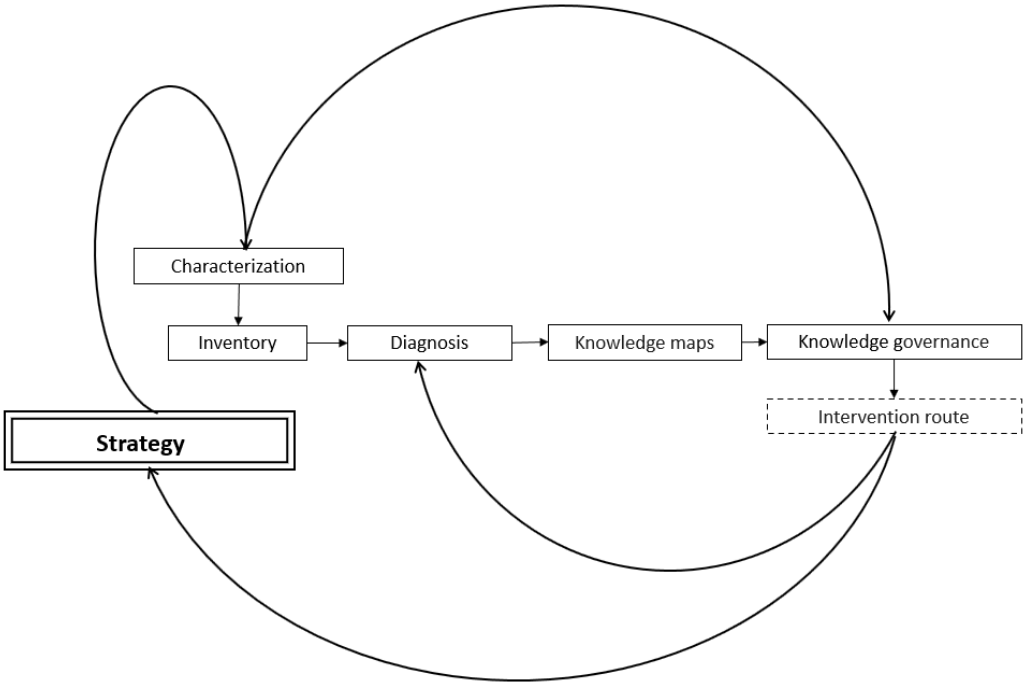


Figure 2: Knowledge Audit for HEIs

5. Discussions and Conclusions

This paper presented a systemic knowledge audit methodology for HEIs, grounded in a literature review and eight applied cases. While HEIs are knowledge-intensive institutions, the study revealed weak strategic assessment of organizational knowledge beyond academic domains.

The proposed model addresses this gap by enabling the identification, inventory, and management of critical knowledge from a relational and systemic perspective, positioning the audit as a reflective intervention (Czarniawska, 2003) that supports institutional learning.

It advances current KA practices by integrating strategic alignment, risk analysis, and governance into a unified framework. Unlike traditional audits focused on inventories, it accounts for the emergent and distributed nature of knowledge in HEIs. Its components—such as multi-level inventories, knowledge and risk maps, and intervention paths—support planning, self-assessment, and transformation processes.

Future research may extend this framework by developing specific tools, maturity indicators, and applications in diverse organizational contexts to reinforce its validation and scalability.

Ethics declaration: This research did not involve human participants, personal data collection, or procedures requiring ethical approval by an institutional review board. Therefore, ethical clearance was not required.

AI declaration: The authors used ChatGPT (OpenAI, GPT-4) solely for language editing and formatting support. All content was critically reviewed to ensure academic integrity.

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Knowledge Management and COVID-19: A Review of the Literature and Implications for Practice

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Abstract: Knowledge Management (KM) was an essential strategic resource during the Covid-19 crisis. KM has been crucial in guiding organizations to make strategic decisions on behalf of individuals. This paper aims to review the research on KM and COVID-19. Based on an empirical systematic review of research conducted, content analysis has been conducted for several peer-reviewed articles in the English language. Research findings, implications, and future research agenda are presented. The results indicate that deploying appropriate KM models and managing knowledge relevant to the COVID-19 epidemic enhances effective decision-making and enables crisis management. The findings stress the importance of using enterprise social networking (ESN) systems in times of crisis, especially during face-to-face restrictions.

Keywords: Knowledge management, COVID-19, Systematic literature review

1. Introduction

The COVID-19 outbreak initiated in China was declared a pandemic on March 12, 2020, by the World Health Organization (WHO) (Brătianu & Bejinaru, 2020). The pandemic affected business organizations worldwide in various ways (Azyabi, 2021, Easa et al, 2024). It is considered one of the most disastrous pandemics, as the world has introduced lockdowns, including several restrictions for each walk of life (Brătianu & Bejinaru, 2020). It requires visionary and capable leadership, organizational capabilities, and sustainable knowledge management practices to lower the impact of such a crisis. In addition, an organization's knowledge ecosystem becomes essential to create explicit and tacit knowledge, containment, and dispersion (Pinzaru & Zbuchea, 2020). Knowledge is crucial during pandemics and crises as it prevents the organization from potential harm by lowering danger to a minimum (Almatrooshi et al, 2021).

In pandemics and crises, employees work off-site, disrupting communication and reducing knowledge sharing (Abdalla, Renukappa, & Suresh, 2022). A similar situation developed during COVID-19 when the concept of working from home started trending and emerged as a threat to organizations' survival (Ng, Fong, & Lo, 2021). This time of difficulty made it possible for organizations to rethink that organizational survival is directly related to knowledge management and innovation (Schiuma, Jackson & Lönnqvist, 2021). According to Morawiec and Sołtysik-Piorunkiewicz (2022), the importance of knowledge management cannot be undermined to manage complicated and challenging situations successfully. In the early days of COVID-19, researchers focused on knowledge management concerning the healthcare sector (Menniniet al, 2021). It requires appropriate knowledge about preventive measures to address the issue quickly (Abdalla et al, 2022).

The quick adaption to external changes determines the resilience of an organization. It is only possible if support for dynamic knowledge is available in a timely available. Wang and Wu (2021) said knowledge is one of the organization's most important assets. However, an organization must know how to use the available knowledge best to ensure business sustainability, especially during turbulence (Mennini et al, 2021). In this regard, Azyabi (2021) complemented the endurance of organizations linked with effective knowledge management and its usage. Wang and Wu (2021) further suggested that knowledge management can develop a better solution for managers to optimum use of scarce resources when a crisis hits the organization. To survive the coronavirus pandemic, organizations must need to develop strategies and methods for managing knowledge (Schiuma et a, 2021). Effective knowledge management can become a reason for organizational survival during Covid-19 and may be a significant factor in its amassed performance (Hsieh et al, 2020).

Nevertheless, knowledge management has yet to be researched concerning pandemics and crisis-related decision-making. The mentioned gap is being addressed in this research by analytically reviewing the available literature, especially conceptually and empirically investigated work relating to COVID-19 and knowledge management. The available knowledge, however, needs to be more articulated and highly fragmented, making the gap more prominent (Ammirato, Linzalone, & Felicetti, 2021).

2. Methodology of the Review

Google Scholar, Emerald, Science Direct, EBSCOhost, JSTOR, Taylor & Francis, Wiley Online Library, and Sage database were used to search for articles published in peer-reviewed international journals or recognized conference proceedings. Our strategy was confined to articles written in English to select relevant and coherent publications. We used keywords like "Knowledge management," "COVID-19," and combinations of these words. The authors managed and cleaned the data. The cited publications were chosen for their relevance to the authors' selected themes. We could find critical sources and rule out the others by analyzing each document's abstract. The relevance of the research, that is, the coverage of the stated subject, was the exclusion criterion. Following this screening, only 23 articles remained in the sample. The papers examined were published in 14 journals between 2020 and 2023 (Table 1). The list is mainly comprised of high-ranking journals in knowledge management.

Table 1: List of journals and ranking

Journal title	Article count	Percentage (%)	Journal ranking in Scopus
Knowledge Management Journals			
Journal of Knowledge Management	4	17%	Q1
Knowledge Management Research & Practice	3	13%	Q2
The Learning Organization	1	4.4%	Q2
Knowledge and Process Management	5	22%	Q2
General Management Journals			
Technology in Society	1	4.4%	Q1
Sustainability	1	4.4%	Q2
Journal of the Knowledge Economy	1	4.4%	Q2
Business Informatics	1	4.4%	Q4
Metamorphosis	1	4.4%	-
Journal of Work-Applied Management	1	4.4%	Open Access /DOAJ Seal
IEEE Engineering Management Review	1	4.4%	Q3
Conference Proceedings			
Proceedings of the 14th International Management Conference	1	4.4%	-
IEEE International Conference on Technology Management, Operations and Decisions (ICTMOD)	1	4.4%	-
Proceedings of International Conference on Emerging Technologies and Intelligent Systems	1	4.4%	-

3. Findings

The previous literature has outlined three main themes of KM linked to COVID-19.

3.1 Knowledge Management Strategies and COVID 19

In their study, Pinzaru and Zbuchea (2020) examined how to incorporate the lessons learned from COVID-19 into knowledge management strategies. They provided a thorough methodology for collecting and organizing tacit knowledge into explicit knowledge. This idea is to gather information and structure a knowledge repository on a collaborative interface that allows networking and communication to build a true knowledge culture. Pinzaru and Zbuchea (2020) highlighted that organizations should set up a unique Covid-19 outbreak learned lessons platform. Lessons learned should be explicitly labeled wherever they fit functionally (namely, departments, circumstances, etc.). Correct classification and distribution to the proper personnel are necessary. The platform's design should also be user-friendly to make usage as easy as possible. Starting with the lessons learned, organizations shall create and develop a knowledge culture at the cultural and organizational levels. Future studies need to go beyond empirical discussions and focus on observations on how the lessons learned during the COVID-19 outbreak are really being implemented into company strategy (Pinzaru & Zbuchea, 2020).

Iacuzzi, Fedele, and Garlatti (2020) focused on the different knowledge management strategies. Under the medical crisis caused by the diffusion of the COVID-19, three schools in Northeast Italy were able to assess critical assets and practices to strategically manage knowledge and maintain functioning during instability whilst responding to uncertain circumstances. Three factors were identified: the directing role of educational leaders, support structures that assisted in sustaining services and activities, and ICT infrastructures that enabled educational and administrative activities to be managed remotely. The authors revealed that Coronavirus epidemics have an influence on knowledge, techniques, and tasks in the Italian educational system. The study emphasized the importance of revisiting existing knowledge management practices and reconsidering those that do not contribute to the larger institutional aim in the current setting.

Hsieh, Nguyen, Wang, and Lee's (2020) research uncovered distinct effective knowledge management techniques for competitive advantage in the franchising hospitality sector. The research revealed three primary topics as effective knowledge management strategies: geographical advantage, crisis management, and a headquarters system. The findings revealed that a strategic knowledge management implementation technique might lead to a massive operation while simultaneously adjusting a firm's competitiveness and performance.

Brătianu and Bejinaru (2020) examined the properties of emergent knowledge strategies and compared them to purposeful knowledge strategies. Deliberate methods are no longer effective, and organizations must move swiftly to ensure their survival. Emergent strategies are based on what is unknown, while deliberate strategies are based on what is known. As a result, KM shall swiftly migrate from knowledge exploitation to knowledge exploration and from knowing what we don't know to not knowing what we don't know.

From a knowledge management perspective, Ng, Fong, and Lo (2021) developed an integrated risk-based paradigm for practice that supports quick action through respective authorities during an epidemic outbreak. The study emphasized the importance of establishing confidence within a healthcare system as the base of KM and communicating by maintaining that public health officials share information consistently through the media whilst also establishing a prolonged working collaboration in spreading vital information during a global epidemic.

Tomé, Gromova, and Hatch (2022) argued that the COVID-19 pandemic is a knowledge disaster with a severe knowledge failure at its heart. They declared that to overcome the coronavirus outbreak, a combination of "old normal" and "COVID-19" knowledge strategies is required. New competencies and abilities will be developed because of the new system. New competencies will indeed be addressed via the use of technology (as hybrid solutions), by changing people (dynamic capabilities and competencies), and by mandating the development of new procedures (new knowledge management strategies).

3.2 ICT and Knowledge Management During COVID-19

Lockdowns in global markets because of the COVID-19 epidemic have expedited a pre-existing shift brought about by the pervasiveness of digital technology (Klein & Todesco, 2021). COVID-19, according to Pinzaru and Zbuchea (2020), boosted and expedited the digitalization process by mandating remote working and demanding rapid business adaption and optimization. It is worth noting that collaborative digital technology (DT) will enable real-time cooperation and knowledge exchange after the epidemic. Knowledge management is required so that the potential of digital technologies may be investigated and used (Klein & Todesco, 2021). Stakeholders will also have more significant and faster access to knowledge (Pinzaru & Zbuchea, 2020).

Wang and Wu (2021) focused on IT-enabled knowledge management and crisis management approaches to fully understand how to use knowledge management in crisis management contexts via IT to avoid or mitigate negative crisis implications for healthcare organizations in Taiwan and lessen the risk of exposure to COVID-19. Mennini et al (2021) argued that decision-makers could manage a crisis by integrating and using data from interactive techniques by employing a knowledge management approach based on the communal sharing of knowledge processes.

Chaturvedi and Singh (2021) offered different knowledge management initiatives that combine technology, process stakeholders, and the relevant organizations. The authors emphasized the need to accelerate knowledge management procedures since knowledge is critical to the success of employees and organizations. Chaturvedi and Singh (2021) recommended developing a solid knowledge management platform with artificial intelligence (AI) capabilities and using integrated digital technologies best. According to Al-Hakim et al (2020), with the use of technology and the application of artificial intelligence, the organization should be capable of delivering a complete, adaptable, and objective knowledge mapping.

Knowledge management processes may be effectively applied in the COVID-19 situation to provide a focused and effective response to the epidemic (Chaturvedi & Singh, 2021). According to Wang and Wu (2021), developing knowledge management techniques to cope with COVID-19 is critical. Mennini et al (2021) added that the COVID-19 outbreak has adversely impacted public bodies' ability to respond to the crisis promptly and efficiently, emphasizing the importance of these organizations reinventing their knowledge approach through process reconfiguration. Azyabi (2021) argued that KM processes enable enterprises to significantly cut lead times by identifying and responding to changing market conditions.

Azyabi (2021) studied the influence of KM processes and information technology on SMEs' responsiveness to the coronavirus crisis. The study assessed the effectiveness of 136 SMEs in the Kingdom of Saudi Arabia in responding to and dealing with the challenges of the COVID-19 epidemic. Raudeliuniene, Albats, and Kordab (2021) highlighted that information technology and social networks positively influence the knowledge management cycle in Middle Eastern organizations. The authors added that the COVID-19 pandemic has exacerbated the global demand for new communication and knowledge-sharing technology.

Sharing knowledge with external and internal organizations may greatly assist SMEs in making better decisions about their varied activities (Azyabi, 2021). This approach may have a role in mitigating the effects of the COVID-19 epidemic. Wang and Wu (2021) revealed that knowledge management enables health organizations to fully utilize knowledge resources to make informed decisions for coping with the COVID-19 pandemic. Haneberg (2021) argued that the COVID-19 epidemic had significantly influenced entrepreneurial endeavors, particularly in areas with few knowledge resources and high contextual uncertainty.

Wang and Wu (2021) added that knowledge management platforms support the improvement of knowledge's accuracy, consistency, and dependability, minimizing fear and anxiety caused by deception and allowing vital ability to be widely shared, assessed, and updated regularly as needed. Mennini et al (2021) highlighted that to build effective strategies and deliver services that meet people's requirements, public institutions must recognize the significance of managing common knowledge.

According to Abdalla et al (2022), smart cities (SC) technologies and techniques encompass a substantial perspective for controlling COVID-19, and their significance is expected to grow in the future. They also stated that using SC technologies allows for effective public participation during the outbreak and permits two-way interaction, which significantly influences implementation protective measures. Hence, investing in knowledge management is crucial since it is one of the significant factors determining the effect of COVID-19 epidemics.

3.3 Knowledge Management and COVID-19 Crisis Management

The Coronavirus enabled individuals, societies, and companies to recognize the absence of a crisis management philosophy on various stages (Almatrooshi et al, 2021). Considerable numbers of research have discussed knowledge management's role in managing the COVID-19 crisis. Edghiem, Guo, Bridge, and McAreavey (2021) suggested the formation of cross-university working groups to improve knowledge sharing among Northwest universities. This will enable the rapid exchange of COVID-19 adaptive guiding principles and the outcomes of coming up with new creative efforts to lead COVID-19 responses. Knowledge management practices help crisis management (Oktari et al, 2020) because available knowledge assists in quick, visionary, and practical decisions learned from past experiences (Martins et al, 2019).

Li, Zhou, Stafford, and Wang (2020) proposed a crisis management prototype model emphasizing the coronavirus outbreak. During the knowledge acquisition procedure, crisis management stakeholders (frontline staff, administrative authority, and technical authority) ought to obtain important crisis management knowledge (COVID-19) needed at work. Li et al (2020) added that effective coordination among these three critical players in knowledge extraction and sharing is necessary for the system and crisis management efforts to succeed. Cegarra-Navarro, Vătămănescu, and Martínez-Martínez (2020) examined knowledge hiding as a coping strategy during the initial stages of the pandemic, comparing behavioral trends in Spain and China. Their findings shed light on how national and organizational cultures influence knowledge practices under pressure. Building on this, Cegarra-Navarro et al. (2021) introduced a context-sensitive view of the shift from knowledge hiding to citizen engagement, underscoring the fluid and adaptive character of knowledge management (KM) processes across both public and private sectors. Further, Martínez-Martínez et al. (2022) applied bibliometric methods to trace the development of environmental KM in the hospitality sector during the COVID-19 period, highlighting how industry-specific research can expose thematic blind spots and identify emerging research priorities.

4. Discussion and Implications

Twenty articles related to knowledge management and COVID-19 published between 2020 and 2022 were reviewed and analyzed in this study. Three main themes were identified: knowledge management strategies, knowledge management, crisis management, and ICT and knowledge management. The COVID-19 epidemic demonstrated how organizations operate in a complicated and volatile business environment. The COVID-19 disaster occurred because of a significant knowledge failure at its core, which exacerbated the crisis.

The COVID-19 epidemic has added to uncertainties and challenged organizations' sustainability. Findings revealed that the management of knowledge for innovation is intrinsically linked to the survival of organizations. Grasping the approach and techniques for managing knowledge to survive the COVID-19 outbreak is critical for any organization's livelihood and sustainability. Previous studies highlighted the importance of knowledge management in managing crises such as COVID-19. Knowledge management is regarded as essential to managing organizations through a problem. The findings indicate that deploying appropriate KM procedures and working knowledge relevant to the COVID-19 epidemic enhances effective decision-making and enables crisis management.

Furthermore, knowledge management strategies are critical in building organizational resilience and reorganizing operations (Easa, 2019, El Khatib and Ali, 2022). KM is expected to give valuable insights to assist managers in rethinking their organizations so that it provides them with the KM ability to digest and respond to the COVID-19 epidemic's consequences successfully. Many industries and businesses are expecting hybrid remote work to become a reality. Firms have realized they need more than traditional strategic thinking in planning and making the right decisions. Leaders must acquire new skills and capabilities to lead firms in the post-pandemic period successfully. On the other hand, IT solutions may improve organizations' knowledge management and crisis management capabilities by increasing organizational responsiveness and flexibility.

Organizations must focus on knowledge exploration and obtaining new competencies through hybrid solutions, building dynamic capabilities, and establishing new emergent strategies to maintain their survival. According to the findings, KM has been crucial in creating knowledge-based networks to develop ideas, find the most suitable techniques for exchanging and analyzing information, and expand capabilities to generate creative solutions. Several studies have recommended using digital technology and investing in knowledge management systems to better communicate and share knowledge during a pandemic like COVID-19.

This research aimed to illustrate how KM, as a contemporary practice and theory, may help managers reconsider and revive their organizations in a crisis. The bulk of the existing research is conceptual, and empirical studies are needed to examine and extend the findings to ensure organizations' resilience during a pandemic.

Ethics statement: We hereby declare that ethical clearance was not required for this research.

AI statement: We hereby confirm that AI tools were not used the creation of this paper.

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How Do Consumers Perceive the Benefits for Businesses Arising from Their Active Involvement in Business Activities and Projects?

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Abstract: Consumer collaboration with businesses has become increasingly prevalent, with consumers being actively involved in various projects aimed at providing their ideas, opinions, and knowledge. These collaborations often leverage digital technologies and occur without formal contractual agreements. While the benefits for consumers are well-documented, the advantages for businesses remain underexplored. This paper presents a study on the benefits businesses gain from the active involvement of consumers in business activities and projects, focusing on consumer perceptions. Using a model of business benefits derived from a systematic literature review, the study categorizes these benefits into four main groups: product-related, reputational, economic and social, and technological and informational benefits. The research, based on 375 consumer surveys, reveals that consumers most strongly associate their involvement with reputational benefits, such as a better understanding of customer needs, more effective promotional activities, and improved customer relationships. Product-related benefits, such as product personalization and tailoring offerings to consumer needs, were also identified as highly valuable. Additionally, technological and informational benefits, including access to emerging market trends and enhanced digital engagement, were seen as critical for driving innovation within companies. However, economic and social benefits, such as risk minimization and the establishment of new distribution channels, were perceived as less impactful by consumers. These findings offer valuable insights for businesses looking to harness consumer knowledge effectively, emphasizing the importance of leveraging consumer input to enhance brand reputation, product offerings, and technological advancements, while also considering potential risks and limitations.

Keywords: Consumer collaboration, Consumer engagement, Benefits for businesses, Product-related benefits, Reputational benefits, Economic and social benefits, Technological and informational benefits

1. Introduction and the Research Gap

The primary focus of this paper is the concept of collaboration between consumers and businesses. Consumers are actively engaged in business projects and tasks aimed at gathering their ideas and knowledge. This collaboration is characterized by continuous variability and dynamism, built upon the utilization of specific knowledge sources and new technologies. It takes on an informal nature, meaning it is not regulated by contracts or formal documents. This collaboration often stems from consumers' willingness to share knowledge and their interest in utilizing new technologies in this regard.

Among the projects that engage consumers are those aimed at the development of applications and IT. A notable example is Apple in Poland, where users were involved in evaluating and providing ideas for product and service development. Additionally, both in Poland and the UK, consumers were engaged in co-designing the OS 11 operating system. Another example is IBM, which engaged customers in Poland in providing ideas for the development of the company's webpage, while at the same time in the UK, customers contributed ideas for additional testing and product development. These projects were carried out between 2018 and 2019 (Ziemba et al., 2022). Importantly, consumer involvement in such activities benefits both businesses and their customers (Eisenbardt, 2020).

The study utilizes a model of business benefits, developed based on a systematic literature review (Eisenbardt, 2024). A thorough analysis of the literature indicates that these benefits can be divided into four categories: product-related, reputational, economic and social, and technological and informational benefits.

The aim of this paper is to explore and evaluate how consumers perceive the benefits that businesses gain from their active involvement in business activities and projects, with a particular focus on identifying which types of benefits – product-related, reputational, economic and social, and technological and informational – are considered by consumers to be the most valuable for companies. The study seeks to provide a consumer-driven perspective on value co-creation and its perceived impact on organizational outcomes. To achieve this aim, the paper is organized into the following sections. It begins with an introduction that outlines the context and importance of consumer engagement in business activities, followed by the literature review, which presents relevant theoretical frameworks for the benefits companies gain from customer involvement. The methodology section details the research approach. The results section presents the empirical findings, highlighting the benefits most recognized by consumers across the four categories considered. Finally, the conclusions

summarize the key contributions, propose practical recommendations for business practice, and suggest avenues for future research.

2. Literature Review on Benefits Arising from Consumers' Activities

This literature review adopts a systematic approach to identify, analyze, and synthesize scholarly research on the benefits of consumer engagement and knowledge sharing for businesses. In the context of consumer collaboration with companies, this approach is particularly relevant for understanding the advantages businesses gain from involving consumers. By actively engaging consumers in various business activities and related projects, companies can obtain valuable insights and strengthen their connection with customers, leading to a wide range of potential benefits (Braun et al., 2016; Hernández-Serrano et al., 2017). These benefits can be categorized into four main groups.

The first category includes product-related benefits, which refer to the fact that engaging consumers in the development process enables companies to create more personalized products or services that are tailored to consumer needs (Chatterjee et al., 2022; Costa and do Vale, 2018; Dewalska-Opitek and Hofman-Kohlmeyer, 2021; Gligor and Bozkurt, 2021; Scarlett et al., 2022; Shi et al., 2023). Additionally, this collaboration can contribute to extending the product life cycle, ensuring that the product remains relevant over time (Katona, 2015). By co-creating products or values, businesses can align their offerings more closely with customer preferences, improving overall satisfaction (Abaidi, Cottel, and Abaidi, 2022). Furthermore, this involvement enables businesses to stay at the cutting edge of service modernity by testing and improving services through direct feedback from consumers (Chang and Hsu, 2022; He et al., 2022). This helps companies minimise last-minute changes and adapt quickly to market demands.

The second group are reputational benefits. The direct involvement of consumers in business activities contributes to more effective promotional and advertising strategies, as companies gain insights into consumer preferences and needs (Burnham et al., 2021; Klimontowicz, 2019). Understanding these needs more deeply leads to more targeted campaigns and better customer relationships (Kohli et al., 2021; Kumar and Kaushik, 2022; Kumar and Kumar, 2020; Sarkar and Banerjee, 2021; Voorhees et al., 2021; Wang et al., 2023). It also helps companies distinguish themselves from competitors by offering unique products and services. By building long-lasting relationships and improving customer retention, businesses can enhance brand loyalty and reputation (Abou-Shouk and Soliman, 2021; Bies et al., 2021; Haq et al., 2025; Jayasingh, 2019). Ahmed et al. (2022) and van Heerden and Wiese (2021) describe consumer engagement as a process through which customers develop connections with brands that extend beyond mere purchase transactions. In addition, involving consumers strengthens the alignment of customer interests with those of the company, resulting in a positive impact on the company's overall image (Boardman et al., 2016; Dessart et al., 2015; Lowe and Johnson, 2017). These interactions can also stimulate creative thinking within the business, leading to innovative solutions that further strengthen the company's position in the market (Bui et al., 2022; Narang and Tiwari, 2022). Recent research also shows that in immersive digital environments such as the Metaverse, Generation Z consumers actively participate in brand-related activities and value co-creation, driven by key psychological factors that enhance business–consumer engagement (Dewalska-Opitek and Szejniuk, 2024; Park and Chung, 2023).

(2021) describe consumer engagement as a process through which customers develop connections with brands that extend beyond mere purchase transactions. In addition, involving consumers strengthens the alignment of customer interests with those of the company, resulting in a positive impact on the company's overall image (Boardman et al., 2016; Dessart et al., 2015; Lowe and Johnson, 2017). These interactions can also stimulate creative thinking within the business, leading to innovative solutions that further strengthen the company's position in the market (Bui et al., 2022; Narang and Tiwari, 2022).

The third group identified are economic and social benefits (Chatterjee et al., 2022; Chi et al., 2022; Hook and Kulczynski, 2021; Lowe and Johnson, 2017; Nadeem et al., 2023; Odoom et al., 2017; Rondell et al., 2016; Sarkar and Banerjee, 2021). One of the primary economic advantages of involving consumers is the potential for increased profits, as consumers are often willing to pay premium prices for products and services that meet their specific needs (Grassi, 2020; Lee, 2022). This active involvement also helps minimise risks, as businesses can test products and services before full-scale release, ensuring that they meet customer expectations (De Bruyne and Verleye, 2023.; Stocchi et al., 2018). Furthermore, consumers can act as business partners, helping to establish new distribution channels (Khare et al., 2022). By building a community around the company and aligning with sustainable development goals and corporate social responsibility (CSR), businesses can cultivate a loyal and engaged customer base that supports long-term success (Lee, Kim, Kim, 2021; Lin, Nugraha, and Hsu, 2025; Park and Kim, 2022; Say et al., 2021; Wan et al., 2022).

Technological and informational benefits are no less important (Bui et al., 2022; Labrecque et al., 2022; McLean et al., 2021; Narang and Tiwari, 2022; Stancu et al., 2022; Stocchi et al., 2018). Direct feedback from consumers also facilitates the collection of valuable insights on emerging market trends, allowing businesses to adapt more quickly to technological advancements (Costa and do Vale, 2018; Davis et al., 2019; Demmers et al., 2020; Gligor and Bozkurt, 2021; Lee et al., 2018; He et al., 2022; Jimenez et al., 2019; Rohden, Tassinari, and Netto, 2023; Zor et al., 2022). Additionally, engaging consumers enables continuous improvement in IT infrastructure (e.g., websites, apps, and other digital platforms), which is critical for businesses that want to stay competitive. Investing in modern IT systems and leveraging diverse sources of information from consumers also helps businesses maintain a technological edge, improving operational efficiency and decision-making.

By leveraging these four categories of benefits, businesses can enhance their innovation capabilities, build stronger relationships with their customers, and ultimately improve their market position. This research will investigate how these benefits manifest in the context of consumer-business collaboration and how companies can maximise the value of consumer engagement.

3. Research Methodology

3.1 Research Questions and Theoretical Framework

The focus of the current study is to explore the benefits for businesses associated with consumers' knowledge, based on consumers' perspectives. In other words, it aims to understand how consumers perceive the advantages that companies may gain through their active involvement in business activities and projects. This includes examining consumers' views on how businesses can leverage their knowledge to enhance product development, marketing strategies, customer service, and overall business performance. By exploring these aspects, the study seeks to provide valuable insights for companies looking to effectively harness the power of consumer knowledge.

In this context, the study attempts to answer the following research question

RQ: How do consumers perceive the benefits that businesses gain from their active involvement in business activities and projects, and which categories of benefits do they consider the most valuable?

To answer the main question, four sub-questions were developed:

- Which product-related benefits are perceived by consumers as the most valuable for businesses?
- To what extent do consumers recognize reputational benefits for businesses resulting from their active involvement?
- How do consumers evaluate the economic and social benefits of their engagement for businesses?
- What is the perceived value of technological and informational benefits for businesses?

Based on the conducted systematic literature review (SLR), a comprehensive framework of benefits for enterprises resulting from active consumer engagement in business activities and projects has been proposed (a reference will be provided after the review process). This study focuses exclusively on the benefits for enterprises arising from consumer engagement, as presented in Table 1. The variables have been grouped into four categories of benefits: product-related, reputational, economic and social, and informational and technological.

Table 1: Theoretical framework for further studies

Benefits to companies	Variables
Product-related benefits	Personalisation of products/services according to customer needs
	Product life extension
	Co-creation of products/values
	Higher level of service modernity
	Tailoring the offer to customer needs
	Product and service testing by customers
	Brand loyalty
	Faster adoption of emerging market trends
	Reduction of last-minute changes

Benefits to companies	Variables
Reputational benefits	More effective promotional and advertising activities
	Better understanding of customer needs
	Offering products and services that stand out from the competition
	Building long-lasting relationships with customers
	Improved customer retention rates
	Loyalty to the company and brand
	Aligning customer interests with the company's goals
	Enhanced company image and reputation
	Increased out-of-the-box thinking within the company
	Participation of well-known individuals in promotional campaigns
	Trend forecasting
	Improved customer service quality
Economic and social benefits	Financial benefits, e.g., increased company profits
	Customers' willingness to pay a higher (premium) price
	Risk minimization
	New product distribution channels
	Gaining customers as business partners
	Building a community around the company/brand
	Improving business processes within the company
	Actions supporting sustainable development and corporate social responsibility
Technological and informational benefits	Direct posts and comments from customers
	Developing social media profiles (fan pages)
	Developing company mobile applications
	Access to emerging market trends
	Continuous improvement in IT areas (e.g., website, blog)
	Investing in modern IT systems
	Diversity of information sources

Source: own elaboration.

3.2 Research Procedure

To answer the research questions, a research instrument was developed. The instrument utilized the groups of benefits and associated variables, as presented in Table 1. For each item listed in the sections, respondents were asked to select one of seven responses on a 7-point Likert scale, ranging from (7) definitely yes—indicating that the benefit is very important to companies—to (1) definitely not—indicating that the benefit is not important to companies.

Data collection is an ongoing process, starting in December 2024 in Poland. The primary assumption for the sample was that consumers are capable of sharing opinions on company-related issues. Furthermore, Gen Z was chosen as the target group, as they are more willing to share knowledge with businesses and engage in activities that provide benefits for companies. Additionally, they have greater experience in using various applications. The questionnaire was anonymous, and participation was voluntary. Google Forms were used for the survey. After screening the responses, 375 valid responses were collected by March 2025 [research-in-progress] and used for analysis. The demographics of the respondents are presented in Table 2.

Table 2: Demographics of the research sample

	Total number	Total in [%]
Gender		
Females	238	63.5

	Total number	Total in [%]
Males	137	36.5
Not specified	0	
Age		
18 – 27 (Z Gen.)	350	93.3
Older than Z	25	6.7
Past experience related to collaboration with companies		
Positive experience	214	57.1
No-opinion	108	28.8
Negative experience	53	14.1

Source: Own elaboration. Reference for Age: (Beresford, 2025)

The data were stored in Microsoft Excel. Since the research is still ongoing, it was decided to limit the analysis to basic methods and statistics, such as descriptive statistics and frequency analyses.

4. Results on Benefits for Companies Arising from Consumers' Activities

To answer the main research question: How do consumers perceive the benefits that businesses gain from their active involvement in business activities and projects, and which categories of benefits do they consider the most valuable? descriptive statistics were used. The results for the key benefits are presented in Table 3. For each group of benefits, we have highlighted in bold the three benefits with the highest mean values.

Table 3: Descriptive statistics of perceived benefits of consumer engagement in business activities.

Variables	Average	Median	Mode	Variables	Average	Median	Mode
P1.	5.82	6	6	**R1.**	5.90	6	7
P2.	4.98	5	5	**R2.**	6.13	6	7
P3.	5.37	6	6	**R3.**	5.40	6	6
P4.	5.47	6	6	**R4.**	5.83	6	7
P5.	6.17	6	7	**R5.**	5.36	5	6
P6.	5.51	6	6	**R6.**	5.65	6	6
P7.	5.53	6	6	**R7.**	5.38	6	6
P8.	5.67	6	6	**R8.**	5.71	6	6
P9.	4.57	5	4	**R9.**	5.27	6	6
				R10.	5.30	6	6
				R11.	5.39	6	6
				R12.	5.88	6	7
E1.	5.55	6	5	**T1.**	5.77	6	7
E2.	5.22	5	5	**T2.**	5.79	6	6
E3.	4.85	5	5	**T3.**	5.61	6	6
E4.	5.26	5	6	**T4.**	5.72	6	6
E5.	4.96	5	6	**T5.**	5.56	6	6
E6.	5.80	6	6	**T6.**	5.30	6	6
E7.	5.18	5	5	**T7.**	5.51	6	6
E8.	4.91	5	5				

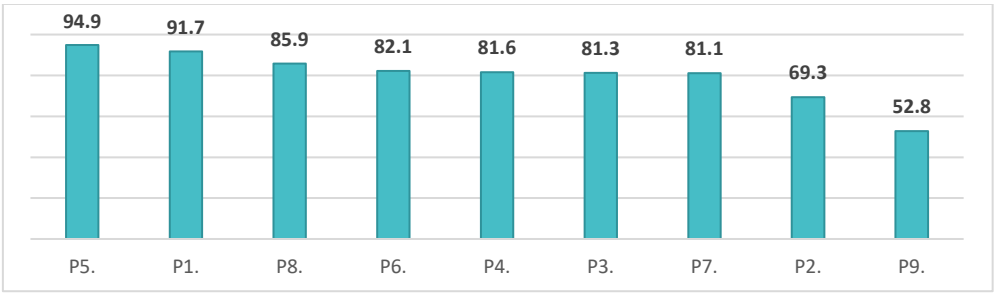
The descriptive statistics showed in Table 3 reflect how respondents evaluated various benefits for companies arising from consumer engagement in business processes and projects. In the product-related benefits, the highest-rated items were 'Tailoring the offer to customer needs' (P5) with an average score of 6.17, and

'Personalisation of products/services according to customer needs' (P1 – 5.82) indicating that personalization is considered a key value. On the other hand, reduction of last-minute changes (P9 – 4.57) received the lowest mean score, suggesting this benefit is less strongly perceived by participants.

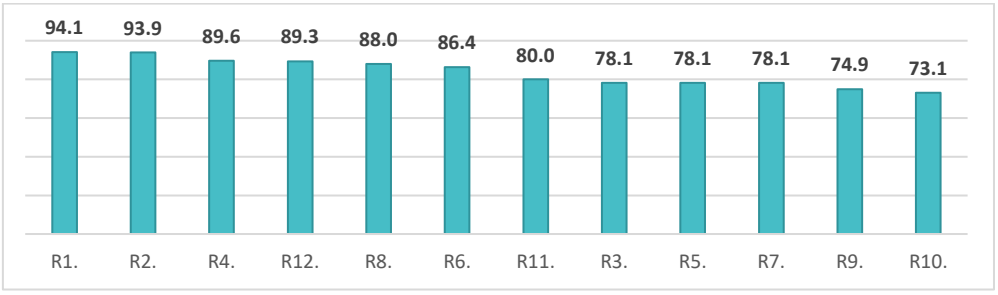
In the reputational category, the leading benefit was 'Better understanding of customer needs' (R2 – 6.13), closely followed by effective promotional activities (R1 – 5.90) and improved service quality (R12 – 5.88). These results indicate that customer engagement significantly supports communication and relationship-building. The consistent medians and modes (mostly 6 and 7) show high consensus among respondents.

The economic and social benefits show a more moderate perception overall. While building a community around the brand (E6 – 5.80) and financial benefits (E1 – 5.55) are rated fairly high, benefits like risk minimization (E3 – 4.85) and CSR activities (E8 – 4.91) scored lower. In the technological and informational dimension, results were consistently high, with social media engagement (T2 – 5.79) and direct customer feedback (T1 – 5.77) leading the category, reflecting the strong impact of digital interaction on business value. Overall, the findings highlight that customer engagement is most strongly appreciated in areas of personalization, communication, and digital feedback, while its role in operational efficiency or sustainability is perceived as less prominent.

The results presented in Table 3 highlight the varying perceptions of evaluated benefits for companies arising from consumer engagement in business processes and projects across four benefits categories. Therefore, it was decided to conduct a detailed analysis to provide a comprehensive overview. Respondents evaluated each item using a 7-point Likert scale, with scores of 5 to 7 indicating a positive assessment of the benefit's relevance to companies. The analysis focuses on the frequency of these positive responses, and the results are presented using percentage values to reflect the proportion of respondents who positively evaluated each benefit. The findings are shown in two separate figures: Figure 1, which illustrates the perceived importance of product-related and reputational benefits, and Figure 2, which covers the perceived importance of economic and social as well as technological and informational benefits.



a) Product-related benefits

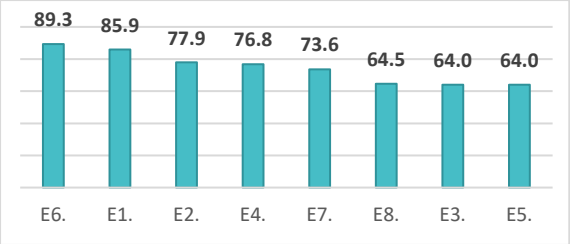


b) Reputational benefits

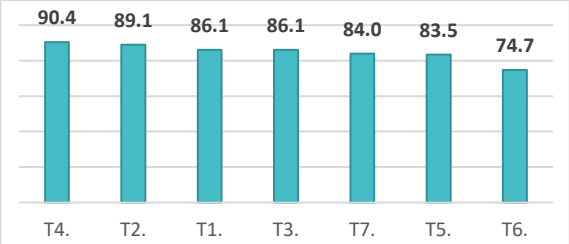
Figure 1: Perceived Importance of Product-Related and Reputational Benefits of Consumer Engagement

Figure 1 presents consumer perspectives on the importance of product-related and reputational benefits resulting from their engagement in business processes and projects. The results, expressed as percentages of respondents who rated each item positively (scores 5–7 on a 7-point Likert scale), reveal that product personalization (P1 – 91.7%) and tailoring the offer to customer needs (P5 – 94.9%) are seen as the most valuable contributions consumers make to businesses. Also notable are faster adoption of emerging market trends (P8 – 85.9%) and product and service testing by customers (P6 – 82.1%), highlighting the perceived role of consumers in supporting innovation and agility. At the lower end, product life extension (P2 – 69.3%) and reduction of last-minute changes (P9 – 52.8%) received comparatively modest support, suggesting these operational efficiency aspects are less visible or appreciated by consumers.

Reputational benefits were consistently rated very highly. Respondents strongly agreed that better understanding of customer needs (R2 – 93.9%) and more effective promotional and advertising activities (R1 – 94.1%) are key outcomes of consumer engagement. These are followed closely by building long-term customer relationships (R4 – 89.6%) and improved customer service quality (R12 – 89.3%), indicating that consumers recognize their role in shaping company reputation, brand loyalty, and communication effectiveness. These results underscore the consumer belief that their participation helps companies align more closely with market expectations and customer priorities.



c) Economic and social benefits



d) Technological and informational benefits

Figure 2: Perceived Importance of Economic, Social, Technological, and Informational Benefits of Consumer Engagement

Figure 2 illustrates the perceived value of economic, social, technological, and informational benefits arising from consumer engagement. Among economic and social benefits, the most appreciated was building a community around the company or brand (E6 – 89.3%), followed by financial benefits (E1 – 85.9%). These responses suggest that consumers recognize their influence on brand growth and financial outcomes. However, items such as risk minimization (E3 – 64.0%) and gaining customers as business partners (E5 – 64.0%) were less positively evaluated, indicating a lower perceived relevance of consumer engagement in strategic and structural business functions.

In contrast, technological and informational benefits were broadly recognized. Access to emerging market trends (T4 – 90.4%) and developing social media profiles (fan pages) (T2 – 89.1%) received particularly strong support, suggesting that consumers value their interactive role in shaping digital presence and market insight. Additionally, direct posts and comments from customers (T1 – 86.1%) and developing mobile applications (T3 – 86.1%) reflect the importance of ongoing digital feedback loops. Even the lowest-rated item in this category, investing in modern IT systems (T6 – 74.7%), still received a majority of positive responses, emphasizing a general awareness of the importance of digital infrastructure.

Taken together, the results in Figure 2 demonstrate that while technological and informational benefits are widely recognized and strongly supported by consumers, economic and social benefits are viewed as somewhat less direct or immediate outcomes of their engagement.

5. Concluding Remarks

The findings of this study offer valuable insights into how consumers perceive the benefits that companies can gain through active customer involvement in business activities and projects. Based on both descriptive statistics and frequency analysis, the results highlight that consumers most strongly associate their engagement with reputational benefits, product improvements, and technological advancements for companies.

From the consumer perspective, reputational benefits were rated highest, with particularly strong agreement on statements related to better understanding of customer needs, more effective advertising, and building long-term relationships. This suggests that consumers are not only aware of the impact their participation can have on brand perception, but also believe that their voice helps businesses align more closely with market expectations. The high ratings reflect the perception that engagement builds trust, enhances credibility, and strengthens brand identity. Product-related benefits were also perceived as significant. Consumers identified tailoring the offer to customer needs and personalisation of products/services as core areas where their involvement adds value for companies. These findings indicate that consumers view themselves as co-creators of value and recognize their role in shaping business offerings to be more relevant and responsive.

The study also reveals that consumers see clear technological and informational advantages for businesses, particularly in terms of accessing market trends, gathering direct feedback, and expanding digital presence through social media. These results suggest that consumers acknowledge their digital interactions as an

important asset for firms in making informed, data-driven decisions and enhancing innovation. Conversely, economic and social benefits were rated slightly lower, though still positive. Consumers appeared less convinced about the immediate financial returns or risk mitigation effects of their involvement. Elements such as risk minimization, CSR support, and gaining customers as business partners were among the least strongly associated with their engagement. This may indicate that while consumers see their input as shaping communication, innovation, and brand strength, they may not fully link their participation to more abstract or indirect organizational outcomes.

To sum up, consumers perceive their engagement as highly valuable for companies – particularly in building reputation, improving products, and enhancing innovation through digital channels. These insights can guide businesses in designing strategies that foster meaningful customer participation and communicate its mutual value. The study contributes to a deeper understanding of consumer-driven value creation and highlights the areas where companies can benefit most from active consumer involvement, as seen from the consumers' own point of view.

6. Limitations

While this study focused on benefits, future research could explore perceived barriers, limitations, or risks of consumer involvement in business processes. What is more, future research could compare the perceptions of consumers with those of other stakeholders, such as managers, employees, or investors, to identify alignment or divergence in the perceived value of consumer engagement. This would help determine whether businesses fully understand the areas of value consumers believe they contribute to.

Ethics declaration: The author declares that there are no conflicts of interest related to the present study. Furthermore, informed consent was obtained from all participants involved in the survey.

AI declaration: A Generative AI tool was employed to assist in the language revision process for this study. The tool was utilized to improve the clarity, coherence, and overall quality of the text, ensuring that the language used throughout the document is free from grammatical errors.

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Exploring Alternative Approaches to Contemporary AI Testing

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Abstract: While the first artificial intelligence test proposed by A. Turing has a long-standing tradition, it is no longer sufficient to meet today's challenges. There is now a strong need for more multi-contextual testing and comparison of AI solutions. Among other things, the emergence of the new Chinese language model, DeepSeek—designed to compete with Western solutions such as ChatGPT, Copilot, and Gemini—has caused quite a stir. It has not only influenced financial markets but also ignited a broader discussion about the quality of contemporary AI systems. As a result, there is a growing need to systematically test and compare these tools. The aim of this paper is to present an original attempt to identify and systematize contemporary approaches to AI testing. The discussion is framed by a reference to the Turing Test and its relevance in the modern context. The author seeks to identify common features between software testing, human intelligence testing, and AI testing. Subsequently, based on a critical analysis of relevant literature and other available sources, the paper outlines and organizes the types of tests currently in use. The conducted considerations allowed for the identification of three trends in contemporary AI testing: tests imitating or referring to human intelligence testing, tests analogous to approaches used in software engineering, and tests based on parameters.

Keywords: Testing of AI, Turing test, AI, Generative AI, GenAI

1. Introduction – the First Verification of Non-Human Intelligence

When discussing AI testing, it is impossible to overlook the first test in its historical context. In 1950, Alan Turing (Turing, 1950) proposed a test for artificial intelligence that involves determining whether a machine can deceive a human to the extent that the human believes they are interacting with another human.

The test is based on a game that Turing himself called the "*imitation game*." In this game, there are three participants: the interrogator, who is isolated from the other players, a human, and a computer. The interrogator's task is to determine, based on interactions with the other two players, which one is the human and which one is the machine.

For decades, it was believed that the Turing Test was impossible to pass. However, the rapid advancement of artificial intelligence has not only enabled many algorithms to exhibit intelligent traits but also to successfully pass the Turing Test — and even surpass it.

It turns out that AI sometimes surpasses human capabilities. What was once deemed impossible—such as defeating chess grandmasters (Deep Blue in 1997) or winning a Go tournament (Google DeepMind's AlphaGo), a game with even more possible moves than chess—is now history (Eisenbardt, 2023). These achievements are merely milestones in AI development.

Thus, intelligence, once considered an exclusively human trait, is no longer reserved solely for people. The Turing test may prove to be completely insufficient.

In this paper, two research questions will be posed. The first concerns the continued validity of the test. The second question is: should we expect that, in the future, additional AI tests will be needed—designed differently and focusing on aspects other than those considered so far?

2. Literature Background

2.1 Turing Test Deficiencies

Many authors criticize the Turing Test for its limitations and imperfections (Saygin, Cicekli, Akman, 2000; French, 2000), pointing out such flaws as bias related to human assessment, narrow scope of application, failure to take into account the fact that AI is already surprising humans in many areas (Mei, et al., 2024; Cameron, 2024), and also such special and very interesting observations as:

- The Chinese room argument – or "imitation of understanding" (Searle, 1980) – is a philosophical argument that (in simple terms) one can communicate in Chinese using a book without knowing the language at all. This is an apt reference to early AI solutions,
- The ELIZA effect refers to the name of the first chatbot of this name. This is a situation where a chatbot imitates intelligence, but in fact uses certain phrases and a certain conversation technique, based on language engineering, to only pretend to understand the content (Łomża, 2021).

Thus, the flaws or limitations of the Turing test had been demonstrated already many years ago. Nevertheless, it was referenced by a certain competition. The Loebner Prize represents exactly this type of competition. It was initiated in 1990 by Hugh Loebner and consisted of a chatbot annual tournament. It boiled down to the evaluation of conversations with chatbots by judges. The winner was selected whose conversation was considered to be the most similar to a conversation with a human. However, the competition was closed in 2020. Besides, it caused a lot of controversy from the beginning (Artiffical.., 2023; Wakefield, 2019; Floridi, Mariarosaria, Turilli, 2009).

So, the Turing test is not very complicated to perform, but at the same time it has many imperfections. The answer to these imperfections is the Feigenbaum's test (Feigenbaum, 2003) based on the selected field area and Ebert's test (Ostrow, 2011; Lee, 2011), regarding voice simulation. But to conclude this part of the study, let a quotation be used: "*imitating a human is only part of what AI can potentially do*" (Nikolić, 2019).

2.2 Competitors of GenAI

A considerable number of studies have already been dedicated to the history of artificial intelligence (Reynoso, 2024; Eisenbardt, 2023). However, the 2020s undoubtedly mark a period of rapid advancement in Large Language Models (LLMs) and Generative AI. One of the definitions is formulated as follows: „*a class of machine learning technologies that can generate new content—such as text, images, music, or video—by analyzing patterns in existing data*" (Brynjolfsson, Li, Raymond, 2023).

As recently as a few months ago (spring 2025), it was still possible to identify the key players in the LLM market. Above all, and unquestionably, these were ChatGPT[1] (Chat Generative Pre-trained Transformer) - produced by OpenAI. However, alternative solutions were proposed by, for example, Microsoft Corporation: Copilot[2], and Alphabet Inc. (owner of Google): Gemini[3], and also Claude[4] and others. At the beginning of 2025, reports emerged about DeepSeek[5] — a Chinese alternative to chatbots based on advanced language models (DeepSeek w praktyce…, 2025; DeepSeek – ujawnia…, 2025). The unexpectedly strong performance, coupled with significantly lower financial investments allocated for its creation, momentarily disrupted the financial markets.

The increasing competition and abundance of available solutions further emphasize the need for comparative tests to evaluate these solutions relative to one another.

3. Research Methodology

3.1 Research Goal and Questions

The aim of this paper is to present selected methods of testing AI, explore potential development trends in the field of testing artificial intelligence solutions, and carrying out a preliminary systematization of AI tests.

The following research questions were posed:

[Q1] Do contemporary AI tests relate to other tests, particularly to human intelligence testing and software testing?

[Q2] What parameters of artificial intelligence are currently being tested?

To achieve the objective and answer the research questions posed, a critical analysis of the relevant literature and a review of selected tools were conducted. The final outcome, depicted in Figure 1, was attained through the systematic organization of the obtained results and the application of creative thinking techniques.

3.2 Research Procedure

In the first step, a literature review on the Turing Test was conducted, followed by a critical evaluation of the test. This stage is reflected in the sections Introduction and Background. The next step involved identifying areas

[1] OpenAI ChatGPT, https://chat.openai.com

[2] Microsoft Copilot, https://copilot.microsoft.com

[3] Google Gemini, https://gemini.google.com

[4] Anthropic Claude, https://claude.ai

[5] DeepSeek, http://www.deepseek.com

of AI testing and comparing them with testing practices in software engineering (chapter Software Engineering and Testing). The subsequent part of the discussion focused on relating AI tests to human intelligence testing (chapter Human and Non-Human Intelligence Testing), with Howard Gardner's widely known Theory of Multiple Intelligences serving as a conceptual foundation.

Following this, an inquiry into the techniques and methods currently used in AI testing was carried out (chapter Contemporary Artificial Intelligence Tests). The issue of AI hallucinations was also addressed (Hallucinations as a Measure of Quality?), along with the parameters that are currently tested in practice (Parameters-Based Testing). All these steps aimed to answer the two research questions posed and to support the development of a proposed classification of AI tests, presented in the Conclusions chapter of this thesis.

4. Results

4.1 Software Engineering and Testing

Software testing is a part of software engineering. It is one of its pillars, and the importance and significance of testing are difficult to overestimate. There are many concepts and classifications of tests (Śmiałek, Rybiński, 2024; Sommerville, 2020; Sacha, 2010, Pressman, 2004). Among the various types of tests, there are unit tests, integration tests, system tests, and adaptive tests (the last two involving the user). Two opposing methods are also employed:

- "white-box (glass-box) testing", which focuses on the code and structure of the software,
- "black-box testing", where inputs and outputs are examined without delving into the software's internals or having knowledge of what is actually happening inside.

It is assumed that a successful test demonstrates the presence of defects, not their absence. In practice, conducting exhaustive testing to show that the software is completely error-free is, in most cases, impossible. Many literary sources indicate that methods similar to those used in software engineering are also applied to artificial intelligence, for example:

- unit tests and integration tests (Goodfellow, Bengio, Courville, 2016; Géron, 2019),
- accuracy and performance tests (Russell, Norvig, 2021; Murphy, 2012),
- robustness and error tests (Szegedy, et al., 2014; Papernot, et al., 2016),
- ethical and security tests (Binns, 2018; Doshi-Velez, Kim, 2017),
- user tests and A/B testing (Kohavi, Tang, Xu, 2020; Amershi, et al., 2019).

Nonetheless, the discourse continues to focus on the assessment of intelligence. Consequently, it is pertinent to draw parallels with human intelligence.

4.2 Human and Non-Human Intelligence Testing

Howard Gardner is an author of the Theory of Multiple Intelligences (MI). The theory was developed in 1983, and the author described it in his book Frames of Mind: The Theory of Multiple Intelligences. This theory is based on the division of the types of intelligence that characterize humans. The types of intelligence have been categorized into eight types, namely:

- logical-mathematical,
- verbal-linguistic,
- naturalistic,
- interpersonal,
- intrapersonal,
- visual-spatial,
- musical,
- bodily-kinesthetic (Gardner, 2009).

Later, H. Gardner added two more types of intelligence to this list: existential intelligence and moral-ethical intelligence.

Thus, human abilities, stemming from their innate intelligence, can influence future development. With proper self-awareness and the right reinforcement of individual traits through appropriate education, the chances of success in specific professions are increased. Therefore, everyone should make the best use of their own natural predispositions.

This theory remains highly popular to this day, but it has also faced significant criticism. The main critiques have been its lack of empirical evidence and the subjectivity of its assessments (Waterhouse, 2006).

An examination of Gardner's theory through the perspective of AI evaluation is warranted. To what extent can it be considered a foundational inspiration? While critiques regarding its lack of objectivity continue to hold relevance, the typology of intelligences it proposes remains invaluable. Given the proliferation of AI solutions and the extensive array of underlying algorithms, it becomes imperative to categorize their evaluation according to frameworks analogous to those advanced by H. Gardner.

In the subsequent part of the discussion, however, it becomes evident that contemporary methods of testing artificial intelligence frequently draw on human intelligence testing. Nevertheless, they are often even more diversified than what is proposed by the Theory of Multiple Intelligences.

4.3 Contemporary Artificial Intelligence Tests

There are many tests to which artificial intelligence is subjected. Here are some of them:

- AIME (American Invitational Mathematics Examination) This test refers to the prestigious American mathematics competition, which is the second stage of the selection process for the U.S. team for the International Mathematical Olympiad [6],
- MATH-500 is a set of 500 diverse mathematical problems, selected from a larger collection MATH Benchmark[7]. It was in this test that DeepSeek proved to be the best, even though the test was prepared by OpenAI,
- MMLU: is a benchmark created to assess the knowledge acquired during pretraining, by evaluating language models [8],
- SWE-bench: a test, which assesses the language model's ability to perform real-world software engineering tasks [9].

Continuing the discussion on the complexity of human intelligence, it should be noted that artificial intelligence can also be complex and can be classified in many different ways. This is why there is such a wide range of tests currently used to evaluate modern artificial intelligence algorithms.

Do the creators and users of AI recognize this complexity of human intelligence, and does it translate into the evaluation of artificial intelligence? In fact, a team of researchers at Google began implementing an initiative in 2022 called Beyond the Imitation Game (BIG-Bench). BIG-Bench gathered scientists from around the world. A set of approximately 200 tests was created, covering various fields of knowledge (Adamska, 2024).

The BIG-Bench comparative test (BIG-Bench Benchmark) is a very popular set of tests designed to evaluate the capabilities and intelligence of large language models (LLMs). BIG-Bench includes tests aimed at assessing (Srivastava, et al., 2022; Chowdhery, et al., 2022; BIG-Bench GitHub repository):

- language understanding,
- logic and reasoning abilities,
- creativity,
- general knowledge,
- mathematical skills,
- understanding of jokes, metaphors, and riddles,
- analysis of emotions and intentions,
- problem-solving in unusual or novel situations,
- understanding of context and cultural nuances [10].

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6 AIME Benchmark, https://www.vals.ai/benchmarks/aime-2025-03-13

7 MATH 500 Benchmark, https://www.vals.ai/benchmarks/math500-03-26-2025

8 Multi-task Language Understanding on MMLU, https://paperswithcode.com/sota/multi-task-language-understanding-on-mmlu

9 SWE-bench, https://www.swebench.com/

10 BIG-Bench GitHub repository, https://github.com/google/BIG-benchChowdhery

BIG-Bench Benchmark is a subset of BIG-Bench Hard (BBH). It is consisting of 23 challenging tasks from BIG-Bench, in which previous evaluations of language models did not exceed the performance of an average human evaluator. BBH evaluates models using prompting techniques, both through the method of few-shot, jak i chain-of-thought (CoT) (Suzgun, et al., 2022; Wei, et al.,2022; Kazemi, 2025).

It may thus be concluded that contemporary tests assess artificial intelligence in a comprehensive and multi-dimensional way. While the selected tests partially correspond to the Theory of Multiple Intelligences, they also encompass aspects not originally accounted for by the theory.

4.4 Hallucinations as a Measure of Quality?

Errors made by AI are referred to as hallucinations. In other words: hallucination is a response generated by AI that contains false or misleading information presented as fact (Maynez et al., 2020). The problem of AI hallucinations is a frequently discussed and genuinely fascinating topic (Ji et al., 2023; Hicks, Humphries, Slater, 2024; Ye et al., 2023; Tonmoy et al., 2024).

Is it sufficient to define the quality of machine intelligence by how often the machine makes mistakes? Does this approach make sense when applied to humans? After all, 'to err is human.' Therefore, the fact that we, as humans, make mistakes is completely natural. But should a machine also make errors? If so, why? Is it to prevent us from feeling embarrassed, because suddenly the human will be the one making mistakes, while the machine is always infallible?

4.5 Parameters Based Testing

Hallucinations and their frequency are not the only criteria that may indicate the quality of an AI system. The literature identifies numerous parameters that are relevant to the testing of artificial intelligence. Among them, several are particularly noteworthy (in parentheses, the approximate number of occurrences — in thousands — of the phrase 'AI + [parameter]' found in Google Scholar as of June 8, 2025, is provided):

- accuracy (5.860);
- latency (1.360) / performance (6.070);
- precision (4.400) & recall (2.010);
- hallucinations – mentioned above (146);
- generalization ability (1.540);
- consistency (5.350);
- robustness (3.690) / adversarial resistance (82);
- fairness & bias (406);
- explainability (169);
- resource efficiency (5.410).

It is worth noting that several of these parameters can already be tested using widely available Python libraries, such as scikit-learn. In each case, the number of results retrieved was in the thousands, with the most longstanding and commonly used parameters generating the highest volumes.

5. Conclusions

The Turing Test undoubtedly holds great historical significance. Its proposal marked a pivotal moment—both a milestone and arguably the beginning of artificial intelligence development. However, the discontinuation of the Loebner Prize serves as compelling evidence that deceiving a human into mistakenly believing a machine is not a machine is no longer the primary concern. Intelligent machines have been among us for quite some time, and we are fully aware of their presence. What matters now is their ability to perform—and how effectively they do so.

The tests presented above sometimes refer to the Turing Test, while at other times draw on widely used assessments from the field of software engineering. Artificial intelligence is also frequently evaluated using methods analogous to those employed in the testing of human intelligence.

Human intelligence is not homogeneous, as highlighted in Howard Gardner's Theory of Multiple Intelligences (MI), which distinguishes eight distinct types. Following this line of reasoning, a similar classification framework could be proposed for artificial intelligence. Given the vast diversity of AI applications, modern testing is increasingly losing its universality. The BIG-Bench Benchmark initiative, and particularly the BBH project,

demonstrates that such domain-specific work is already being carried out successfully. Contemporary AI tests are often tailored to specific fields or domains of knowledge.

Joseph Weizenbaum, creator of the ELIZA program developed between 1964 and 1966—the first chatbot in history—was notably skeptical of the growing fascination with machines simulating human conversation (Łomża, 2021). His main concern was that machine responses were not the result of genuine comprehension or learning, but rather a superficial simulation of thought. This concern resonates with the modern issue of AI hallucinations. Perhaps a key indicator of artificial intelligence quality could be its low propensity for hallucination—that is, the highest possible percentage of accurate responses. Still, in the context of testing and evaluating AI systems, hallucination frequency is not the only factor warranting attention.

It is also noteworthy that there is a growing trend toward testing AI systems based on selected performance parameters.

The findings are summarized in Figure 1. Based on the conducted analysis and reasoning, it can be concluded that there are at least three principal paradigms in contemporary AI testing. Artificial intelligence tests may thus be categorized as follows:

- those imitating or referring to human intelligence testing;
- those analogous to approaches used in software engineering;
- those based on specific parameters of AI functionality.

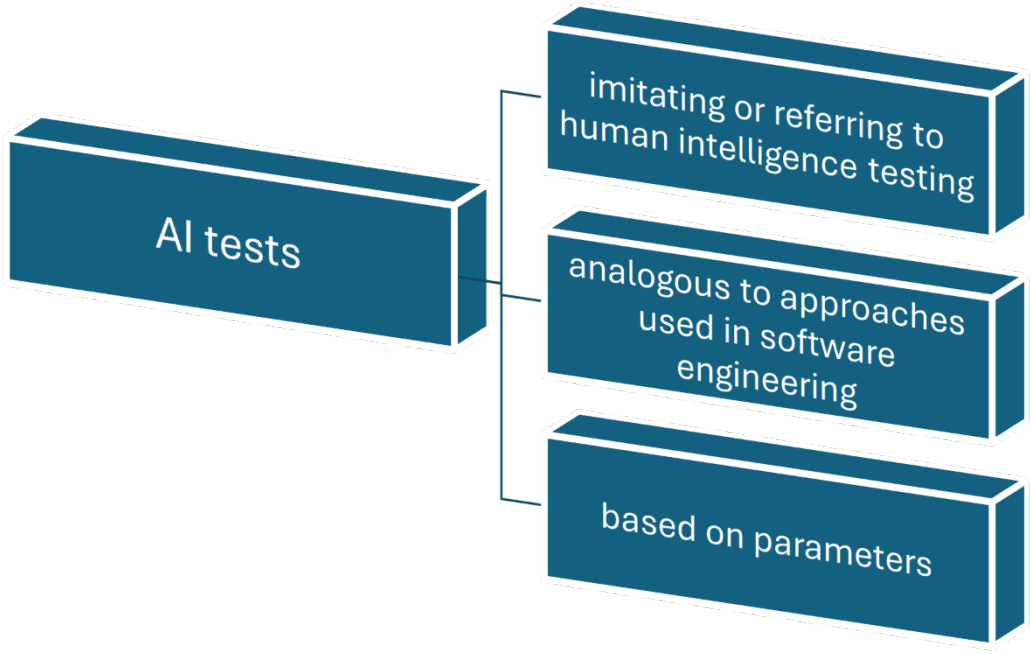


Figure 1. A proposal for the systematization of artificial intelligence testing Source: Author's own work based on the sources listed in the bibliography

In fact, we still view AI through the lens of human intelligence, testing it in ways that mirror human capabilities. However, the range of AI applications is constantly expanding. It was once inconceivable that artificial intelligence could autonomously create artistic content and be utilized in literature, music, painting, and graphic design. This transformation only began with the emergence of large language models (LLMs), and now it is a reality rather than the vision of a futurist. Following this line of reasoning, one can expect that much more will unfold in the realm of AI development and the consequent need for its testing.

6. Limitations and Implications

This study addresses an issue that is undergoing radical technological changes. Some of the presented theses and descriptions of solutions may be temporary and will not be applicable in the case of further, unpredictable developments in artificial intelligence. The presented state of knowledge pertains to the spring of 2025. The author anticipates that the issue of AI testing is currently in its early developmental phase. The described solutions are likely not final.

Ethics declaration: The author declares that there are no conflicts of interest related to the present study. Furthermore, informed consent was obtained from all participants involved in the survey.

AI declaration: A Generative AI tool was employed to assist in the language revision process for this study. The tool was utilized to improve the clarity, coherence, and overall quality of the text, ensuring that the language used throughout the document is free from grammatical errors.

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Project Execution Models and Knowledge Management

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Abstract: Projects are one-time activities that are aimed at achieving a particular objective within limited time and limited resources. Though projects are per definition unique, they also have known elements, such as known methods, approaches and solutions. Hence, projects are considered as learning arenas where new knowledge is developed (knowledge exploration), and existing knowledge is shared with other members of the projects (knowledge exploitation). Several measures are taken to ensure effective and efficient execution of projects. One such measure is to use project execution models. These models provide guidelines for project managers to conduct their projects effectively. They are developed based on the best practices and lessons learned over a period of time. They give a standard way of conducting projects in organizations. In this regard, it is interesting to look at project execution models with respect to knowledge management. This paper describes the connection between the application of project execution models and knowledge management by looking at concepts / theories that are related to knowledge sharing and learning. It also takes into consideration the topics of organizational structure and organizational culture to discuss the use of project execution models. Information about project execution models that are used in two municipalities in Norway serves as a background for this paper. Qualitative research method was applied in this study. Interviews were conducted to collect data. In addition to the interviews, document study was carried out to obtain more detail about the project execution models that are used in the municipalities. The study on which this paper is based, is connected to a pre-project that is financed by Project Norway. Project Norway is a national competence center for the development of future project processes through research and knowledge sharing.

Keywords: Reflection and learning, Continuous development, Knowledge sharing, Project management, Team development, Learning organizations

1. Introduction

Projects are considered as popular work-form, and several organizations conduct projects to achieve specific objectives within limited time and resources. Though projects are per definition unique, they also have known elements, such as known methods, approaches and solutions. Hence, projects are considered as learning arenas (Pemsel, 2012; Duffield & Whitty, 2015) where new knowledge is developed (knowledge exploration), and existing knowledge is shared with other members of the projects (knowledge exploitation). Several measures are taken to ensure effective and efficient execution of projects. One such measure is to use project execution models (PEMs). These models provide guidelines for project managers to conduct their projects effectively. They are developed based on the best practices and lessons learned over a period of time. They give a standard way of conducting projects in organizations.

The overall research question is: What is the connection between the application of project execution models and knowledge management? In this regard, this paper considers PEMs that are used in two municipalities in Norway to describe the connection between PEMs and knowledge management by looking at concepts / theories that are associated with knowledge sharing and learning. The aim is to contribute to building a conceptual foundation for PEMs from the knowledge management perspective.

2. Research Method

An interview-guide was developed, and interviews were conducted to gather data. A total of six interviews were conducted online. Project managers and department heads from the municipalities participated in the interviews. The interviews lasted approximately one hour. The interviews were semi-structured, thus providing a certain degree of flexibility to discuss relevant topics spontaneously and naturally. In addition to interviews, documents from the municipalities were used to gain a better understanding of the municipalities' PEMs. Those who participated in the interviews are mentioned as respondents in this paper.

3. Relevant Concepts / Theories

This chapter presents some concepts that are relevant for discussing the results of this study in Chapter 4.

3.1 Project Execution Models (PEMs)

PEMs are one of the central themes in project management. There are several processes, methods, and tools that support the effective execution of projects. PEMs are one of them that provide an overarching view of how a project can be carried out systematically. There are several definitions and descriptions of PEMs. According to

Rolstadås et al. (2023), a project model presents aspects related to a project; for example, criteria for evaluation, organizational solutions, procurement guidelines, division into (project) stages and phases, and control and decision points. The authors note that a project execution model – compared to project model – is more specific in terms of specifying phases, control gates, and decision points.

PEMs also provide information on who (the role / responsibility) does what, when and how (guidelines). One of the purposes of PEMs is to simplify communication internally and externally, so that the project is executed effectively. There are many advantages to using PEMs. Here are some of the advantages (Rolstadås et al., 2023, p. 133):

- standardize the way projects are executed
- ensure knowledge transfer and shared knowledge development as well as
- create predictability for those involved in the project

3.2 Reflection

Argyris and Schön (1996) are two of the key contributors to the development of the concept of organizational learning. When they discuss how learning can occur in organizations, they mention that reflection on a mismatch between expected outcomes and actual outcomes of an action or event can initiate a learning process. Inquiry into the mismatch leads to finding a solution to eliminate the discrepancy. This can occur in two ways:

- Single-loop learning: When a mismatch is experienced, one looks at existing procedures, rules, routines, and norms to correct the situation within that framework.
- Double-loop learning: This involves finding a solution to eliminate the mismatch by asking critical questions about existing norms, procedures, and assumptions. Here, questions such as "why do we do that we do?" are posed to uncover possible outdated assumptions and norms.

Another concept that can be related to the discrepancy (between expected outcomes and actual outcomes) is sense-making. Karl Weick is a key figure who has researched this concept. Here is a description of sense-making:

> *"Explicit efforts at sensemaking tend to occur when the current state of the world is perceived to be different from the expected state of the world, or when there is no obvious way to engage the world. In such circumstances there is a shift from the experience of immersion in projects to a sense that the flow of action has become unintelligible in some way. To make sense of the disruption, people look first for reasons that will enable them to resume the interrupted activity and stay in action. These 'reasons' are pulled from frameworks such as institutional constraints, organizational premises, plans, expectations, acceptable justifications, and traditions inherited from predecessors. If resumption of the project is problematic, sensemaking is biased either toward identifying substitute action or toward further deliberation" (Weick et al., 2005, page 409).*

The concept of sense-making requires reflection on what is happening or has happened. It is hence relevant to look at reflection on practice (that is, reflection on what one does or on one's experience).

Donald Schön (1998) discusses to types of reflection on practice in organizations:

- "Reflection-in-action": This involves reflection on an action (or event) while the action is taking place.
- "Reflection-on-action": This involves reflection on an action (or event) after the action has been completed.

Both types of reflection contribute to learning. The following quote illustrates how reflection can lead to learning – particularly, double-loop learning:

> *"A practitioner's reflection can serve as a corrective to over-learning. Through reflection, he can surface and criticize the tacit understandings that have grown up around the repetitive experiences of a specialized practice, and can make new sense of the situations of uncertainty or uniqueness which he may allow himself to experience" (Schön, 1998, page 61).*

Learning through reflection can occur at both the individual and organizational levels. To take a closer look at the process from individual to organizational learning, it is relevant to consider a model described by Nonaka and Takeuchi (1995), known as the SECI model.

3.3 The SECI-Model

The SECI model shows four processes for creating knowledge in organizations: Socialization, Externalization, Combination, and Internalization. The authors (Nonaka & Takeuchi, 1995) state that through these processes, interaction occurs between tacit knowledge (the type of knowledge that cannot be easily expressed directly in words) and explicit knowledge (which can be easily expressed in words) to create organizational knowledge / learning (Figure 1).

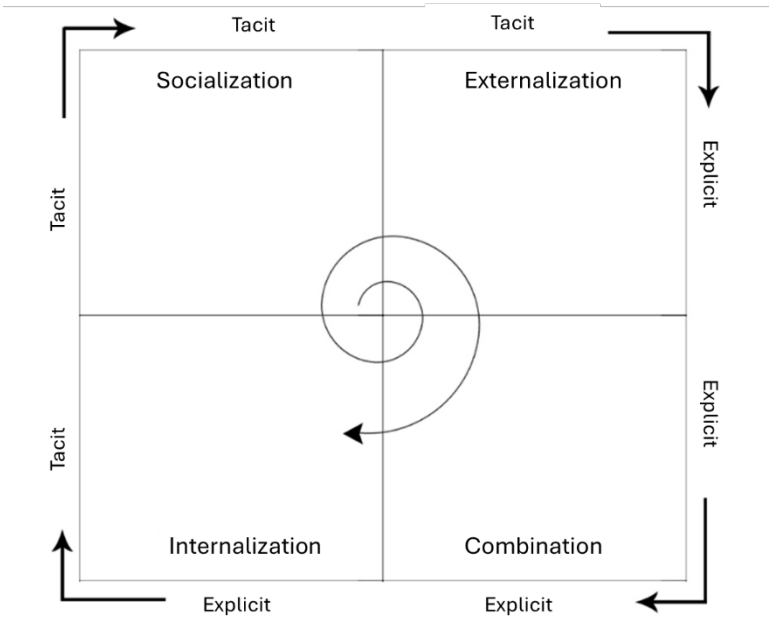


Figure 1: The SECI model (Nonaka & Takeuchi, 1995)

Here is a brief explanation of the four processes mentioned in the above figure:

- Socialization (Tacit to Tacit) – Socialization is a process for sharing knowledge, including observation, imitation, and practice. New employees work with their mentors in the organization to gain knowledge through direct interaction, imitation, observation, and practice.
- Externalization (Tacit to Explicit) – Externalization is the process that transforms tacit knowledge into explicit knowledge, where knowledge is crystallized and can thus be shared by others, becoming the foundation for new knowledge. At this point, personal tacit knowledge becomes useful to others as it is expressed in a form that can be interpreted and understood – for example, written documents.
- Combination (Explicit to Explicit) – Combination involves organizing and integrating knowledge, where different types of explicit knowledge are merged in a harmonized manner. The new explicit knowledge is then shared with other members of the organization.
- Internalization (Explicit to Tacit) – Internalization is about a process where a person receives and applies the new combined knowledge, so that knowledge becomes that person's personal knowledge (over time).

The internalization process usually occurs in several rounds. Kolb's model of experiential learning can be used to take a closer look at how this process takes place.

3.4 Experience-Based Learning

Experiential learning, introduced by Kolb, suggests that concrete experiences provide the basis for observation, reflection, and abstract conceptualization. Kolb's experiential learning model consists of four stages that develop in a spiral (Kolb, 1984):

1. Concrete experience
2. Observation and reflection on that experience
3. Formation of abstract concepts from that reflection
4. Testing of the new concepts

As one goes through the four stages, there is an opportunity to understand the new knowledge more and more in each round and gradually internalize the new knowledge.

Learning and knowledge sharing play an important role in collaborative work-settings such as projects. In this regard, it is relevant to look at another topic: Team development in projects.

3.5 Team Development

When a selection of people who do not know each other well is assembled into a group, they must go through a process to become an effective team. This process has five stages (Klakegg et al. 2023; Karlsen, 2023):

- Stage 1 – Forming: In this stage, the group members get to know each other. They show enthusiasm for starting something new, something exciting. They have positive expectations. They are eager to know their roles and tasks. Generally, the atmosphere is good at this stage.
- Stage 2 – Storming: In this stage, group members begin to find their place in the group/project. They try to figure out specifically what their tasks, responsibilities, and authority are. This stage can be characterized by frustrations, as some group members may be disappointed that their previous expectations about the project (their roles, the nature of the tasks, the collaboration situation, etc.) do not align with reality. Group members may try to position themselves, which can result in a kind of power play. Such disappointment and possibly the effects of the power play can contribute to increased frustration among group members. This will affect the group process moving forward.
- Stage 3 – Norming: In this stage, team members begin to understand each other more and more. There is better communication flow. They build trust within the group and dare to express their opinions and provide critical feedback (in a constructive manner) if needed. The group tries to avoid destructive conflicts moving forward. Each group member feels a sense of belonging to the group and accepts other group members as part of the team.
- Stage 4 – Performing: Interaction is very good in this stage. There is a high degree of trust among group members. Open communication and mutual understanding help coordinate activities better and manage changes and uncertainty effectively. Team members feel like part of a community and take pride in the work they do. Effectiveness is at its highest level in the process.
- Stage 5 – Adjourning: This is the concluding stage of teamwork. Since there is no long-term need for human resources in the project, members prepare to leave the group. They may begin to think about what happens after the project is completed. Will there be a new collaboration after this? What will be the work situation in the next project? Such thoughts can create concerns and/or frustrations among some team members, and this can negatively affect effectiveness.

Figure 2 illustrates the stages.

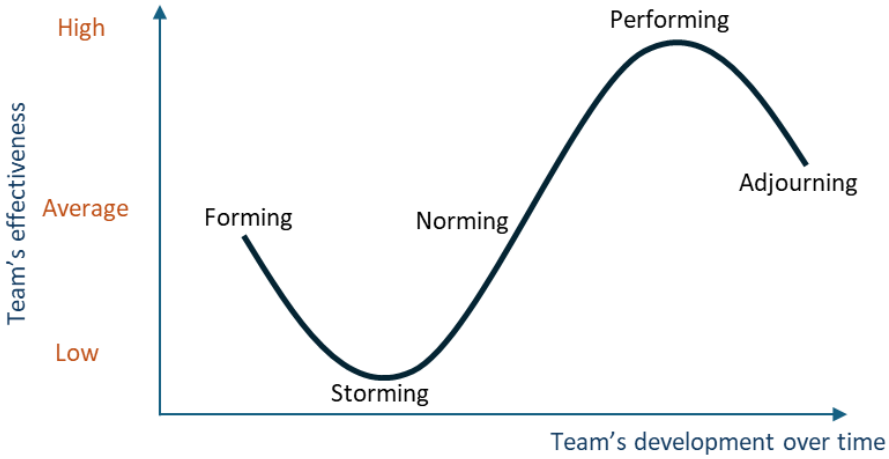


Figure 2: The five stages of team development (based on Karlsen 2021)

Some researchers (for example, Sjøvold, 2014) believe that a team development process does not have to go through all five of these phases. They argue that there may be groups that do not go through any of these phases. They also state that some groups experience these phases, not linearly, but as a sporadic mix based on varying

situations throughout the group process. This may seem natural to find, for example, in project processes that include many iterations where different specialists must solve problems together.

3.6 Systems Thinking and Learning Organizations

Systems thinking is about viewing a system not just as a collection of individual elements (that form the system), but also the relationships and interactions between the elements. Peter Senge (2006) addresses the theme of systems thinking in relation to learning in organizations. He is a central figure who has contributed to the development of the concept of learning organizations. He mentions that organizations that have a genuine interest and ability to learn something new and valuable to develop their competence can be referred to as learning organizations. Senge mentions five aspects that characterize learning organizations (Figure 3).

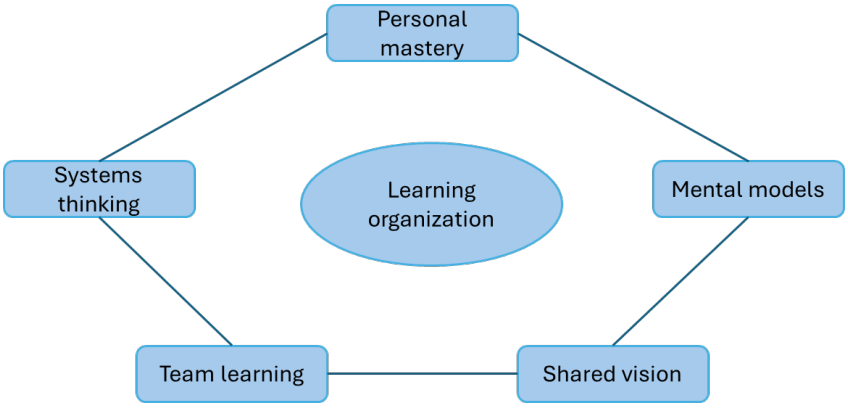


Figure 3: Learning Organization (Senge, 2006)

Here is a brief explanation of the five aspects (Senge, 2006; Klakegg et al., 2023):

- Personal mastery refers to an individual's genuine interest in learning and mastering something valuable, as well as the motivation, ambition, and vision they have to achieve it.
- Mental models relate to the assumptions, premises, and understanding one has, related to, for example, a task or a project. Some mental models are tacit – they are not explicitly expressed and may reside in the subconscious. It is important to reflect on and manage mental models, especially in a collaborative situation.
- Shared vision is important to ensure a common understanding (of, for example, a task or a project), team spirit, and a collaborative climate.
- Group learning involves sharing valuable experiences and knowledge that can ensure that one does not "reinvent the wheel." Sharing knowledge can also lead to developing new knowledge together.
- Systems thinking views a system not just as a collection of individual elements (that make up the system), but also the interaction/connection between the elements. Systemic thinking is about creating a holistic understanding to reap benefits: If a project team member understands how their task is linked to others' tasks, then it can be advantageous, for example, when they need to handle changes.

Senge mentions that learning organizations can effectively manage changes and uncertainty, increase productivity and profitability, and achieve sustainable competitive advantage.

4. Reflection and Discussion

Respondents mention that their PEMs contribute to ensuring effective execution of projects. This chapter discusses the use of these PEMs in accordance with concepts / theories presented in Chapter 3.

4.1 The Need to use PEMs

According to the respondents, PEMs are used in all phases from the start of the project to its conclusion. Not everyone actively uses the PEMs all the time; they are used when there is a need. The need for use may arise (1) when one does not know what must be done in a given situation, or (2) when one sees that there is some discrepancy between expected outcomes and actual outcomes related to an action or an event. Let us take a closer look at these two alternatives:

- Do not know what must be done in a given situation: This situation most likely concerns new employees. They may find it difficult to understand the situation – challenging with "sense-making" of the situation. It may be hard for them to figure out where they need to start. PEMs can assist them in this situation – providing an understanding they look for. Once the employees gain that understanding, then the outcome can be as follows:
- *They can obtain complete understanding and handle the situation immediately, or*
- *They can get a preliminary understanding and then they have become to know specifically what they need to know more about, so that they can handle the situation. That is, PEMs provide them with a foundation for determining what kind of details they need to learn more about. The need for details may vary from person to person, and it is not possible or appropriate to include all details in PEMs. When PEMs provide the basic information to the employees, then the employees gain a certain understanding first, which can help them to figure out specifically what additional information that they need to know more about to handle the situation. They can then utilize relevant sources to obtain that information /* knowledge. This can be seen as a process where sense-making occurs.
- Discrepancy between expected outcomes and actual outcomes: In this context, PEMs serve as a means to promote single-loop learning; that is, one looks at existing procedures, standards, and norms – which PEMs represent – to find a solution that can eliminate the discrepancy. If existing procedures and standards are not applicable to address the current situation, then opportunities for double-loop learning may arise. The resulting new knowledge can contribute to the work on revising and improving the PEMs. It is to be noted that the municipalities collect information on difficulties in using PEMs and improve their PEMs periodically.

4.2 Internalization and the SECI Model

The development of the municipalities' PEMs can be seen in connection with the SECI model. It appears that the development, use, and revision of the PEMs primarily concern the following components of the SECI model:

> *New knowledge (new best practices) has been identified and learned in collaborative / socialized settings, and the crystallization and development of that knowledge goes through externalization, combination and internalization processes.*

For a new employee (and others using a revised version of the PEM), the PEM contributes to the internalization process. The internalization process occurs in several rounds. Here, one can refer to the four stages in Kolb's model of experiential learning presented in Chapter 3. As one goes through the four stages, there is an opportunity to understand the new knowledge more and more in each round and gradually internalize the new knowledge.

Some respondents mention that they rarely refer to their respective PEMs since they already know what it contains. This shows the effect of the internalization process. At the same time, it may be wise to take relevant measures to identify and address potential challenges related to the internalization process. However, a respondent says that it can be a challenge to determine how best to internalize what is stated in the PEM.

Relevant measures (for example, sufficient training and motivation) can help address this potential challenge. In an indirect way, the internalization process highlights an important point to remember regarding the use of a recently revised version of the project model: It is crucial to inform all involved parties about the revisions that have recently been made and to ensure that the new version will be utilized.

4.3 Modifying and Improving PEMs

By definition, projects are unique. However, there are both known and unknown elements in each project. Project contexts can vary. The PEMs used by the two municipalities generally work well in their projects. However, a kind of mismatch may arise between what the PEM suggests and what the project context requires. In such cases, a project manager must reflect on the practice (which is guided and shaped by the PEM). The concepts of "reflection-in-action" and "reflection-on-action" come into play here. The reflection can lead to a new understanding (sense-making) and create new knowledge through double-loop learning. The project manager questions the current practice (current procedures, norms, assumptions, etc.) in the light of the new context and seeks to find a new and better approach or solution to address the new situation. The new experience / knowledge will be communicated to senior management as a suggestion for further development of the PEM.

The new knowledge that the project manager gains in the new context can be tacit or explicit. If that knowledge is tacit, then efforts must be made to make the knowledge explicit. This is externalization, as mentioned in the SECI model. The explicit knowledge must be combined with other existing explicit knowledge (including other suggestions for improving the PEM) in an appropriate manner. Systems thinking is important here to ensure that both the new and existing knowledge are interconnected, make sense ("sense-making"), and lead to a better outcome than before. The combined knowledge can be utilized by other employees multiple times in the future so that the knowledge will become internalized. When all or more individuals in the organization use the new version of the PEM, internalization occurs at an organizational level.

In a learning context, it is important to question current outdated practices – for example, "why do we do that we do?" This can lead to (conscious) unlearning, which is also part of the learning process. New situations/contexts in projects may prompt the municipalities to reflect on the relevance and effectiveness of current practices and their PEMs. Those responsible for revising the PEMs continuously gather suggestions for improving / adjusting the PEMs and make changes to the PEMs at regular intervals. New ways of thinking and working require unlearning outdated practices as well as learning more effective solutions that fit the current context best. Research highlights the importance of unlearning in project contexts (Thiel & Grabher, 2024).

4.4 Team Development

Chapter 3 provides a description of different stages in a team development process. As the description states, storming is the challenging stage where project participants try to find their place (their tasks, roles, and responsibilities, etc.) and position themselves within the project organization. In this phase, misunderstandings can arise. Each project participant may understand their role and areas of responsibility in different ways. PEMs can help to manage this situation. They provide information regarding roles and responsibilities and describe what should be done if certain situations arise. In this way, PEMs can help to minimize the duration and negative effects of the storming phase in a team development process. As a result, the project team can move on to the norming phase where a harmonious work culture is established and reinforced.

4.5 Learning Organization

As we have seen earlier, the two municipalities developed their respective PEMs by reflecting on and studying their own and others' experiences and best practices. The municipalities actively work on revising their PEMs periodically based on what project employees have experienced, observed, read, or learned. This demonstrates a genuine interest in learning and improving project work. This is one of the important characteristics of learning organizations.

The use of PEMs can also be linked to the five aspects that Senge mentions regarding learning organizations. PEMs attempt to create a shared vision (for example, a common understanding of a task or a project). They can help raise awareness and harmonize different mental models (that various project employees have) in a work context. In this way, they can enhance team learning and team development. As we have seen, systems thinking is somehow intertwined in the development, use, and revision of the project models.

This study suggests that (well-functioning and effective) PEMs can potentially help an organization (or a unit) to become a learning organization. Projects are mentioned as learning arenas where new knowledge is developed and existing knowledge is shared with others. PEMs can be seen as a concrete example that illustrates how learning in projects manifests and creates a positive effect.

5. Concluding Comments

This paper considers PEMs utilized in two municipalities in Norway to illustrate the relationship between PEMs and knowledge management by exploring concepts and theories related to knowledge sharing and learning. The objective is to contribute to developing a conceptual foundation for PEMs from the perspective of knowledge management. Interviews and document studies were conducted to gather data.

The study shows that the PEMs used by these two municipalities generally work well. It points out that there is a strong connection between PEMs and knowledge sharing and learning. The following points illustrate this:

- PEMs can be seen as a collection of (reflected) experiences and best practices.
- By using PEMs, the (collected) knowledge is shared with others in the organizations.
- The municipalities revise and further develop their PEMs in accordance with changing environments and conditions. This shows that the municipalities have a significant focus on continuous learning and development (related to project execution and management).

With their PEMs, the two municipalities achieve several positive effects. Some of them are:

- Establishing/securing a common understanding and practice
- Active integration of experiences and learning points
- Better communication
- Creating/maintaining a good working and project culture

The last point shows a clear link between organizational structure (PEMs and corresponding guidelines – what must/should be done) and organizational culture (practice – what actually happens in the workplace). Organizational structure and culture influence each other. We will look closer into it.

Municipalities have developed their PEMs based on their project experiences and practices (best practices, lessons learned, etc.). This means that the development, at least to some extent, has taken into account both organizational structure (formal systems such as procedures, routines, technology, and the organization's infrastructure) and organizational culture (informal systems such as norms, values, interpersonal relationships, trust-building, and collaboration).

PEMs traditionally represent organizational structure (i.e., a formal and standardized way of doing things). A PEM that is not in accordance with the organizational / work culture may face considerable challenges in implementation and effective use of it. However, since the two municipalities have developed their own PEMs by reflecting on practice and work culture ("reflection-in-action" and "reflection-on-action") over time, it appears that they have taken cultural elements (norms, values, behavioral aspects, etc.) into account and integrated them into their PEMs. Since cultural elements are integrated / represented in the PEMs, it becomes relatively easier for the municipalities to use the PEMs effectively. This is one of the reasons why both municipalities have positive experiences with their PEMs.

This situation can also be seen in relation to systemic thinking. Organizational structure and culture influence each other. When studying an organizational problem or finding a solution to that problem, it is appropriate to view the situation from a holistic perspective (in other words, a systems thinking perspective) that covers both the structural and cultural dimensions of the organization and the interaction between these two dimensions (Figure 4).

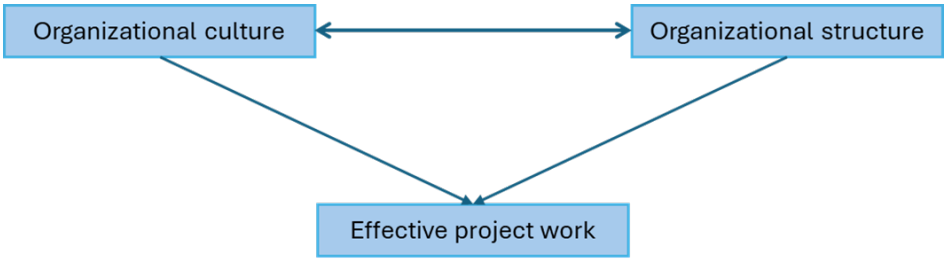


Figure 4: Project Culture and Structure

Even though project team members have different backgrounds, worldviews, and mental models, the PEM can in a way (raise awareness of and) harmonize their mental models in a work context.

For a new employee, PEMs provide a description of how the organization works with its projects. PEMs can help a new employee become familiar with the organization, collaborate with other team members, obtain important information and knowledge, and contribute effectively to projects. This can be seen as part of the internalization process mentioned in the SECI model. Furthermore, PEMs can strengthen the organizational / work culture, because they show the employees “what and how we do things here”.

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AI declaration: AI tools were not used in this paper.

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Application of Knowledge Discovery in Databases to Determine Car Sales Trends in Türkiye

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Abstract: In today's world, organizations of all sizes, including companies, institutions, and governments, manage vast amounts of data. Organizations that effectively harness data and extract valuable insights can achieve their strategic objectives. This study exemplifies the application of data mining techniques by analyzing the trend of vehicle sales. It highlights the significance of data mining in the automotive sector and demonstrates how accurate and meaningful results can be produced.

Keywords: Data mining, Knowledge discovery, Vehicle sales trends

1. Introduction

The renowned Italian sculptor Michelangelo, when asked, "How do you create your sculptures?" responded, "I do not create sculptures; the sculpture is already within the stone, I merely remove the excess." The discovery of information from raw data in much the same way. The information uncovered, akin to Michelangelo's statue of David, brings new horizons, new solutions, and also new questions.

Data mining has become an essential tool for extracting meaningful information and valuable insights from large datasets in today's world. In data-intensive industries such as the automotive sector, it is possible to optimize business processes, gain a competitive advantage, and enhance customer experience by leveraging this abundance of data.

Since the early 2000s, with the advent DSL and 3G technologies, the widespread adoption of the internet has led to a rapid increase in the amount of digital data. Websites, social media platforms, e-commerce sites, and other online platforms have started generating large volumes of data. During this period, industries such as search engines and online advertising began using data mining and big data analytics techniques to analyze user behavior.

The aim of this study is to demonstrate how Knowledge Discovery in Database(KDD) process is being used in the automotive industry to determine car sales trends. We used a dataset gathered between 2020 and 2024 in Turkey and utilized the Rapidminer program (2024) and Python libraries to analyze the data and obtain meaningful results.

The following section presents the related works. Section 3 explains the methodology followed step by step. In Section 4, we use these methods to analyze car sales trends in Turkey between 2020-2024, and finally, Section 5 presents discussion and conclusions.

2. Related Works

One of the foundational works in the field of Knowledge Discovery in Databases (KDD) was presented by U. Fayyad, G. Piatetsky-Shapiro, and P. Smyth (1996) . In this work, the authors provide a comprehensive overview of the KDD process and explain the relationship between data mining and KDD, highlighting how both are connected to related disciplines such as machine learning, statistics, and database systems.

The Gordon and Betty Moore Foundation's Data-Driven Discovery Initiative (DDD) launched an Investigator Competition (IC) to identify some of the leading innovators in data-driven discovery. As a result of this competition influential works in data driven discovery are listed and summarized by M. Stalzer and C. A. Mentzel (2016).

L. Cao (2017) provides a comprehensive survey and tutorial covering the core aspects of data science. This paper explores the evolution from traditional data analysis to modern data science, introduces key concepts, and presents an overarching view of the data science era. The paper also discusses major challenges and future directions in data innovation, the essence of data analytics, emerging industrial and service opportunities within

the data-driven economy, the professional competencies required for data science education, and insights into the future of the field.

Mikalef et al. (2018) highlight that to address the transition to a data-driven era and offer guidance to practitioners on implementing big data initiatives, researchers have introduced the concept of 'BVA (Business Value Analysis) capability.' This concept refers to a company's proficiency in obtaining strategic and operational insights from big data. Fundamentally, BVA capability aims to deeply explore the strategic potential of big data and maximize the benefits derived from this rich source of information. It encompasses not only technological tools and data analysis methodologies but also the organizational resources needed to support this process. In this way, it offers a more comprehensive and diverse perspective on big data.

C. Zehir and M. Bilgetürk (2022) state that Big data, with the capability to solve business operations in real-time, contributes significantly to decision-making processes by mining understandable information from scattered data.

Data analytics includes concrete resources like data and technology, human resources such as management and technical skills, and abstract resources like data-oriented culture and organizational learning (Gupta and George 2016).

Tekerek (2011) describes data mining as the process of obtaining information and analyzing data from large-scale datasets. This process involves discovering relationships, patterns, anomalies, and trends within data found in databases, data warehouses, or files. By uncovering and analyzing this information, data mining provides essential preliminary insights for decision support mechanisms in the business domain, utilizing Knowledge Discovery in Databases (KDD) applications.

The process of information discovery in the database is an interactive and iterative process consisting of several steps. Although the concepts of data mining and information discovery may appear similar, they have distinct differences. Information discovery encompasses the entire process followed to obtain meaningful information from data, whereas data mining is one of the crucial steps in this process (Bölükbaş 2013).

There are various techniques and approaches for big data analytics. These include methods such as data mining, machine learning, artificial intelligence, deep learning, natural language processing, statistical analysis, and visualizationv(Hastie, Tibshirani and Friedman 2009). In this study, we focus on data mining in KDD.

3. Methodology

The KDD process is considered in a broader framework than data mining, encompassing stages such as data processing, analytics, and application of knowledge. This process enables organizations to derive meaningful and actionable insights from raw data, aiding their use in decision-making processes of significant strategic importance. Based on this point, we can outline the steps of the knowledge discovery process as follows: Data Selection, Data Cleaning and Pre-processing, Data Transformation, Data Mining, Evaluation and Interpretation, Information Presentation and Utilization.

3.1 Data Selection

At this stage, raw data obtained from various sources are examined, and the data to be analyzed is selected. This selection is made based on data quality, relevant features, and analysis objectives.

In the example we will consider, an automotive company wants to perform customer segmentation by analyzing customer behavior and developing personalized marketing strategies. For this purpose, the company's data analytics team needs to select appropriate data sets from the customer relationship management (CRM) database considering the following points: Goal Setting, Source Identification, Identifying Data Features, Data Selection and Data Integration.

Once the data selection stage is complete, the company will have a clean, consistent, and appropriate data set necessary for customer segmentation. This data set will be prepared for use in subsequent data mining and analysis stages and will form the basis for a better understanding of customer behavior.

3.2 Data Cleaning and Pre-Processing

Filling in missing data, removing noise, and correcting outliers are performed. This stage ensures that the data is consistent and analyzable.

The main purpose of data cleaning and pre-processing is to transform the data into high-quality data. The characteristics that data must have to be considered high quality are as follows:

- Data should convey certainty and should not contain vague or ambiguous information.
- Data should be complete, with no missing values.
- Data should be internally consistent and up to date.
- Data should be within credible ranges.
- Data should be easy to understand, interpret, and analyze.

Data cleaning and pre-processing are performed as follows.

Detection and Imputation of Missing Data: At this stage, these gaps can be filled with values that will not skew the average, or with data from other customers with similar characteristics, a process known as imputation.

y replacing the average of a variable to the missing data, the mean value of the variable remains unchanged. However, this method brings the missing data's value directly to the mean, thereby reducing its distance from the mean to zero and leading to an underestimation of the variance (Işıkoğlu and Atar2020).

Detection and Handling of Outliers: It is essential to check for incorrect or out-of-range values, which we refer to as 'noise.' Situations such as a customer being 12 years old, having a vehicle count of -2, or the vehicle price being extremely low or high should be identified and addressed.

Many statistical methods can be used to detect noise, but they all share the common feature of identifying data that falls outside the standard range. The most basic method among these is the Z-score method (Dayanıklı 2021).

3.3 Data Transformation

Data transformation is done to reduce the size of the dataset or to create the necessary features for analysis. This involves normalizing, aggregating, or encoding data to ensure it is in a suitable format for further processing and analysis.

To make the data suitable for the model to be used, a transformation process must be performed, as how the model and algorithm process the data is of great importance. When the means and variances of the variables differ significantly, variables with higher means and variances can overshadow others and reduce their impact. Therefore, it is necessary to apply normalization to the data (Tunç and Ülger 2016).

3.4 Data Mining

The mining process here refers to extracting meaningful relationships, patterns, and models from datasets using mining algorithms and techniques. To carry out these processes, there are specific methods for the mining operation. The previous steps involve preparing datasets that establish the necessary conditions for mining to be performed.

The mining process to be conducted should ensure that the data yields meaningful results. Therefore, the method used to process the data is very important. The mining method applied should be suitable for our objectives. The method to be used should be analyzed and determined at the beginning of the project to meet the needs. Additionally, the methods for preparing and transforming datasets will vary according to the model.

In this study only some of the data mining techniques are used. One of them is clustering. Clustering is the process of dividing data points into groups (clusters) based on their similarities. The data is grouped by considering the similarities between them. This similarity actually refers to the distance or proximity between the data points. The vehicles were grouped according to their types and places of manufacture using this method.

For predictive modeling, both **regression analysis** and **neural networks (NN)** were employed. Regression analysis enables the forecasting of future values by mathematically modeling the relationship between variables (Coşkun, 2016). In this study, it was used to explore the connection between historical vehicle sales (independent variable) and more recent sales figures (dependent variable), assessing whether this relationship could reliably support future predictions.

Neural networks, particularly those based on deep learning architectures such as **LSTM** (Maier 2023), were used to capture more complex, non-linear patterns in the data. Unlike traditional regression, NN models are capable of learning intricate temporal dependencies, making them particularly effective for time-series forecasting. The

accuracy and reliability of both methods were evaluated to determine their suitability for predicting future vehicle sales

3.5 Evaluation and Interpretation

The evaluation, which is the final stage of the knowledge discovery process, involves examining the model's performance and the accuracy of the findings. This stage is crucial for determining how well the model can solve business problems and making any necessary adjustments (Seker and Erdogan 2016).

There are specific techniques to determine model performance. Root Mean Squared Error (RMSE) and Mean Absolute Error (MAE) are calculated to evaluate these models {Noyan 2020).

3.6 Information Presentation and Utilization

Even if the model's performance metrics are high, it is also important to evaluate whether the model meets business needs and objectives. Additionally, the results of the evaluation and findings from the knowledge discovery process should be shared with relevant stakeholders. Therefore, it is necessary for the obtained results to undergo a thorough reporting process, ensuring that the findings are presented in a clear and actionable manner. To achieve this, presentations should be organized using graphs, charts, and tables to convey complex data in a more understandable way.

4. Analyzing car Sale Trends

In this study we tried to answer the following questions:

Which brand stands out in vehicle sales in Turkey? How are the brands ranked in terms of passenger-commercial market share? What is the status of sales for domestically produced and imported vehicles?

Is it possible and meaningful to make predictions for 2024 based on the monthly sales figures from 2021 to 2023?

4.1 Data Selection of Vehicle Sales

We have a dataset containing the monthly and brand-specific list of vehicle sales in Turkey for the years 2020-2024. This dataset was created by combining the monthly data published on the Automotive Distributors and Mobility Association (ODMD) website. The monthly market sales figures for 2020 to 2024 were downloaded individually from the retail sales market section at https://www.odmd.org.tr/ and then merged into a single list, formatted to suit the results we aim to achieve. By mining this data warehouse, we will generate some meaningful results.

4.2 Data Cleaning and Pre-Processing of Vehicle Sales

Since we have set our goals, we need to define the characteristics of our data warehouse. We have a dataset consisting of five columns and approximately 10,000 rows. This table contains the sales figures for brands by month. To use the month value in comparisons, the 1st day of the month is entered as a date. The fields in the table are as follows: DATE, BRAND, MODEL, ORIGIN and QUANTITY.

After loading the data to Rapidminer we noticed that there are some missing values in Quantity fields. The reason for the empty sales quantity values is that the Automotive Distributors and Mobility Association does not enter data for vehicles that have not been sold. Here, what we need to do is enter zero '0' for the empty values. If this field were to be included in the average calculation, we would need to fill it with the average sales quantity value so that it would not affect the calculation.

Then we will find and clean the outliers. There are some values in the sales quantity that we have identified as outliers. We can perform an outlier analysis on this field and, if necessary, filter out the outliers. For this, we will use the Detect Outlier operator. We connect the Detect Outlier operator to follow the Replace Missing Values process. As parameters, we enter the neighborhood distance and the total number of outlier records we want to find. We want to identify 10 outliers in our dataset. To perform this detection, we use the Euclidean distance function.

The Detect Outlier operator has identified the 10 most extreme values for us, we used 2 extreme values as outlier values. A filter was used to remove the outliers we found from our list.

4.3 Data Transformation of Vehicle Sales

We want to see how data is arranged in the 0-1 range using Min-Max Normalization. To do this, we will use the Normalize operator in Rapid Miner. After grouping by the YEAR and BRAND fields, we use the Normalize operator to list the SUM(QUANTITY) field by normalizing the data within the range of 0.0 – 1.0 using the range transformation method. In the resulting list, we see many values that are 0 (zero). This result shows us that, when looking at the annual sales quantities of brands, brands with high sales volumes in certain years stand out from other brands

4.4 Data Mining for Vehicle Sales

To find out which brands are sold the most, filtering and grouping operations were performed sequentially on our dataset. The Generate Attributes operator was used to extract the month and year values from the DATE field. The sales quantities grouped by year were summed using the SUM function to determine the sales quantities for each brand. A grouping was performed with the Aggregate operator using the values BRAND, YEAR, and SUM(QUANTITY).

The annual sales quantities for each brand were drawn with bars. The bars were colored according to the years. However, since we saw that there were too many brands in the graph and it became very difficult to read, vehicles with annual sales quantities of less than 20,000 units were not included in the list as shown in Figure 1.

We can see that the FIAT brand has a significant advantage in the Turkish market. Especially for the year, 2023, with sales figures approaching 200,000, it appears to be far ahead of other brands. Additionally, it is possible to say that all brands increased their vehicle sales in 2024.

To find out how the brands are ranked in terms of passenger-commercial market share, first, a grouping was done based on vehicle model. It is known that some brands do not have any commercial models, and very few dealerships do not have passenger models. Considering overall sales, it is possible to say that passenger (automobile) sales are higher than light commercial vehicle sales.

As an initial listing, let's determine the sales quantities of Passenger Cars/Light Commercial Vehicles by year. Here, like we did with the brand-based list, we took the list and finally added the MODEL field to the Aggregate operator to enable the grouping of sales quantities into Passenger Cars/Light Commercial Vehicles.

Based on this, we can say that the sales of passenger cars/light commercial vehicles, which showed a notable difference, were significantly surpassed by passenger car sales in 2023 due to a surge in automobile sales. It seems reasonable to think that brands may have conducted campaigns to direct customers toward passenger vehicles or that the increase in the number of automobile models by brand has led to a rise in sales.

To address our main question, let's examine where the brands stand in this distinction. In this case, by looking at the classification of all vehicles sold between 2020 and 2024 as Passenger Cars/Light Commercial Vehicles, we can generate the pie chart as shown in Figure 2. This shows us that:

- FIAT emerges as a significant player in Turkey, dominating both the passenger car and light commercial vehicle segments.
- While FORD is the leader in light commercial vehicle sales in Turkey, it does not seem to have established any superiority in passenger car sales.
- On the other hand, RENAULT appears to have achieved success in passenger car sales but has not shown the same level of success in light commercial vehicle sales.

Not let's answer this question: What is our situation regarding the sales of domestically produced and imported vehicles. To answer this question, the dataset was grouped according to the origin of the vehicles. Among the brands sold between 2020 and 2024, only FIAT, FORD, HONDA, HYUNDAI, ISUZU, KARSAN, RENAULT, TOGG, and TOYOTA are produced locally in our country. Brands outside of these, in addition to imported vehicles, also have certain models that are marketed as imported products.

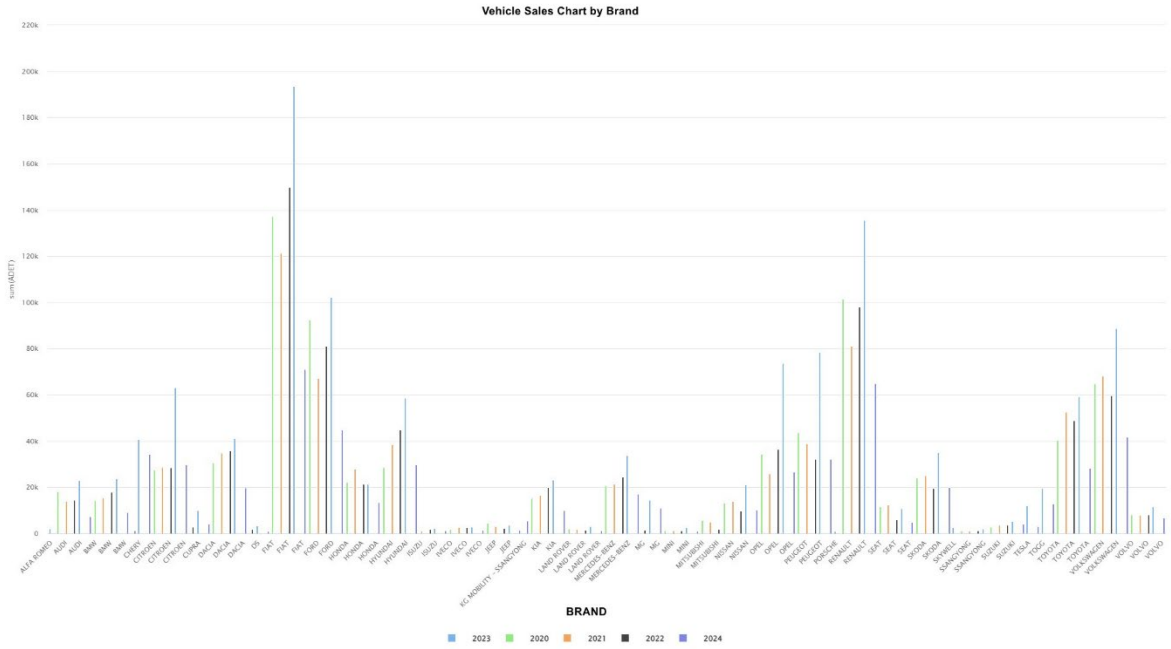


Figure 1: Vehicle sales chart by brand

It is observed that, except for Honda, all locally produced brands have significantly higher sales of domestically produced vehicles compared to imported vehicles. It is also possible to say that FIAT's imported models are not very popular in Türkiye.

Additionally, looking at the overall framework, we can say that nearly 40% of vehicle sales in Turkey are from domestically produced vehicles. FIAT holds the largest share in this segment. Following FIAT, RENAULT and FORD also have a significant proportion of domestic production. However, it is possible to say that the sales quantities of imported vehicles for these two brands are closer to average values compared to FIAT.

Now we will seek an answer to the following question: Is it possible and meaningful to make predictions for 2024 based on the monthly sales values from 2021 to 2023. If so, how accurate and meaningful is it? To make this analysis we do the following steps:

- First, we need a labeled and ordered dataset for the field to be predicted. Since predictions will be made based on monthly sales numbers, one group of the dataset will be used for testing, and another group will be used for analysis.
- The results obtained from the data group used for analysis will be tested on the data set aside for testing to determine the accuracy and reliability of the model

We prepared a regression model using Rapidminer and Scikit-learn (Scikit learn 2025) Python library with **FIAT** as an example brand. Among the two approaches tested, the **ARIMA model** produced more accurate results. A graphical comparison of the actual and predicted sales data for the last six months is presented in **Figure 3**.

As seen from Figure 3, although the predictions were close for the first three months, the predictions did not foresee the drop in Fiat's sales in the fourth month. The prediction performance was evaluated with an **RMSE of 6,555** and an **MAE of 6,136**..

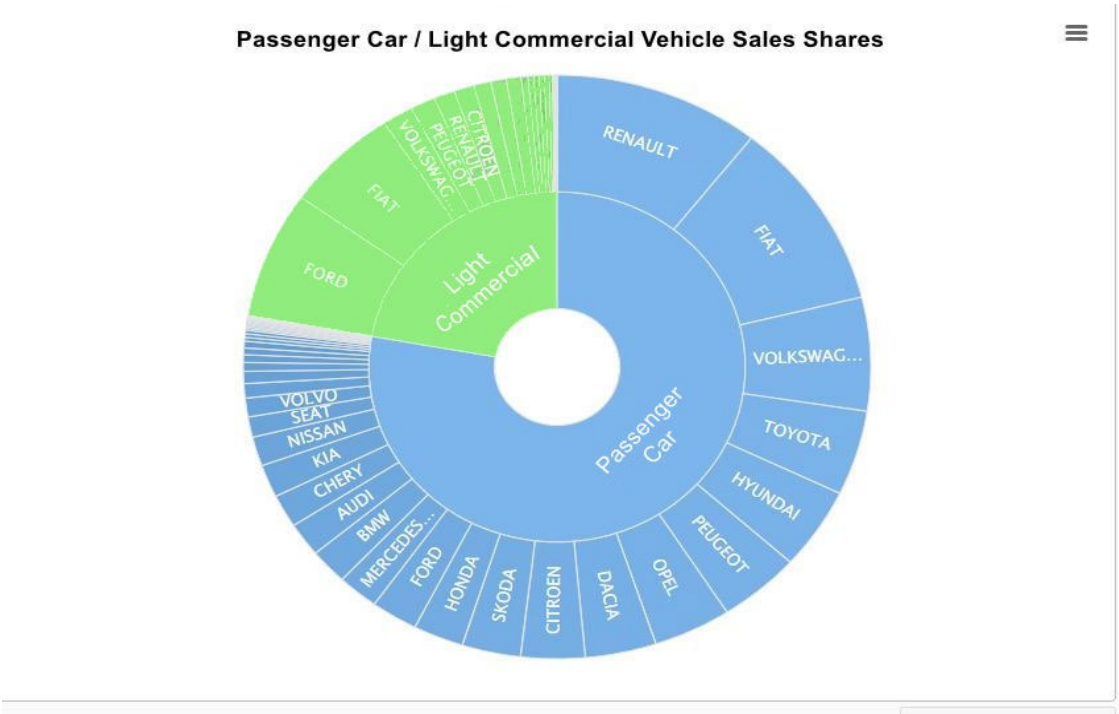


Figure 2: Passenger car/light commercial vehicle sales shares

In addition, we employed the **Keras (2025)** deep learning library to construct a **Neural Network LSTM model** for forecasting future sales. The results, presented in **Figure 4**, indicate that this model outperformed the regression-based approaches. The LSTM model achieved an **RMSE of 5,917** and an **MAE of 5,476**, reflecting improved accuracy than regression models. RMSE and MAE were calculated as 5917 and 5476 respectively.

However, it is not very feasible to make future sales predictions with the data we have on past monthly sales. There are many other factors affecting sales, and without data on these factors, our analysis will not produce accurate and reliable results. The results showed that past sales alone were insufficient for predictions. Incorporating diverse datasets, such as nationwide vehicle price changes or promotional campaign expirations, would improve accuracy.

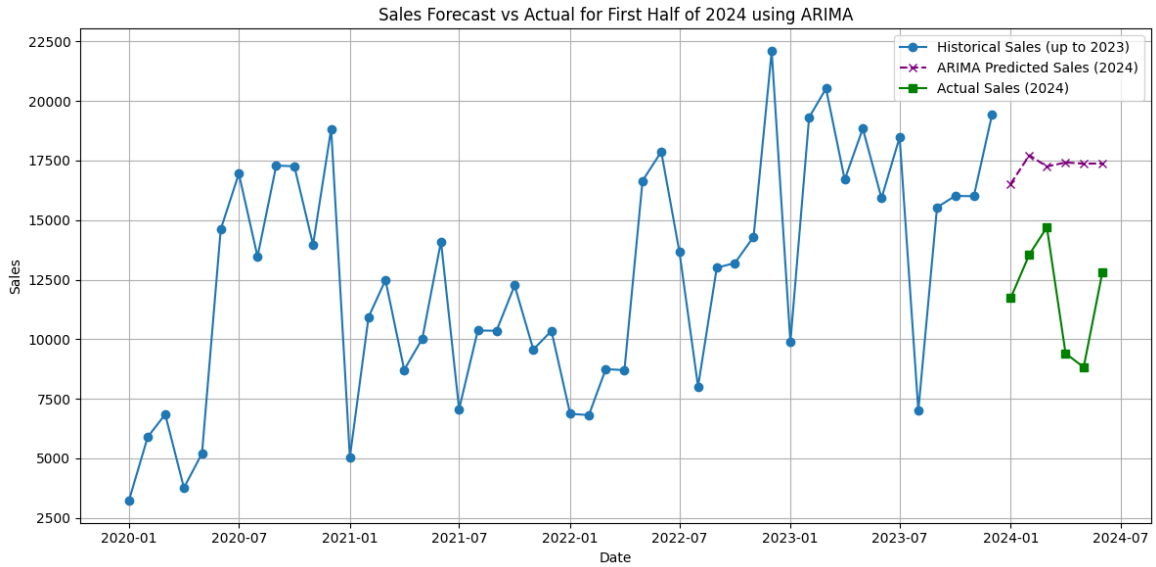


Figure 3: Actual sales and predictions for the Fiat brand using ARIMA algorithm

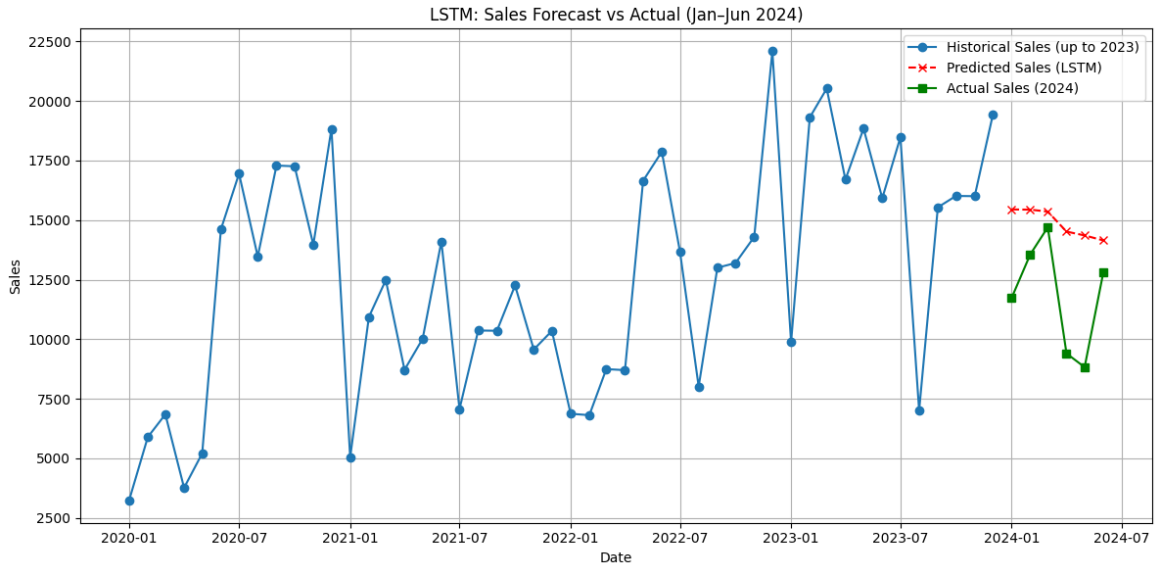


Figure 4: Actual sales and predictions for the Fiat brand using NN LSTM model

5. Discussion and Conclusions

Data mining is an indispensable method for producing meaningful results from large datasets, which can consist of thousands or even millions of rows. Data mining is used in all sectors, especially in the automotive marketing sector. The most important point here is optimizing large data sources in the best possible way. No matter how hard we try, we cannot obtain accurate results from a dataset that has not been well-optimized. Therefore, we can say that pre-processing is the most important step in mining.

There are many factors that affect car sales. Factors such as the country's tax rates, geographical conditions, and family and demographic structure greatly influence car sales. In this context, we can see that we need more data for critical issues such as sales forecasting. More complex models are necessary to make better predictions which considers not only the past sales but other economic factors and customer behavior. For this reason, automotive companies ask for a lot of information from their customers during sales. Their goal is to reach the right customer with the right options and achieve maximum sales. The most effective way to achieve this is through accurate data mining and marketing efforts.

While not everyone can create a work of art by removing the excess from a block of marble, anyone who wants to can extract meaningful results from large data piles using the right methods. The cost of learning data mining methods and applications is negligible compared to the cost of the product. The solutions produced by data mining go beyond marketing to make life easier and increase efficiency. However, alongside all its benefits, it also encompasses concerns such as privacy, security, and the misuse of data.

Ethics declaration: We declare that no ethical clearance was needed.

AI declaration: ChatGPT is used to enhance the English in this paper.

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Categorisation of Tacit and Explicit Knowledge and its Implications for Organisational Growth in Higher Education Institutions

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Abstract: In this paper, we report on the categorisation of tacit and explicit knowledge and its implications for organisational growth in higher education institutions (HEIs), which are known as universities. We note that the two types of knowledge- tacit, which resides in a person's mind is acquired through personal experience over time, and explicit, found in manuals and documents- have become increasingly vital for organisational growth, particularly in universities, from the perspectives of operational effectiveness and the sustainability of lecturers' roles. Unfortunately, not all lecturers, students, and staff members in universities are familiar with categorising these two types of knowledge and the implications this knowledge portrays for organisational growth. Two research objectives guided this study: first, to examine how the two types of knowledge can be categorised for better application in universities, and second, to determine which of the two categorised types plays a key role in universities. A quantitative research method of PRISMA and interpretive content analysis was used in this study, wherein the authors examined and synthesised literature on tacit and explicit knowledge sourced from Scopus and Google Scholar databases. The findings revealed that the two types of knowledge were categorised based on their distinct functionalities in universities. The study indicates that lecturers now mix tacit and explicit knowledge for creating lecture notes and modules from diverse reading materials, assessing student submissions, delivering lectures in class, and conceptualising and drafting research papers. Tacit knowledge is more advantageous since much of what occurs in universities relates to lecturers' intuitive knowledge application in teaching, learning, and research, as well as in supporting students. Nevertheless, integrating both enables lecturers to develop, reflect, and gain a comprehensive understanding of their teaching and research practices. To foster engaging dialogue and continued participation in universities, the study suggests enhancing awareness of the various types of knowledge among lecturers and scholars, considering their diverse backgrounds.

Keywords: Tacit, Explicit, Knowledge, Organisational growth, Higher education institutions

1. Introduction

Higher Education Institutions (HEIs), also known as universities, have transformed into commercial enterprises that produce graduates for profit and revenue generation, serving as a means of exchanging goods and services to promote societal advancement. The term' universities' would be used in place of 'HEIs' in this study. The authors were prompted to question the qualifications that graduates obtain from universities, particularly those lacking the necessary knowledge to thrive in the workplace. Ideally, universities are established to foster innovation and creativity among individuals in addressing societal problems (Aithal & Maiya, 2023). As universities evolve through increased knowledge production and transfer from lecturers to students, the development of adaptable skills, critical thinking, and a commitment to lifelong learning in students becomes their core focus, thereby preparing students to handle complex future issues (Aithal & Maiya, 2023). With this continuous progress, mechanisms and tools that promote reflective innovations are needed to realise this lifelong learning, including technological integration, cultural relevance and inclusivity, competency-based education, and upskilling initiatives (Aithal & Maiya, 2023). Nonetheless, several universities in developing nations no longer consider whether students are adequately equipped with the relevant information and knowledge for problem-solving initiatives aimed at societal development. The significance of tacit and explicit knowledge in advancing society has become increasingly vital (Hayek, 2013), thereby encouraging scholars to continuously generate new knowledge that can positively impact humanity. The authors of this study reflect on the significance of knowledge in promoting societal advancement, as previously noted by Hayek (2013). Hayek (2013) emphasises the need to categorise tacit and explicit knowledge for a better understanding of organisational growth. The evolving nature of universities in equipping students for problem-solving initiatives in society necessitates the simplification and categorisation of knowledge. When knowledge is categorised, lecturers, students, and other staff members in universities can determine which type is most suited for addressing specific problems. Given that the human brain and mind hold hidden expertise and experience, tacit knowledge offers a solution to the challenges faced by universities. One of the challenges is the inability to identify the appropriate type of knowledge that addresses certain societal issues. It becomes crucial that when knowledge is categorised according to type and functionality, both lecturers and students will not be novices in selecting the right type of knowledge to apply in solving societal and personal problems. It is anticipated that

when graduates begin their studies in universities, they are equipped with the right type of knowledge to use, regardless of the context, rather than the current scenario in which many graduates are unsure of which type of knowledge can assist in addressing specific workplace problems.

The activities of teaching, learning, and research conducted in universities are supported by both types of knowledge. A practical example can be illustrated when a student in any university is assigned to write an essay on the "use of digital technologies," and the student is required to summarise the essay in two thousand (2000) words. The student completes the essay but is not sure how to conceptualise and internalise the essay as expected because the appropriate tacit type of knowledge required was not applied. The central issue here is that the student lacks the necessary knowledge to summarise the essay, which may lead to failing the module or course. The expectation is that if the student had known and applied the right type of knowledge, they would have understood how tacit knowledge functions. The understanding surrounding tacit knowledge encompasses experience and beliefs. The tacit type of knowledge is more advantageous than the explicit type, as it involves integrating experience with contextual information. Pears (1971) refers to tacit knowledge that comes with new ideas, insights, and innovations applied to human behaviour and organisational sustainability. These revelations, inventions, intelligence, and novel concepts cannot exist in isolation; therefore, it is essential to categorise and share them among lecturers and students to ensure continuous performance in higher education institutions. The successful outcomes of lecturers' work performance, competitiveness, and effective planning and decision-making in higher education institutions are linked to the various categories of tacit and explicit knowledge utilised.

In section two of this paper, we provided a background of the literature on tacit and explicit knowledge and their categorisation regarding their implications for organisational growth in universities. This was followed by research objectives that aim to close the knowledge gap of tacit and explicit knowledge and its implications for organisational growth in their various types, namely:

- To examine how the two types of knowledge can be categorised for better application in universities.
- Determine which of the two categorised types of knowledge plays a key role in universities.
- Assess the publication of papers by year.
- Analyse published papers by type.

2. Background of the Study

The categorisation of tacit and explicit knowledge is crucial for the success of lecturers, students, and other individuals' work operations in universities. Most of what is obtainable in universities is the combined elements of tacit and explicit knowledge that enhance the teaching, learning, and research activities occurring in universities.

2.1 Tacit Knowledge

Tacit knowledge is a type of knowledge that is intrinsically personal, deeply rooted in individual experiences, and often difficult to define and express (Puusa & Eerikäinen, 2010). It relates to ideas, experiences, practical abilities, and intuitive insights that are hard to convey through words or symbols (Hvorecký, Šimúth, & Lipovská, 2015). The productivity of universities largely relies on tacit knowledge, particularly when lecturers carry out their responsibilities effectively. Much of the knowledge acquired by lecturers remains hidden until a specific task is assigned (Enakrire & Smuts, 2022). It consists of the knowledge that individuals retain in their minds, often acquired through practice, firsthand experience, and the environments in which they work. The desire for more tacit knowledge has led academics to take up roles such as editors, navigators, educators, information consultants, and gatekeepers of knowledge (Enakrire, 2025).

2.2 Explicit Knowledge

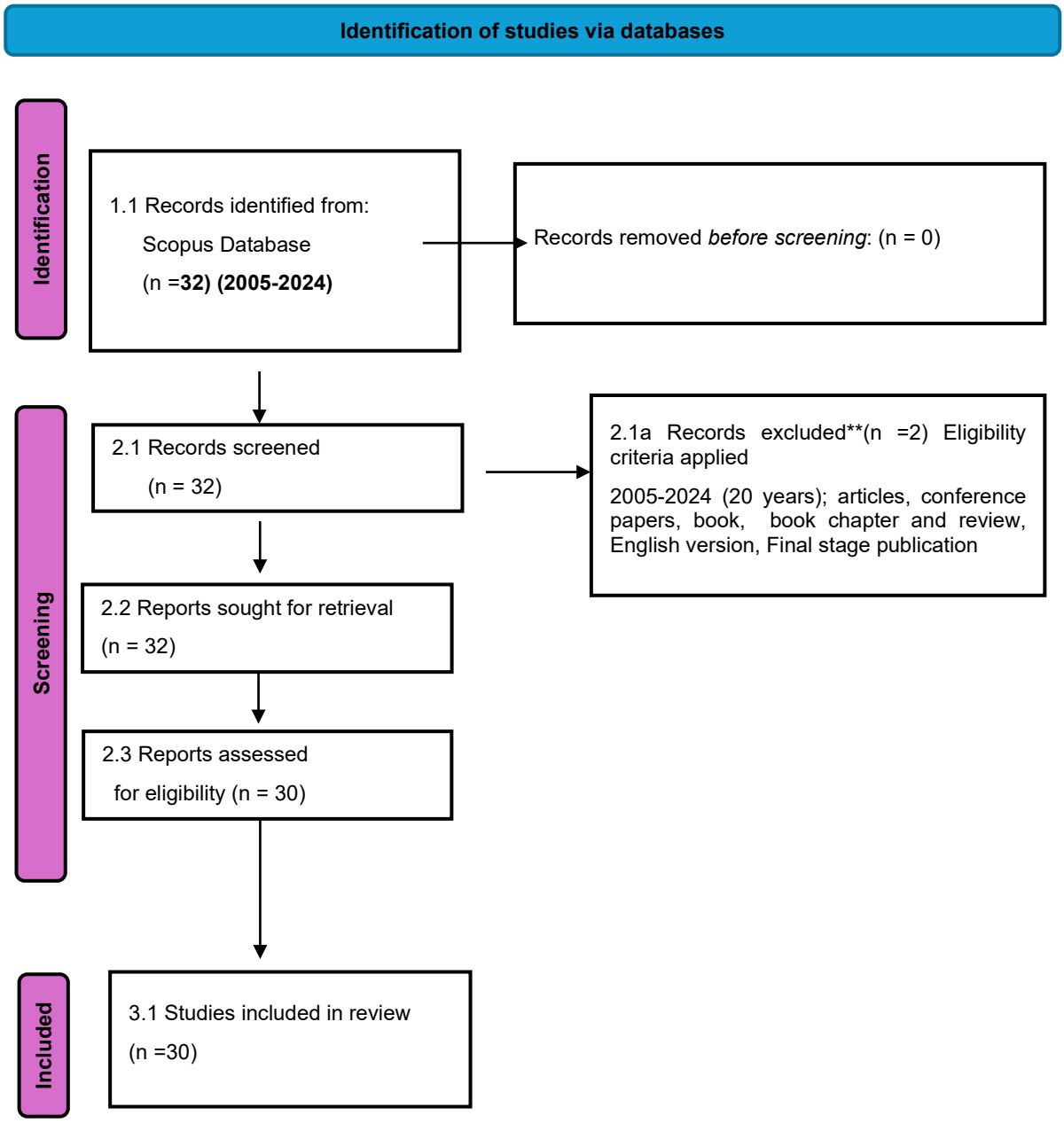
Explicit knowledge is a type of knowledge that can be articulated verbally and expressed in a manner that others can understand based on their inquiries (Davies, 2015). This type of knowledge is well-documented and easily shared, comprising facts, formulas, instructions, and everything that can be readily expressed, codified, and stored. Explicit knowledge is portable and can be easily disseminated through written documents and systematic processes (Carr, Miles-Board, Woukeu, Wills, & Hall, 2004). The roles that tacit and explicit knowledge play among lecturers, students, and other staff members are indispensable (Smith, 2001). The strategy for survival depends on how these groups utilise tacit and explicit knowledge in their work operations. Such knowledge can assist them in times of uncertainty, especially when they are uncertain about what actions to take. The availability and accessibility of tacit and explicit knowledge for work operations rely on ongoing engagement in

various responsibilities and discussions. In this sense, tacit knowledge is ingrained in them and is related to human endeavours. The key to the productivity of universities lies in the tacit knowledge embedded within their employees. Much of an employee's knowledge remains hidden until they are assigned a specific task or duty, at which point it begins to surface. Lecturers, students, and other staff members in universities can leverage both tacit and explicit knowledge for their benefit, depending on the tasks at hand. However, it is crucial to consider how both types of knowledge can be shared or disseminated to foster innovation for organisational growth. Many lecturers, students, and staff in universities may not have identified how the different types of knowledge function when applied. The utilisation of these types of knowledge depends on how they are recognised; hence, this study is significant in the context of universities.

In section three, we presented the research methodology for the study.

3. Methods

We applied two methods in this study. The PRISMA for data gathering and interpretive content analysis of documents. The PRISMA method harvested 32 articles from the Scopus database for data screening using a search string of *Article title, Abstracts and Keywords* of ("tacit AND explicit knowledge") AND (university). The eligibility criteria applied between 2005-2024 (20 years), focusing on articles, conference papers, books, book chapters and reviews. The selected papers were in the English version and final stage of publication, hence the 30 articles collated after included and exclusion criteria in the PRISMA process. The second stage employed interpretive content analysis (Drisko & Tina Maschi, 2015) of documents, harvesting 35 articles from the Google Scholar database. The essence is to critically evaluate each of the articles that relate to tacit and explicit knowledge. While the authors were scanning and reading through each of the articles, they identified those in the areas of tacit and explicit knowledge and how they were also categorised based on the interpretive content analysis method. The authors considered that interpretive content analysis is a research technique that focuses on comprehending the underlying meanings, contexts, and nuances within the data. This helps to obtain a deeper, more nuanced understanding of the content rather than merely counting words or themes in the text. The researchers selected 35 research papers that were different from the previously identified database of Google Scholar using the keywords "tacit knowledge and explicit knowledge" and categorisations of both the tacit and explicit knowledge that support the organisational growth in universities." How the authors of this paper came about this method was the interpretive content analysis method used, where they scanned and read through the title, abstract and content of each of the 35 articles. The articles examined showcased how organisational growth in universities has been impacted by the classified tacit and explicit knowledge articles harvested from the database. The authors concluded that this method provides a deeper comprehension of internalised literature associated with various occurrences. The conclusions of the study are covered in the following section, based on the interpretive content analysis of documents taken from the Google Scholar and Scopus databases. In universities, the focus on classifying explicit and tacit knowledge and how it affects organisational development was substantiated. Before conducting this study, the researchers submitted an ethical clearance application form to the School of Consumer Intelligence and Information Systems Research Ethics Committee of the University of Johannesburg, for a secondary data research project, with the title “categorisation of tacit and explicit knowledge and its implications for organisational growth in Higher Education Institutions" which was approved with the ethical number of 2025SCiiS025. Since the study primarily used secondary data, all consulted sources were referenced in the paper. The next sections address the PRISMA diagram, the study's findings of both PRISMA and the interpretive content analysis of the literature harvested. The main emphasis of the result highlights the publication by year, different types of papers harvested, categorised into tacit and explicit knowledge and their characteristics in universities.



In Section four, the study's findings and contribution were presented, and the paper's conclusion is hinted at in Section 5.

4. Findings

4.1 Description of Tacit and Explicit Knowledge

This segment summarises the publication of papers by year, descriptions of tacit and explicit knowledge and sources from which they were extracted in the literature.

This segment presents the publication of papers by year.

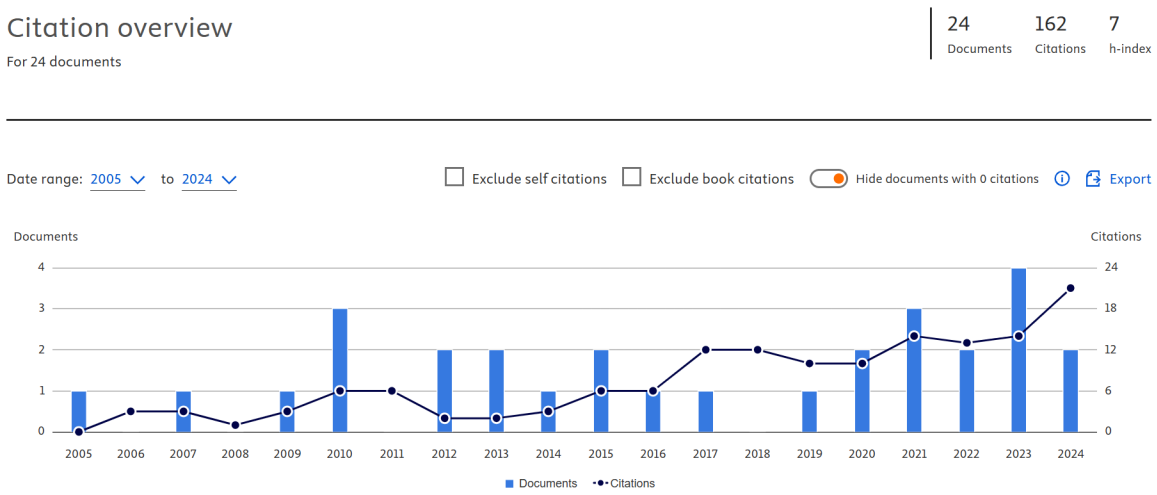


Figure 1: Publication of papers by year

The result in Figure 1, which reflects the publication by year, indicates that the progression of papers started rising from 2016 to 2018, but then it plateaued from 2019 to 2020. In 2021, it rose but dropped again in 2022, but took off from 2023 to 2024. The reason the progression of paper publication was not stable could be that the lecturers/scholars who publish were busy with other academic activities. There are situations where some papers take more than two years, especially those submitted to top journals, before they can go through all the stages of review, acceptance, corrections and publication. Interestingly, there were 162 citations with a 7 h-index over these periods.

This segment presents the publication of papers by type.

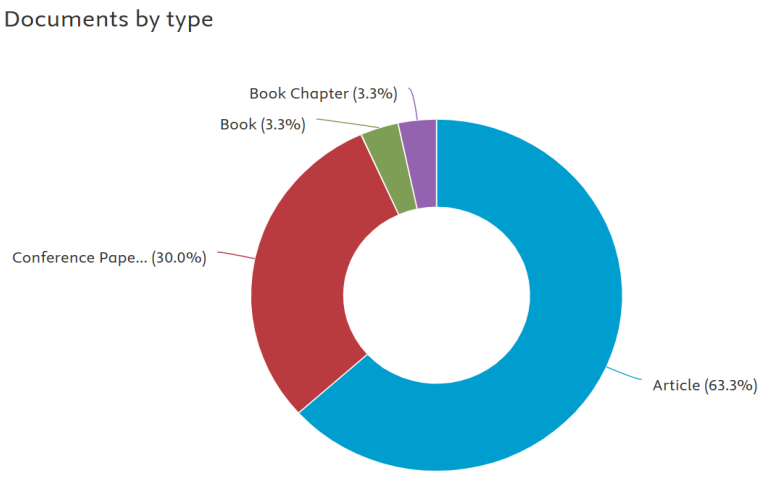


Figure 2: Publication of papers by year

The result in Figure 2 indicates that of the papers harvested from Scopus, the majority were communication through articles (63.3%), followed by conference papers (30.0%), and book/book chapters (3.3%). It is envisioned that the reason we have more papers in article form is that many recent happenings are publicised in articles. Many universities prefer their lecturers to publish their research findings in article form, and many scholars and researchers tend to consult articles more as they are used for promotion. Many universities also get incentives when their lecturers publish in articles.

This segment presents the categorisation of tacit and explicit knowledge.

Table 1: Categorisation of tacit and explicit knowledge

Tacit	Explicit
Individual skills	Manuals
Expertise	Procedures
Education	Documents
Experience	Video
Insights	How to guide
Intuition	Databases
Observation	Memos
Cultural beliefs	Records
Values	Notes
Mental model	Communicated data
Attitudes	

The result obtained in Table 1 indicates that the different categorisation of tacit and explicit knowledge is unique. Some of the identified elements in the tacit type of knowledge are difficult to convey through words or symbols because they are embedded in human thoughts, experiences, practical abilities, and intuitive insights. These elements reside in the human mind or brain. Another crucial issue is that they take much longer to attain. For instance, education, expertise, experience, individual skills, ideas, attitudes, values, observation, and cultural beliefs are built up over a long time. The more the individual engages in certain activities, the more these elements develop and enhance in the workplace. Drawing an analogy from the tasks of lecturers and medical doctors, we see how they interplay, particularly employing more of a tacit type of knowledge in rendering services. For example, when lecturers teach in the classroom environment, they apply tacit knowledge to unveil issues related to real-life situations. The lecturer uses various examples that are not completely present in the study modules, all to ensure that the students have a better understanding of the course or module being taught. Another example is Polanyi's (1967) theory of tacit knowledge dimension, where human knowledge exceeds what they can communicate. The expectation here is that lecturers know more than they can articulate because, during the delivery of lectures, lecturers elaborate more on the subject and concept under discussion with relevant examples, facts, experiences, values, and beliefs to support their argument. Lecturers in universities rely more on tacit knowledge when fulfilling their professional duties (Enakrire & Uloma, 2012). Drawing an analogy from a different perspective, let us consider the approach applied by medical doctors, who use their real-life experience in medical practices to understand the cause of ailments and consequently proffer solutions for treatment and permanent cures. Medical doctors who utilise evidence-based diagnostic analysis to make judgments based on explicit knowledge, and these insights are cross-fertilised to offer substantive recommendations to patients (Wyatt, 2001). This is also applicable to lecturers who teach and conduct research investigations in universities. The tacit knowledge of lecturers is concealed in their minds, which does not unfold as expected when delivering lectures in classrooms or academic forums, except during conversation and sharing of knowledge with others. This implies that knowledge sharing enhances professional growth among colleagues (Enakrire, Chisita & Chigwada, 2019).

In the case of explicit knowledge, most of the components consist of manuals, procedures, documents, videos, memos, notes, and records that could be communicated easily through diagrams, formulas, and language. The authors of this paper establish that any layman should understand and engage with explicit knowledge because it has been substantiated compared to the tacit type. Much of what we read in books, manuals, and research papers results from the transition of tacit to explicit knowledge. Someone may possess wonderful ideas, insights, or innovations, but if they are not made explicit, it might be difficult for someone to access them. Consequently, universities globally are spending millions of dollars reviewing and regulating curricula that address certain innovations that could be transformed into explicit knowledge for lecturers to utilise in supporting students, researchers, and other anticipated staff members in the institutions. This analogy aligns with Nonaka's SECI model, known as Nonaka's model of knowledge creation (Nonaka, 1994; Nonaka, Byosiere, Borucki, Konno, 1994; Nonaka & Takeuchi, 1995; Nonaka, Toyama, Konno, 2000; Nonaka, Toyama, Byosière, 2001a; Nonaka & Toyama, 2003). The SECI model originated from the information creation in innovating companies (Imai, Nonaka, & Takeuchi, 1985; Nonaka, 1988a; Nonaka, 1988b; Nonaka & Yamanouchi, 1989). In the SECI theory, four modes are identified, namely, Socialisation, which is tacit to tacit; Externalisation, tacit to explicit; Combination, explicit

to explicit; and Internalisation, explicit to tacit. The process proceeds to a new "level" following internalisation, which is why a "spiral" of knowledge generation is used as a metaphor. This study reflects that the categorisation of tacit and explicit knowledge can be likened to the SECI model postulated by Nonaka because every activity in universities carried out by lecturers, students, and staff members applies the SECI model in various ways, depending on the task. The SECI procedures are essential in universities, ranging from knowledge generation to sharing among lecturers and students in all academic teaching, learning, and research.

4.2 Characteristics of Tacit and Explicit Knowledge

This segment summarises the characteristics of tacit and explicit knowledge based on extracts from the literature.

Table 2: Characteristics of tacit and explicit knowledge

Characteristics	Tacit	Explicit	Ways of Capturing	Examples
Form of knowledge	Greater intuition	Tangible	Documents databases	Training
Transferability	During the discussion, task execution	Easily transferred	Manuals	Specific recipes
Codification	Challenges to codify	Codified and stored in documents	Procedures	Performing tasks
Storage	Peoples' brain	Libraries, databases, internet	Observation	Sharing best practices
Acquisition	Personal beliefs, experiences and mental models	formal education, reading	Experience	Initiating innovation
Expression	Social interactions, skills, and habits	Communicated in language	Mentorship	Building relationships
Dependence on Context	Highly context-dependent	Context-independent	Storytelling	videos
Learning Process	Subconscious immersion, activities over time	Conscious/deliberate study	Communities of practice	Memos
Replicability	Complex interplay; not easily replicable	Replicable or duplicated	Knowledge sharing platforms	Standard operating procedures
Documentation Effort	Documentation is challenging	Minimal to document	Person to person	Databases
Value in Innovation	Source of innovation: problem-solving	Develop new ideas	Discussion	Documents
Accessibility	Limited to the owner	Easily accessible	Learning under tutorship	Feedback
Measurement and Evaluation	Difficult to measure	Quantified and measured	Long years of experience passed to others	Personal wisdom

Source: Ashikuzzaman (2024) and Bloomfire (Understanding the different types of knowledge)

The result in Table 2 indicates that the diverse characteristics of tacit and explicit knowledge have distinguished various forms of knowledge existence, emphasising transferability, codification, storage, acquisition, expression, dependence on context, learning processes, replicability, documentation efforts, value in innovation, accessibility, and measurement and evaluation between tacit and explicit knowledge. These determinants serve as a panacea for solving real-life problems in universities and workplaces alike. The pervasiveness surrounding the characteristics of tacit and explicit knowledge is far richer than the disparities in the experiences of individuals unwilling to showcase what they possess within the organisation. This supports Oranga's (2023) claim that tacit knowledge has driven improvement through the learning occurring in universities. Oranga (2023) further notes that approximately 90% of the total knowledge within universities is tacit, which influences their overall output and effectiveness. Therefore, understanding the characteristics of explicit and tacit knowledge is crucial for efficiently managing and applying knowledge in any university.

5. Conclusion

The study highlights that tacit and explicit knowledge are fundamental for organisational growth in universities. These enable lecturers to perform the core function of teaching and learning daily. The elements that constitute the classification of tacit and explicit knowledge are multifarious. Tacit and explicit knowledge are believed to affect the organisational growth of universities, especially where knowledge is transferred among lecturers, students, and other staff. Although the classified types of knowledge exhibit some similarities and differences. The categorisation is vital because it indicates how and when tacit and explicit knowledge are utilised to improve research, teaching, and learning in universities. The research determined that certain aspects of tacit knowledge may be challenging to express through language or symbols, as they are rooted in human concepts, experiences, practical skills, and intuitive understandings. Nonetheless, the Nonaka SECI model of internalisation (from explicit to tacit), externalisation (from tacit to explicit), combination (from explicit to explicit), and socialisation (from tacit to tacit) has shown its ability to connect knowledge gaps regarding how the organisation should grow. This has enhanced the relationships and social interactions necessary for assisting students in their academic endeavours and objectives, tackling organisational issues, and promoting the professional growth of university staff. It has been shown that both tacit and explicit knowledge can support lecturers in their various job functions when they consistently share what is known with the unknown. This would assist every area of the lecturer's expertise in determining the best daily practices while adhering to policies and procedures in universities.

The study highlights that universities should build resilience by equipping instructors, students, and staff with relevant competencies (knowledge, skills, and attitudes) to effectively promote the organisation's goals and objectives. As uncertainty prevails and the information needs of students increase within this dynamic knowledge economy, universities are tasked with developing strategic methods to ensure that appropriately categorised knowledge, both explicit and tacit, is utilised to inform students about what they need to know for a strategic approach to guarantee success in their key performance areas upon graduation. Even as the study emphasises the vital importance of applying tacit knowledge for organisational growth within universities, it acknowledges the contextual variations that underscore the necessity for genuine types of knowledge that facilitate university development. Thus, the study advocates for the cultivation of both tacit and explicit knowledge in a classified manner to carry out tasks effectively. Nevertheless, a limitation of this study is that it does not investigate African universities. By integrating both, lecturers can develop, engage in critical thinking, and gain a thorough understanding of their teaching methods and research. To promote stimulating dialogue and sustained participation in universities, the study advises professors and other academics to enhance their comprehension of the diverse types of knowledge, given their different backgrounds.

AI and Ethics declarations: The use of AI was not part of this study while developing and writing the paper**.** Ethical considerations were adhered to where the topic investigated was approved. This means that declarations indicate that all consulted sources were referenced and cited during the research investigation.

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Predictive Analytics: Digital Metrics for Estimating Knowledge Assets

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Abstract: Digitization, big data, and follow-on metrics have burgeoned over the last couple of decades. While the knowledge management (KM) community has embraced some of the advances in data-driven decision-making in business, there remain new applications that are relatively unexplored. One of these applications is the use of digital metrics to estimate knowledge holdings or intellectual capital (IC). In a discipline still at the mercy of troublesome metrics, new opportunities to better measure IC would fill a large gap in the existing body of knowledge. Previous work, across several industries and well-known brands, established digital media variables of interest such as volume of mentions, variability of mentions, influencer quality, brand sentiment, and some more platform-specific (X, Facebook, etc.) measures (Erickson, 2023; Erickson & Rothberg, 2023; Erickson, Schmidt & Rothberg, 2020). These indicators were compared with brand equity from a separate source and methodology, establishing apparent links. In short, certain digital media variables seemed related to higher brand equity, a proxy for the intellectual capital component of relational capital. More recent research explored the statistical link between digital metrics and brand equity (relational capital) (Erickson & Rothberg, 2024). On a very small sample, key indicators were shown to predict brand equity values at a very high correlation using different approaches (regression, neural network). This study continues that work, with a larger set of firms. The firms are drawn from two industries, autos and information technology, both of which have a number of companies with available brand equity estimates. Moreover, the study adds price/book value ratios, calculated on an annual basis (like brand equity) but which can also be easily estimated for shorter time periods by altering share price. As a result, in estimating correlation, periodic digital media independent variables can be compared not only with annual brand equity metrics but with matching periodic price/book ratios. Price/book is an effective proxy for not just relational capital but all intellectual capital of the firm, providing a different approach from a new perspective.

Keywords: Intellectual capital, Relational capital, Knowledge assets, Brand equity, Sentiment analysis, Predictive analytics

1. Background/Literature Review

Intellectual capital (IC) metrics remain a difficult concept for researchers. While a wide range of options exist, those that work best can only really be used on a firm or two at a time. Those looking to evaluate a wider sample of organizations have their advantages but not nearly the depth or capacity for applied analysis on how and why different approaches yield different levels of success. The discipline also increasingly relies on self-report surveys raising obvious questions about subjectivity and the respondent's capabilities in judging the organization's success in managing intellectual capital or knowledge.

This study continues a broader research program to investigate new and innovative approaches to estimating the intellectual capital of the firm. Previous efforts have focused on relational capital, in particular, and how contemporary social media metrics, including sentiment analysis, can be applied gain a sense of the relative success of different entities in managing intangible assets. This paper broadens that effort by looking at two industries populated with a number of high brand equity (relational capital) competitors as well as an alternative, more widely available output metric (price/book ratio). The results are encouraging, potentially providing new, easily implemented metrics for comparing multiple firms and their knowledge management (KM) efforts in a large sample.

1.1 Intellectual Capital

Previous studies have broken the ice on this topic and developed background on the concepts of intellectual capital (IC) in general and relational capital (RC) and brand equity in particular. In the interest of saving space and featuring some of the newer research on applying digital media metrics to estimating the value of a firm's intangible assets, this literature review will cover IC, RC and brand equity only briefly. Fuller literature reviews, as noted, are available in previous work (Erickson & Rothberg, 2024; 2023; Erickson 2023).

Intellectual capital is essentially the score-keeping side of knowledge management (KM), defining and measuring the intangible assets (knowledge) of the firm (Bontis, 1999; Edvinsson & Malone, 1997). KM theory suggests that better management of these knowledge assets leads to competitive advantage in the marketplace (Grant,

1999; Teece, 1998), and IC is the means to better understand and account for this knowledge, allowing more effective growth and application.

As a result, IC can be an important tool in trying to assess the impact of better knowledge management on firm performance. If knowledge really is a key competitive differentiator (Nonaka & Takeuchi, 1995), we should be able to capture the construct and its influence on profit, margins, innovation, etc. So how do we define and measure IC?

The most common breakdown in the field remains human capital (individual knowledge on how to perform one's job), structural capital (processes/procedures captured by the organization), and relational capital (knowledge about external entities, particularly customers) (Bontis, 1999). Much of the literature on knowledge management concerns how to better capture individual human capital and turn it into more of an organizational structural capital asset. Relational capital (Roos & Roos, 1997) has been less addressed. Termed customer capital in early IC frameworks, relational capital was coined as the more inclusive term, bringing in other external concerns such as suppliers, local communities, regulators, and others, but the vast majority of relational capital asset value still comes from customer knowledge.

The lack of emphasis on relational capital is also evident in some of the common IC metrics. Sveiby's (2010) well-known catalog counts over 40 published approaches, including recognizable frameworks such as the Balanced Scorecard (Kaplan & Norton, 1992). Sveiby differentiates between those methods usually applying company-specific information or non-dollar measures, both harder to apply across multiple firms (if the data can even be obtained) vs. approaches making use of readily available, objective, dollar-based inputs from financial statements such as Pulic's (2000) VAIC or Tobin's q (Tobin & Brainard, 1979). But Pulic's approach does not have a separate relational capital component (it is lumped in with structural capital) and the Tobin metric measures only overall IC, not the individual components. Whether a specific objective measure can deliver the detail desired by KM practitioners remains an open question.

Relational capital, then, is an understudied and under-measured concept. And, as we'll discuss, one can certainly make the claim that customer knowledge in an age of big data and relationship marketing is a burgeoning and increasingly important intangible asset in organizations. Relational capital builds through repeated successful interactions between the seller and the customer. The seller accumulates data, often on individually identifiable buyers, and learns what satisfies that customer (Sussan, 2012; Stahle & Stahle, 2012). In other contexts, this value is often referred to as brand equity. Turning the vast pool of customer data into actions delivering loyalty demonstrates deep brand equity and relational capital (Change & Tseng, 2005; de Castro, et al., 2004). So what can we take from the available data and related marketing concepts to change our thinking on how we might measure relational capital or even full intellectual capital in organizations?

1.2 Brand Equity and Digital Media

As above with IC, the branding literature has also been fully explored in previous work related to this study (Erickson & Rothberg, 2024; 2023; Erickson 2023). More associated with marketing as branding is one of its core concepts, a unique and valuable intangible asset. But, again, the value of a brand is not in a catchy name or logo but in its record of repeated satisfactory interactions with customers. Customers build expectations about what the brand will deliver, and if the experience matches those expectations, the buyers are satisfied and will continue with the brand. Their purchases, then, as they use the brand as an indicator of their expected satisfactory experience, show value in the identifying brand itself (Seggie, et al., 2006; Aliwadi, et al., 2003; Keller, 1993; Aaker, 1996; 1991).

More recently, brand value is associated not just with product use experiences but also digital interactions surrounding the brand, including website and in-store activities, social media activity, loyalty program activity, and other data collection opportunities. Information and communication technologies enhance interactions and have expanded individualized, identifiable contact between buyer and seller (Lechman, 2017). The result is a wealth of data concerning users that can be used to build knowledge, not only on an aggregate but on a personalized level (Rothberg & Erickson, 2017; Sigala & Chaikiti, 2014; Levy 2009).

From that point, it's a fairly straightforward logical step to suggest that data drawn from digital interactions could be used to assess the value of a brand or, alternatively, the level of knowledge assets constituting relational capital. To some degree, organizations have long realized that comments on social media provide some insight into how users feel about a brand, with contributors providing uncensored positive and negative comments (Rovai, 2002). Moreover, the content can go into unusual depth, providing meaningful guidance about true feelings toward the brand (Rizun & Kucharska, 2018).

As a result, social media metrics are now being recognized as a potentially valuable input in estimating brand equity on both the academic side (Fagundes, et al., 2023) and on the applied/consulting side (McDowell, et al., 2023). While research has commenced on the details of the relationship such as how user involvement, participation, and expression through social media might be linked to brand awareness and loyalty, such studies also point out the need for much more attention to the topic in these still early days of academic research (Fagundes, et al., 2023; Algharabat, et al., 2020).

This paper contributes to filling this gap, adding to what we know about the relationship between digital media metrics and brand value. Applying learnings from recent research, the study also extends the findings by including objective data, going beyond subjective self-report surveys. Although not definitive, and this paper only presents the initial insights from the study, it provides guidance to coming research including much larger datasets and a range of interesting variables.

2. Methodology

Previous studies used to explore and establish a methodology around digital metrics and brand value (relational capital) employed a brand equity outcome variable sourced from marketing consultancy Interbrand (Erickson, 2023; Erickson & Rothberg, 2023; Erickson, Schmidt & Rothberg, 2020; Erickson & Rothberg, 2017). Interbrand (2025) publishes a list of the Top 100 Global Brands every year as well as some more focused lists (Top 100 Chinese Brands). Their methodology is proprietary but does give a reasoned, concrete number to brand value. On the other hand, only the largest, best-known brands are included providing sharp limits on available brands to study. For this study, one objective is to move toward an alternate, more readily available brand value metric. The easily accessed (stock) price/book ratio is therefore included and will be covered shortly.

Two industries were chosen, each with multiple strong brands present in the Interbrand rankings, automobiles and information technology. Autos are obviously a more consumer-oriented brand while the info tech brands were purposely chosen as those with a greater business-to-business emphasis. These industries should be very different in terms of their approach in branding. As a result, both similarities in spite of the differences and dissimilarities should be of interest. When setting up the data collection earlier in the year, Tesla was included given its place as a Top 10 brand as was Chinese provider BYD. A lot of recent political news has impacted the Tesla social media results while the brand value indicator, based on last year's financials, stayed constant. There was some discussion on whether to keep Tesla in the data pool, but in the end we decided to report the results. The results can be rerun without Tesla as a future extension of the research.

Data used in the study were collected over four weeks, February 25 to March 24, 2025. The Sprout Social listening platform was used for data collection. Previous studies had employed Salesforce Social Studio, but that platform has been discontinued by the provider. Sprout Social is similar in that its listening function, when provided a prompt such as a brand name, will scrape the internet for social media activity (e.g. X, Reddit), shared media (YouTube), blogs, and other web mentions. As we'll see in the results, these mentions can run into the millions or even billions for a keyword on a daily or weekly basis. Consequently, the potential exists for objective, big data studies of global feelings toward brands and a volume of data well beyond what researchers in the field can usually gather.

For the dependent variable, brand value, the Interbrand 2024 Best Global Brands and related rankings were used to estimate brand equity (Interbrand 2025). In addition, as noted, we added a second potential brand value estimator in the price/book measure was obtained off *The Wall Street Journal* financial data quotes website (WSJ, 2025). The new metric has a couple of possibilities. One, as noted earlier, is based on the possibility that relational capital makes up an ever-growing part of intellectual capital in an era of digital business and marketing. An overall IC indicator may be dominated by the RC component and so could be used as a proxy measure for brand value and relational capital. Alternatively but relatedly, one could ask whether digital media data can be used to assess IC in general as opposed to just RC. If so, it is again a potentially useful tool in better understanding the role of intellectual capital in the competitiveness of firms.

As noted, data were gathered for auto brands and B2B IT brands. For the former, top brands include Toyota, Mercedes, BMW, Tesla, Honda, BYD, Hyundai, VW, Ford, and Nissan. For the latter, top brands include Microsoft, Cisco, Adobe, Oracle, IBM, SAP, Nvidia, Intel, and Salesforce. Data generated by Sprout Social and included in the analysis were volume (messages/day), potential impressions (views/day, number of times audience could have viewed messages based on followers), engagements (actions/day, number of times messages were publicly interacted with), and sentiment (percentage positive, users' feelings about brand). Standard deviations for each metric were also calculated and included in the analysis.

Statistical work was done on SAS Viya allowing easy addition and deletion of variables with immediate feedback on each variable's significance and its influence on the significance of already included variables. SAS Viya also has multiple options for modeling, including various regression approaches, a neural networks option, and specialized techniques such as clustering or decision trees. Moreover, the platform allows easy comparison of the quality of each model's outcomes. The results included here are limited due to space and so provide only a taste of what is possible with the data and the analysis software. As will be noted, the results call for much more, much deeper analysis, analysis that can be performed by the SAS Viya system.

3. Results and Discussion

Initially, we performed a correlation analysis on each of the available variables in the models. We expected considerable overlap in the data we were tracking and wanted a sense of how big those relationships might be. The full dataset included:

- Brand equity (dependent variable)
- (Stock) price to book (alternate dependent variable)
- Volume of digital media conversations
- Volume standard deviation
- Sentiment (positive)
- Sentiment standard deviation
- Impressions (potential reach of each conversation)
- Impressions standard deviation
- Engagement (user interaction with content/conversations)
- Engagement standard deviation

Results are included in Figures 1 and 2. As expected, correlations are high, as indicated by the darker blue results, especially among the consumer-oriented automobile brands. More volume of chatter is likely to lead to more impressions (more initial posts would lead to more follow-on shares or posts) as well as more engagement (more initial posts and follow-on impressions could lead to more interaction). Interestingly, in the auto brands correlation, sentiment is not highly correlated with much of anything nor is the outcome variable brand equity. For B2B IT brands, sentiment is more closely correlated with a number of the other variables but neither outcome variable shows singular attachment to any of the explanatory variables. The fuller analysis sheds further light on those relationships, but one would expect considerable collinearity within most models, not diminishing their overall predictive power but limiting the reliability of individual component results.

We then ran linear regressions on each data set for both outcome variables. Initially, all explanatory variables were included but then removed sequentially in order of significance (those with the least significance came out first). Given the high degree of correlation between some of the variables, these steps unsurprisingly served to increase the significance of some of the remaining variables. After several iterations, the regressions with the highest explanatory power and the clearest contributions from independent variables were identified. These are included in Tables 1 and 2.

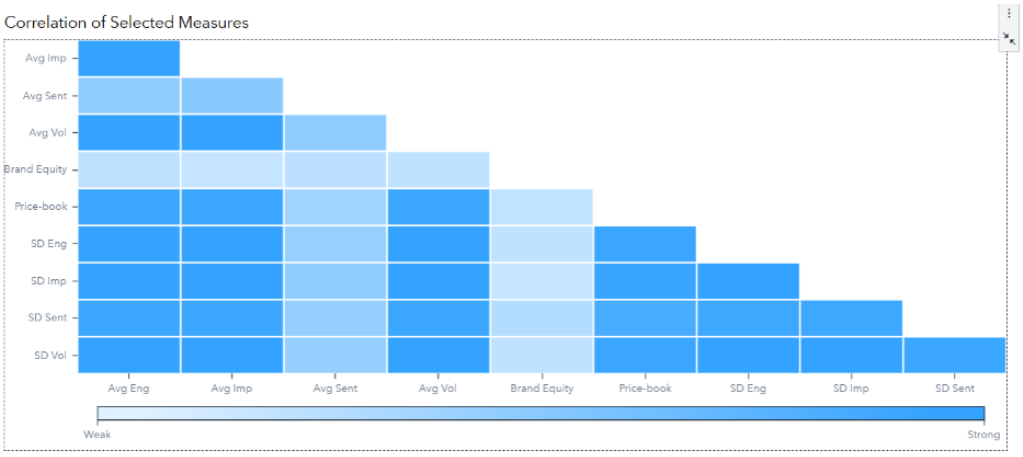


Figure 1: Auto Brands Correlation Matrix

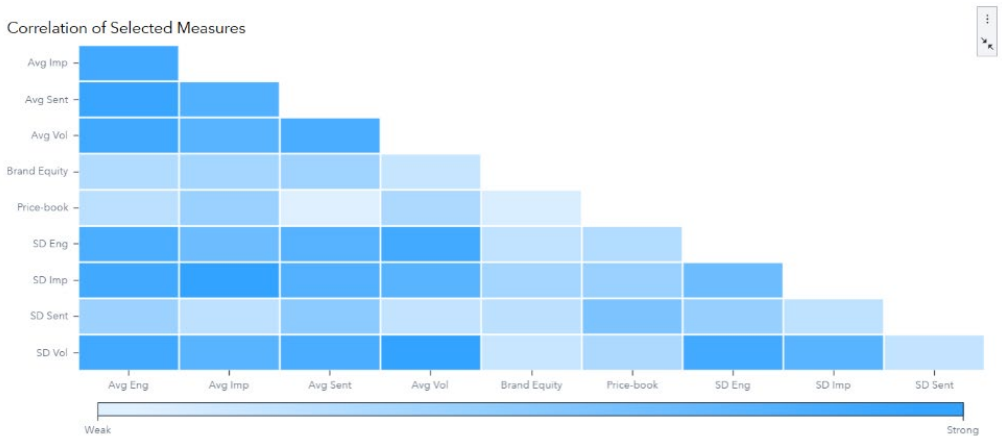


Figure 2: Information Technology Brands Correlation Matrix

We also ran neural network modeling on all the variations. Given the apparent collinearity in the model, neural networks are a good technique to establish the combined predictive power of all the variables. But we don't know the specific contribution of each independent variable, those specifics remain a bit of a black box. But with all variables included, the neural networks obtained Average Squared Errors (ASE) for the automobile brands with price/book ratio (0.01) and brand equity (0.02), very low as compared to the ASEs from the regressions. The ASEs for the information tech brands were price/book ratio (0.03) and brand equity (45), similar to the regression results for price/book and somewhat lower for brand equity. Note that neural networks do not generate R^2 values, so ASE is the available tool for comparing results from other models, including regression. ASEs for the regression equations are reported alongside the R^2 values.

Those results are very interesting as they indicate a very high predictive capability of the outcome variables when applying all of the variables. As above, we're not sure of the role of the explanatory variables, but there is clearly a strong connection, especially with the price/book ratio and social media metrics. That result supports the regression analysis and begs for deeper research in the future into the specifics generating the neural network results.

Table 1: Auto Brands Results

	Price/Book		**Brand Equity**	
	R^2=.668, ASE = 54		R^2=.275, ASE = 7400	
Parameter	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**
Intercept	-112.6	0.052	668.9	.168
Impressions	0.000002	0.083		
Sentiment	1.41	0.040	-7.11	.196
Volume	0.0005	0.154	-0.003	.331

Table 2: Information Technology Brands Regression Results

	Price/Book		**Brand Equity**	
	R^2=.983, ASE = 0.23		R^2=.378, ASE = 247	
Parameter	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**
Intercept	-4.16	0.030	3.63	0.001
Impressions			-0.001	0.091
Sentiment	0.075	0.020		
Volume			0.18	0.087
Imp Std Dev	0.0002	0.007		
Vol Std Dev	-0.014	0.025		

As for the regression analyses themselves, all the results show some promise but some stronger than others. For the consumer goods, the automobile brands, the price/book equation (R^2 = .668) is a considerably better predictor than the brand equity equation (R^2 = .275). Both equations show some explanatory power in the volume and sentiment variables, with the impressions variable also significant in the stronger equation. More specifically, in the brand equity equation, volume and sentiment are not technically significant, above even the relaxed 90% confidence level given the P-values but are the strongest predictors. In the better fitting equation, price/book ratio, sentiment is significant at the 95% level, impressions at 90%, and volume around 85%. There is some stability present in the price/book predictor with the intercept also significant at 95%, but what movement there is in the outcome variable, it can be fairly well-explained by the social media variables.

The B2B IT brands equations are both stronger, particularly the price/book predictor. For brand equity, R^2 comes in at .378 and the impressions and volume variables significant at the 90% level according to the P-values. Note the impressions variable is negative but that may be a function of the colinearity we expect in the equation. The price/book ratio is a very strong result (R^2 = .983) with highly significant explanatory variables in impressions standard deviation (99% confidence), volume standard deviation (>95%) and sentiment (>95%), though do note the volume SD coefficient is again negative. That equation is the only one in the group that found the standard deviation or consistency of any of the variables to be a significant input, interesting because social media metric stability was one of the characteristics that had noticeably stood out in some of the previous work. It is apparent here in the most impressive result, so perhaps that characteristic still holds true.

This study was designed to take a closer look at larger datasets that previous work, in multiple industries, and with an alternative metric for brand equity/relational capital. The results are quite interesting and additional depth of analysis is available and can be included in the conference presentation and further work. Initially, the larger dataset continues to provide support to the idea that social media metrics can predict the value of a firm's brand or relational capital. The methodology is backed by very large numbers (some impression numbers include billions of observations per week), but the actual data gathering does still have limitations, including only 9 and 10 brands, respectively. Even so, as we continue to increase the number of firms and brands included, the approach continues to confirm a relationship exists that can be further explored.

The relationship is apparent in two very diverse industries, the consumer-based auto industry and the more B2B-focused information technology brands included here. While one might expect brands and social media to be more associated with consumer goods and services, both industries show promise in predicted brand equity/relational capital. Somewhat surprisingly, better results were actually obtained in the B2B sector, suggesting that the interpretation of brand value as a series of successful interactions with customers and users is correct. The metrics, even though social media, do reflect concrete views and opinions, making their predictive power concerning firms' success in managing intangible assets more convincing.

Finally, the price/book ratio was by far the more accurately predicted outcome variable for both industries. As mentioned at the beginning, this is very positive and raises interesting questions. Initially, price/book is available for just about any publicly listed company, allowing a substantial increase in the available firms/brands to study. Moreover, though a single annual number is reported in widely used data sources, it could conceivably be recalculated on a weekly or even daily basis as stock price changes. Consequently, monthly/weekly/daily social media metrics could be compared with matching price/book values. The actual moves of social media data and this impact could be assessed on a much more granular basis.

Further, the questions posed concerning whether price/book is a metric for all intellectual capital rather than just relational capital is less of a problem than an opportunity. Being able to minutely assess the impact of social media as an accurate predictor of a firm's full IC standing would be valuable in and of itself. If we don't need to limit analysis to relational capital, that's not necessarily a problem. And to the extent that relational capital may be becoming a larger component of intellectual capital is something that could be explored as the metric is applied.

4. Conclusions

This study expands work on using objective, readily available social media data to predict levels of brand value or, by extension, intellectual capital. While earlier work focused solely on brand equity or relational capital, this effort brings in a potentially broader metric encompassing relational capital but more specifically related to overall intellectual capital.

While the field is teeming with methodologies for measuring intellectual capital or knowledge assets, many are firm-specific and so hard to gather for a substantial multi-firm sample. Alternatively, others are based on

subjective self-report surveys which, although valid, also have their limitations. Social media metrics are readily available, objective, and can be gathered in enormous, big-data-enabled samples.

The study demonstrated considerable potential for using social media metrics including volume, impressions, engagement, and sentiment in two very diverse industries, both consumer and business-to-business. The results also showed some validity in both IC metrics, brand equity and price/book ratio, with the newer ratio variable demonstrating particular strength. A further extension using an AI neural network tool confirmed the predictive power of the variables.

Future work can take this methodology into much bigger data sets as the price/book variable opens many more potential brands for analysis and allows more granular study of changes in the social media and IC relationship over time. Understanding what contributes to more effective use of knowledge assets and the value of intellectual capital can markedly enhance the prospects of the KM and IC disciplines.

AI and Ethics Declaration: The research involved no human subjects but only aggregate data collected from publicly available social media platforms. No AI tools were used at any stage of the paper's development.

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Perceived Factors of Trustworthiness in Generative Artificial Intelligence (GenAI): Towards an Understanding of how to Assess and Build Trustworthiness

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Abstract: Given the benefits and risks associated with GenAI adoption in organizations, many academics and practitioners have stressed the importance of understanding how humans come to trust these technologies and the information and knowledge (e.g., solutions/decisions) they produce. The objective of this paper is to further examine human trust in AI technologies through the lens of a widely accepted organizational trust theory and model developed by Mayer, Davis, and Schoorman. More specifically, this paper focuses on developing a better understanding of perceived factors of GenAI trustworthiness since assessing trustworthiness is a critical determinant of trust. Building on the existing theory and model, it is proposed that an individual's perception of one or more of the following dimensions of trustworthiness - ability, integrity, and benevolence - will determine how trustworthy they find GenAI to be. Ability (or competence) refers to the trustee's specific skills, knowledge, and expertise required in a specific domain. Integrity reflects the trustee's sound values or principles (e.g., fairness, consistency, justice). Benevolence is an altruistic loyalty that reflects the trustee's concern for the welfare, needs, desires, and interests of the individual over organizational or profit motives. Many researchers have proposed assessments related to GenAI ability, but integrity and benevolence are more difficult to assess, as technologies do not intrinsically embody human values or altruistic behaviors. Consequently, other parties within the organizations, such as AI designers and developers, strategic decision-makers, or the organization may be conflated into perceptions of these dimensions. The paper continues by briefly discussing how emotions and organizational culture may influence individuals' perceptions of trustworthiness and concludes by suggesting potential directions and strategies for building and representing each dimension of perceived trustworthiness in the context of GenAI.

Keywords: Trust, Generative artificial intelligence (GenAI), Trustworthiness, Model oftTrust, Organizational

1. Artificial Intelligence (AI) Technology Adoption

The adoption of Artificial Intelligence (AI) technologies in organizations has drastically increased over the last couple of years (Singla et al., 2024). Furthermore, McKinsey and Co. (Singla et al., 2025) recently found that AI adoption is happening across all sectors and organizational functions, however, each organization applies "the technology where it can generate the most value—for example, service operations for media and telecommunication companies, software engineering for technology companies, and knowledge management for professional-services organizations" (p.5). AI technologies can be understood as a "generation of technologies capable of interacting with the environment by (a) gathering information from outside (including from natural language) or from other computer systems; (b) interpreting this information, recognizing patterns, inducing rules, or predicting events; (c) generating results, answering questions, or giving instructions to other systems; and (d) evaluating the results of their actions and improving their decision systems to achieve specific objectives" (Glikson and Woolley, 2020, p. 628).

Given the vast and ever-growing volume of data and information available to organizations today, it is no surprise that organizations are exploring ways to leverage AI, and more specifically, Generative AI (GenAI), for strategic planning (Leoni et al., 2024), decision-making (Marvi et al., 2024), operational efficiencies (e.g., process or task improvements and automations) (Brynjolfsson et al., 2018; Ferrario et al., 2020; Arias-Pérez and Vélez-Jaramillo, 2022; Giovine et al., 2024), or innovation (i.e., creative tasks) (Giovine et al., 2024; Zhang et al., 2025). These implementations will not likely slow down, as organizations are seeing immediate benefits through increased revenues and reductions in costs (Singla et al., 2024).

AI also presents considerable risks for organizations and their employees. The most publicized risk relates to job loss and labour displacements from the automation of various organizational tasks and processes (Briggs and Kodnani, 2023; Zhang et al., 2025) but other known risks include algorithmic bias, misinformation, inaccuracy, hallucinations, technological dependence, as well as privacy and cybersecurity concerns (Singla et al., 2024; Zhang et al., 2025). Most importantly, AI lacks explainability (i.e., it is non-deterministic and non-transparent), making its behavior difficult (or impossible) for individuals to understand or predict (Giovine et al., 2024; Zhang

et al., 2025). Many of these risks open the possibility of using inaccurate or biased information in the decisions being made.

Considering the benefits and risks, many academics and practitioners have stressed the importance of understanding how humans come to trust these technologies and the information and knowledge (e.g., solutions/decisions) they produce (Ferrario et al., 2020; Glikson and Woolley, 2020). The objective of this paper is to further examine how AI trustworthiness can be assessed through the lens of a widely accepted organizational trust theory and model developed by Mayer, Davis, and Schoorman.

2. A Theoretical and Empirical Model of Trust

In the academic literature, trust is a widely defined and operationalized concept, with hundreds of different psychometric measures. However, there are only a handful of characteristics of trust (and associated models) that are based on well-grounded theory and have been empirically tested, especially in an organizational setting (McEvily and Tortoriello, 2011).

Theorists generally agree that trust is dependent on a trustor's (i.e., the person doing the trusting) expectation of how the trustee (i.e., person/actor being trusted) will behave, or what the outcomes of the act of trusting (e.g., interaction) would be. When a trustee fulfills the trustor's expectations, this acts as a mechanism for creating and increasing trust. In many cases, especially those where no prior interactions exist, the trustor must be willing to take a risk (or make themselves vulnerable) to engage in a trusting behavior (Mayer et al., 1995). Of course, no risk-taking behavior is needed for there to be a willingness to be vulnerable (or trust), as all the risk is "inherent in the behavioral manifestation" or engaging in the trusting behavior and "assuming the risk" or making themselves vulnerable (Mayer et al., 1995, p. 724). Perceived risks moderate an individual's willingness to be vulnerable and their risk-taking behavior (Mayer et al., 1995). The level of trust needed to engage in a trusting behavior will directly relate to the level of perceived risk or vulnerability involved in the situation (relative to the known benefits). The higher the perceived risk, the more trust is needed. Thus, context is a particularly important factor to consider because trust is largely situational and should always be qualified with a consideration of what the trustee is being trusted to do (Mayer et al., 1995; O'Neill, 2002; 2020). Trust typically develops over time through interactions between the trustor and the trustee but often changes based on a particular situation or context. For example, one may trust their nanny to care for their kids more than to fix their computer.

A trustor needs to make themselves vulnerable (through their risk-taking behavior) to gather data about the trustee to see if they can be trusted in a particular situation. The trustee's response (or the outcomes of the trusting behavior) is then used to assess their trustworthiness. Interactions (i.e., outcomes) where expectations of the trustee's actions are fulfilled lead to a greater perception of their trustworthiness. If a trustor does not have enough interactions to accurately assess trustworthiness, they exhibit a "trust similar to blind faith" (Mayer et al., 1995, p. 730) or gauge trustworthiness through other individuals' (or the organization's) accounts of the trustee.

Numerous factors or dimensions have been proposed to explain trustworthiness. However, the most widely adopted factors are those identified by Mayer et al. (1995; 2007). According to the authors, a trustor's overall perception of the trustworthiness of the trustee will depend on their assessment of the trustee's ability, integrity, and/or benevolence. Although a high amount of all three dimensions will produce a high perception of trustworthiness, all three are not needed for the trustor to engage in a specific trusting (i.e., risk-taking) behavior. Moreover, each dimension contributes uniquely to the perception of trustworthiness, and one dimension may be more pertinent or meaningful in a particular trusting situation than the others (e.g., Chen et al., 2011; Evans, 2012; 2013). For this reason, Mayer et al. (1995) propose that trustworthiness should not be viewed as binary, but rather as a continuum where the relative importance and strength of each dimension may change over time, especially as the number of interactions increases.

Trust is further complicated by the proposition that every trustor has relatively stable internal characteristics that influence the amount of trust they have for any given trustee. Grounded in personality or social construction (culture, past experiences), Mayer et al. (1995) argue that individuals have a general willingness (or propensity) to trust others, especially prior to interacting with them, which transfers from one trusting situation to the next. In the context of AI, this trait could be understood as the overall willingness of the trustor to trust in AI, in the absence of a specific situation, context, or AI system (Hoff and Bashir, 2015; Schlicker et al., 2024).

Mayer et al. (1995) define trust as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of

the ability to monitor or control that other party" (p. 712). In addition, the authors (Mayer et al., 1995; Schoorman et al., 2007) present a multidisciplinary Integrative Model of Trust [MoT], which further explains the relationship between all the factors discussed above (see Figure 1).

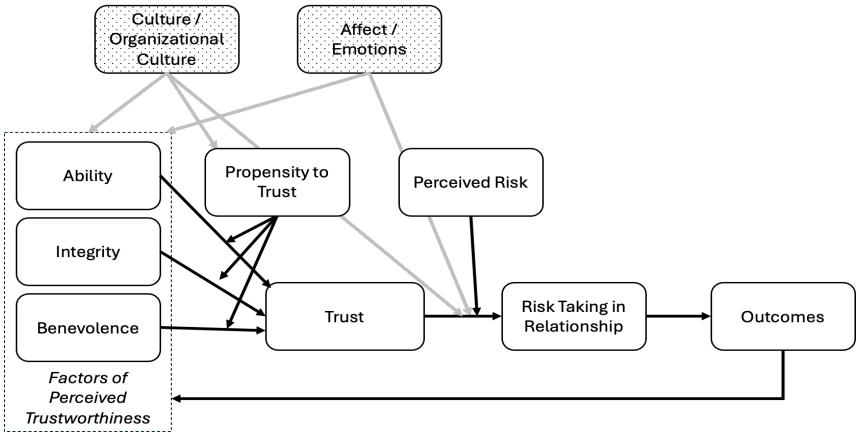


Figure 1: Mayer et al.'s MoT (Adapted to include emotions and culture)

This definition of trust, and the MoT, are among the most widely adopted and investigated conceptualizations of trust. Moreover, many MoT factors have been successfully operationalized and validated across numerous settings and disciplines (Schoorman et al., 2007; McEvily and Tortoriello, 2011). The MoT is also appropriate for studies looking at human trust in AI technologies because it is designed for organizational settings, applicable across different levels of analysis, and designed for unidirectional trust analysis (Mayer et al., 1995; Schoorman et al., 2007).

3. Trust in Humans vs. Conversational GenAI

There are some important differences in discussing how humans place trust in other humans and GenAI technologies. The first distinction is that the perceived and actual risk associated with trusting AI-produced information is different than the perceived or actual risk associated with acting on AI-generated information, without further challenging or verifying it. The former involves negligible risk since the AI is being used simply as a decision-aid. In fact, it may even reduce perceived risk by giving users the ability to privately ask questions that may be perceived as ignorant or risky if asked of a work colleague. On the other hand, taking the AI solution/information, unchallenged, and acting on it (or allowing the AI to autonomously act) bears a higher risk since there are now perceived and actual risks to the organization or its operations. As AI autonomy increases, or it is expected to complete more important tasks, make riskier decisions, or implement complex solutions, perceived (and actual) risk increases, requiring more trustworthiness in the AI.

Some researchers argue that humans are naturally skeptical and risk-averse when it comes to relying on new technologies in general (Omrani et al., 2022) and AI systems specifically (Schmidt et al., 2020), especially when using them for important decision-making tasks (Solberg et al., 2022). Textor et al. (2022) suggest such concerns may be due to AI's inability to understand and act on ethical principles, seeing ethical decision-making as a uniquely human skill. Other noted concerns include fairness, accountability, transparency, misuse, and privacy (Omrani et al., 2022; Marwala, 2024). Research also suggests that trustworthiness may be influenced by third-party evaluations, culture (Mayer et al., 1995; Schoorman et al., 2007), and past experiences with AI (McKnight et al., 2017; Omrani et al., 2022; Choung et al., 2023a). Furthermore, humans are prone to cognitive biases (Solberg et al., 2022; Chi et al., 2023; Riley and Dixon, 2024) and affect (moods and emotions), which may distort assessments of risk and trustworthiness (Schoorman et al., 2007; Schmidt et al., 2020; Albahri et al., 2023). These same distortions have been argued to exist with trust in AI (e.g., Evans and Wensley, In press), with some researchers showing empirical evidence for it (Gillath et al., 2021; Chen et al., 2011; Frazier et al., 2016; Solberg et al., 2022; Choung et al., 2023a).

Conversational AI is also unique in how users interact with it. For instance, the iterative nature of conversations allows users to receive numerous complex answers or solutions in a brief period of interacting with the AI. This type of information and knowledge exchange is rare in human-to-human interactions, as humans need time to process solutions, only have expertise in a limited set of domains, or may not have access to relevant information. Each solution or answer the AI provides, like information/knowledge exchanges with humans, acts as a proxy for helping to determine trustworthiness in a particular domain. For AI, trustworthiness may be

gauged in a shorter timeframe because interactions are more efficient (i.e., individuals can have a greater number of information and knowledge exchanges than with humans). However, conversational AI may also pose a problem for gauging trustworthiness because of how AI solutions are 'negotiated' to fit the user's prompts. GenAI models use Natural Language Processing to analyze prompts, which are designed to infer and respond to the user's conveyed tone, as well as their wording or phraseology. Inadvertently, users may introduce biases into their prompts that alter the GenAI solution in a way that it better aligns with the user's expectations or affects information quality. From a trust perspective, the GenAI is crafting a solution (outcome) that the user will inherently perceive as more or less trustworthy based on how prompts are designed, or conversations are negotiated.

In a similar vein, it is important to note that the range of possible generated solutions fundamentally hinges on the data set used for training the GenAI (generally referred to as the corpus), as well as the statistical models and algorithms employed. The latter defines how the GenAI interprets and learns from the data, ultimately limiting or expanding the range of possible solutions. Users have no practical method to evaluate the corpus, the statistical models, or the algorithms used in decision-making, and even if they were able to access them, they would have no way to understand the nondeterministic logic used in generating any given solution. From a trust perspective, one could argue there is inherently higher risk in situations requiring the need for higher trustworthiness in lieu of sheer 'blind trust.'

4. Trustworthiness Dimensions and GenAI

Although every factor in the MoT is critically important for there to be an accurate assessment of trust, trust researchers (e.g., McKnight et al., 2000; Cho et al., 2015; Yilmaz and Liu, 2022) have stressed the specific importance of the trustworthiness factor. One of the most commonsensical arguments supporting this proposition is that individuals should want to put more trust in the trustworthy and less in the untrustworthy (O'Neill, 2002; 2020).

As previously mentioned, the MoT proposes (and operationalizes) three dimensions, which as a set "explain a major portion of trustworthiness while maintaining parsimony" (Mayer et al., 1995, p. 722): Ability, Integrity, and Benevolence. Before elaborating on how each dimension applies in the context of GenAI, it is important to note that trustworthiness is situational (Mayer et al., 1995; Hoff and Bashir, 2015; Schlicker et al., 2024), and assessments change across tasks, domains, and even over time. It is also worth acknowledging that, unlike humans, AI technologies do not inherently possess benevolence, integrity, or any other values, making these dimensions difficult to directly observe or attribute to AI. Perceptions of these dimensions likely reflect some strategic organizational directive or organizational culture/value, which is 'programmed' into the decision-making of the technology. This may cause users to conflate these trustworthy dimensions between the AI and the strategic planners who instituted the organizational cultures and directives, or the designers and developers of the technology. Moreover, designing and developing AI technologies to autonomously and programmatically follow a set of values (or act benevolently) may bias or modify the information/solution, influencing other trustworthy dimensions like ability (e.g., see Evans and Wensley, In Press).

The next section explores each of the three dimensions of perceived trustworthiness. Each dimension is defined and explained in a human-human trust context and then in a human-AI trust context. It is important to note that although numerous studies exist exploring trust in AI, the AI or AI-related research papers cited below directly acknowledge or build on Mayer et al.'s MoT model and their Perceived Factors of Trustworthiness. This is meant to confirm the constructs are understood and applied uniformly, which is critical given the large number of trust measures and models available (McEvily and Tortoriello, 2011).

4.1 Ability/Competence

Ability-based trustworthiness refers to a "group of skills, competencies, and characteristics that enable a party to have influence within some specific domain" (Mayer et al., 1995, p. 717). It implies possession of domain-specific information or knowledge that has the potential to increase organizational performance, increase operational efficiency, or lead to greater innovation.

In humans, ability or competence is traditionally specific to a single, fixed domain (Zand, 1972), which supports why individuals may warrant higher trust in one domain than another (Schoorman et al., 2007). Since disparate knowledge may be required across different domains, ability-based trustworthiness in one domain does not guarantee it in another. Hoff and Bashir (2015) argue that a similar domain-specific trust will exist with AI technologies, suggesting researchers measure trustworthiness relative to the characteristics of the task being

performed by the AI. The context of the information or knowledge being requested is significant since GenAI will perform better in some contexts than others, based on the corpus and machine learning algorithms.

Characteristics often connected with ability include professionalism, dedication, preparedness, and carefulness. In the context of decision- or task-aiding GenAI, ability-based trustworthiness will largely be assessed based on how "helpful, competent, or useful" (Glikson and Woolley, 2020, p. 631) the information (or solutions) the system provides are. Lewis and Marsh (2022) suggest that evidence of competence comes from past performance and/or an understanding of the AI's mechanisms and capabilities.

Several researchers have built on, or extended, Mayer et al.'s (1995) ability-based trustworthiness dimension to apply it in an AI or AI-related context (e.g., automated-systems, machine learning technologies, multi-agent systems, automation, and robotics). From a theoretical perspective, this dimension is commonly adopted verbatim, referring to the technologies' ability (e.g., Kessler et al., 2017; Toreini et al., 2020; Schlicker et al., 2021) or competence (e.g., Lewis and Marsh, 2022; Matsuura and Shirasaka, 2024). These terms can be considered as being synonymous, both referring specifically to the technology's skills and domain knowledge. Other theorists suggest latent computer science-related dimensions, which relate closely to the construct of ability, like explainability (Giovine et al., 2024), accuracy (Ferrario et al., 2020), transparency (Hoff and Bashir, 2015; Glikson and Woolley, 2020), performance, robustness, latency, or accuracy (Schlicker et al., 2021; 2025).

Ability (e.g., Langer et al., 2023; Agnihotri and Bhattacharya, 2024) and competence-based trustworthiness (e.g., Gulati et al., 2018) have also been explored empirically, in the context of AI and AI-related technologies. These factors largely measure whether the technology performs tasks effectively and efficiently (i.e., meeting user expectations), considers important information, possesses technical know-how, and provides accurate results. Other empirical studies, building on the MoT, employ latent subdimension variables to represent ability- or competence-based trustworthiness, like performance (Park, 2020; Chita-Tegmark et al., 2021; Alarcon et al., 2024a), functionality (Choung et al., 2023b; Kleizen et al., 2023), capability and reliability (Chita-Tegmark et al., 2021). Most of these constructs accurately capture aspects of ability and competence; however, some also introduce the notion of consistency over time, which, as will be discussed below, is likely an aspect of integrity-based trustworthiness, not ability. It is important not to conflate these constructs. Moreover, Singh and Mayer (2024) warn that although a greater perception of ability may increase trustworthiness in the AI, if the AI is perceived as malevolent, higher ability could also lead to decreased trust. This highlights the importance for research studies to explore all the dimensions of trustworthiness and the interactions between them to better understand their impact on AI trustworthiness.

4.2 Integrity

Integrity-based trustworthiness reflects a perception that the "trustee adheres to a set of principles that the trustor finds acceptable" or that are "sound" (Mayer et al., 1995, p. 719). These principles can vary slightly; however, common themes include acting fairly, consistently, and with a strong "sense of justice" (p. 719). As with ability, several researchers have built on or extended Mayer et al.'s (1995) integrity-based trustworthiness dimension to apply it in an AI or AI-related context. From a theoretical perspective, this dimension is commonly adopted directly, referring to the technologies' integrity (Kessler et al., 2017; Toreini et al., 2020; Schlicker et al., 2021; Lewis and Marsh, 2022). Most of these authors propose definitions that generally suggest the trustee's adherence to a set of principles acceptable to the trustor. Schlicker et al. (2021) provide some further guidance on this measure in AI by associating it with related factors like transparency, adherence to ethical guidelines, and reliability. Several other theorists follow suit with factors that relate closely to the construct of integrity, like honesty (i.e., making and honoring agreements, avoiding deception, and adhering to promises or expectations) (Lewis and Marsh, 2022; Mehrotra et al., 2024), reliability (i.e., the technology exhibits behavior that is expected by the user, and that it acts consistently over time) (Hoff and Bashir, 2015; Glikson and Woolley, 2020; Matsuura and Shirasaka, 2024), predictability (i.e., the technology performs actions consistently and expectedly) (Toreini et al., 2020; Lewis and Marsh, 2022), transparency (i.e., the technology informs the user about the decision-making logic or operating rules) (Glikson and Woolley, 2020; Hoff and Bashir, 2015; Shin, 2021; Mehrotra et al., 2024), and fairness (Mehrotra et al., 2024).

Integrity-based trustworthiness has also been explored empirically in the context of AI and AI-related technologies (e.g., Gulati et al., 2018; Choung et al., 2023b; Langer et al., 2023; Agnihotri and Bhattacharya, 2024). In these studies, integrity is generally used to describe technologies that provide honest, objective, consistent, unbiased, or reliable recommendations and those that adhere to ethical standards valued by the trustor. Other closely related factors include reliability (Chita-Tegmark et al., 2021), predictability (Gulati et al., 2018), accountability (Shin, 2021), fairness (Shin, 2021), and honesty (Gulati et al., 2018).

4.3 Benevolence-Based

Benevolence-based trustworthiness reflects a perception that the trustee has the trustor's welfare (e.g., needs, desires, and interests) in mind and intends on doing "good to the trustor" (Mayer et al., 1995, p. 718), "aside from an egocentric profit motive" or extrinsic reward (Schoorman et al., 2007, p. 345). Essentially, this is a perception that the trustee will not harm the trustor, knowingly, and will even go out of their way to help. Low benevolence-based trust would be assessed in cases where "information [is used] in a way that helps the company most, even at the possible expense of the employee" (Mayer et al., 1995, p. 721). Common characteristics associated with benevolence include altruism and loyalty.

Fewer researchers have proposed, adapted, or extended Mayer et al.'s (1995) benevolence-based trustworthiness dimension to an AI or AI-related context. From a theoretical perspective, this dimension is largely adopted directly, referring to the technologies' benevolence (Evans and Wensley, In press; Kessler et al., 2017; Lewis and Marsh, 2022; Schlicker et al., 2021; Toreini et al., 2020). Most of these authors propose definitions that generally suggest a belief that the technology will do good to the trustor, or act in the trustor's best interests. Benevolence has also been explored empirically, in the context of AI and AI-related technologies (Agnihotri and Bhattacharya, 2024; Choung et al., 2023b; Gulati et al., 2018; Langer et al., 2023). Operationalization in these studies reflects a similar definition. Other studies measure closely related factors like goodwill (Matsuura and Shirasaka, 2024), which is described as the trustee's intention to act in the trustor's best interest or purpose (Alarcon et al., 2024a; Alarcon et al., 2024b; Park, 2020), which is described as an alignment between the intended application of the system and the user's needs.

5. Building Trustworthiness in GenAI

Although research has been conducted identifying individual factors that influence trustworthiness dimensions, most of these findings offer limited practical application or guidance for GenAI use in organizations. This paper will, instead, conclude by briefly speaking to three potential avenues for building Gen-AI trustworthiness: subject matter expertise validation, explainable AI (XAI), and prompt engineering education.

Subject matter expertise validation builds perceived trustworthiness in AI by involving credible experts or trusted agencies to assess and endorse AI systems (Afroogh et al., 2024). This process can ensure transparency through comprehensive documentation, which outlines the system's lineage, safety, performance, and ethical considerations. Expert evaluations also reassure users about the system's accuracy, reliability, and ethical compliance, fostering trustworthiness without requiring technical expertise. In healthcare, subject matter experts like clinicians and biomedical scientists enhance trustworthiness by ensuring dataset quality, refining diagnostic criteria, interpreting outputs in real-world contexts, and advocating for AI adoption (Winter and Carusi, 2022). Their collaborative involvement throughout development integrates social, epistemic, and technical dimensions, making AI outputs relatable, actionable, and socially acceptable. This approach highlights that trustworthiness in AI is not just a technical achievement but a sociotechnical construct shaped by human expertise and interactions.

Explainable AI (XAI) is also a promising approach for building perceived trustworthiness in AI systems by making their decision-making processes transparent and understandable to users (Chamola et al., 2023). XAI addresses the black-box nature of AI models, which lack clarity in their operations, leading to concerns about correctness, bias, reliability, and accountability. By providing clear explanations of how AI systems arrive at their conclusions, XAI fosters trustworthiness and confidence among users, stakeholders, and regulators. Transparency and interpretability are key aspects of XAI, enabling users to comprehend the rationale behind AI decisions, particularly in high-stakes sectors like healthcare and finance. Additionally, XAI supports accountability by ensuring AI systems can be held responsible for their actions and aids regulatory compliance by adhering to legal frameworks like GDPR. XAI also enhances the reliability of AI-user interactions, fostering trust in the collaborative process between AI and its users (Ferrario and Loi, 2022). XAI research has already examined factors closely related to trustworthiness dimensions (e.g., accountability, fairness, transparency) and has found them to have a positive influence on trust (Shin, 2021). Recently, XAI researchers (Mehrotra et al., 2024) have even begun testing integrity-based AI explanations based on schemas for fairness, transparency, and honesty with similar positive results.

Finally, prompt engineering education is identified as a key method for building perceived trustworthiness in AI systems (Kraljic and Lahav, 2024). By teaching users how to craft well-structured prompts, it enhances the quality of AI-generated outputs, making interactions more reliable and goal-directed (Knoth et al., 2024). This education helps users understand AI's capabilities and limitations, reducing misconceptions and fostering confidence in its

outputs. It also enables users to critically evaluate results, address issues like hallucinations, and delegate tasks appropriately, which are essential for trust-building. Additionally, prompt engineering complements AI literacy by empowering users with knowledge about AI processes, roles, and limitations, allowing them to make informed decisions and maintain agency in AI-assisted tasks. Together, these skills create a foundation for responsible and confident use of AI in professional contexts. Still, critics suggest that prompt engineering may limit accessibility and currently does not align with natural human language use, advocating for collaborative AI interfaces that evolve intents with users to share effort (Kraljic and Lahav, 2024). Despite this, prompt engineering remains a valuable tool for fostering trustworthiness by empowering users to better understand and control AI outputs.

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A Systematic Literature Review on Intergenerational Tacit Knowledge Transfer: A KPI Perspective

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Abstract: Organizations often have several generations working with them at the same time. Without an effective strategy experienced workers of older generations will leave the organizations taking with them a precious amount of relevant knowledge and skills. What do organizations currently do to support tacit knowledge transfer from Seniors to Juniors? Which formats have been proven to be especially successful? What Key Performance Indicators (KPI) could be used to evaluate cost and benefit of Tacit Knowledge Transfer across generations? Decision-makers faced with a potentially critical amount of tacit knowledge loss due to retiring senior experts are applying different solutions and strategies to overcome this problem, while encountering the challenge to measure and quantify the outcomes. Our research revealed that a gap exists regarding the balancing of the investment and compelling business cases for transferring tacit knowledge from senior to junior employees. We offer Key Performance Indicators (KPIs) with financial and social perspectives that may be applied to guide the enterprise. To achieve this, we conducted a thorough analysis and literature review to evaluate the business cases behind different formats of intergenerational knowledge transfer. Various studies have looked at the methodology behind intergenerational knowledge transfer: we analyzed publications that approach this matter from an organizational perspective including the start-up and Business Angel environment and a further stream of publications that look at the perspective of the individuals involved. Even though organizations are increasingly creative and willing to keep senior experts on board beyond legal retirement age the cost/benefit question is difficult to answer. The analyzed literature regarding Serious Games as one format for intergenerational tacit knowledge transfer was often based on small sample groups or specific needs of an organization or industry. The authors writing about Serious Games agreed that transferability was limited. Their contributions are nonetheless significant as the data collected in pilot projects is invaluable in any decision-taking process for potentially larger scale operations. Based on the current need to balance spending and ensure knowledge continuity our study contributes with novel KPIs and success factors for intergenerational knowledge transfer that can help decision makers in building a business case and steering their investments. The KPIs depend on desired outcomes such as Interpersonal Trust and Increased Efficiency – and therefore we see KPIs such as Quality of Relationships and Skill Improvement Score. KPIs also depend on Expected Investments such as Buying Lost Knowledge (e.g., involving rehiring retirees, or external consultants).

Keywords: Tacit knowledge, Business case, Knowledge transfer, Management tools, Quantification, ROI

1. Introduction

The sharing and transfer of knowledge has been practiced and researched for generations (Grant, 1996). The advent of digital tools facilitates this process – up to a point. The purpose of this paper is to research best practices for the *intentional transfer of tacit knowledge* and highlighting opportunities and developments focusing on key concepts such as success factors and possible business cases of these activities.

In view of the shortage of skilled workers in the German labor market and the increasing numbers of experts reaching the legal retirement age and leaving the companies, successful knowledge continuity across generations has become more crucial for the competitiveness of organizations (Rui and Ju, 2022). Decision makers faced with a potentially critical amount of knowledge loss might find parameters and tools how their organization might benefit from a more curated approach to a topic that is gaining in importance.

For our research we follow Burmeister et al.'s (2020) definition of knowledge *transfer* as "…a communicative process during which at least two individuals interact such that one individual can receive and utilize the knowledge that was shared by another individual…" (Burmeister, Wang and Hirschi, 2020). We postulate that in an organizational context effective *tacit* knowledge transfer builds on the acquired *explicit* knowledge of the junior with the senior sharing their tacit knowledge thus facilitating the development of know-how and the growth of expertise in the knowledge recipient over time.

Our study focuses on a successful transfer of *tacit* knowledge, when the express purpose of this transfer is, to make the senior superfluous. On a factual level Senior and Junior are not in competition for the next promotion as the senior's next career move is retirement. Research continues to highlight that a relationship of trust and

mutual respect of the partners' competences and contributions are a crucial foundation for the transfer of tacit knowledge (Cecchi *et al.*, 2022; Leon, 2023). The generativity motivation (Doerwald *et al.*, 2021) to support the next generation might seem counterintuitive to the building of trust especially in an environment where organizations and seniors strive to prolong the employment of the senior experts – if for the sole reason that "…it is more cost-effective to retain older workers and accommodate accordingly (e.g., by retraining them) than to hire new employees and incur the costs associated with recruiting, training, and socializing them into the workplace…" (North and Fiske, 2015). For a successful relationship the senior's next career move needs to be voluntary and not encouraged by the organization's "rejuvenation strategy".

Research question: What Key Performance Indicators (KPI) could be used to evaluate cost and benefit of Tacit Knowledge Transfer across generations?

This article continues with a methodology section, followed by a section analyzing the publications selected, after that we present the results of the study and end with the discussion and conclusion.

2. Methodology

As a basis for our study, we build on the literature available on this topic applying the PRISMA method (Page *et al.*, 2021). We were especially interested in criteria to measure the success of tacit knowledge transfer, in business cases and evaluations if the methods chosen for intergenerational knowledge transfer met the expectations.

The systematic literature review (SLR) (Saunders, Lewis and Thornhill, 2019) was conducted in the online database Scopus between July and December 2024, based and following up on research conducted between April and November 2024. Papers published and added to Scopus after that date were not included in this article. Only peer reviewed publications in English were evaluated. Due to the dynamic developments in this topic, we focused on publications after 2014 (a ten-year period). The literature we analyzed for our research had to have a business and managerial scope with adult sample groups and focus on private sector industries and services.

For the purpose of this study, we build on the vast and ongoing research on the development of our understanding of *knowledge* - which continues to be refined based on each author`s focus and intention - and we focus on *tacit* knowledge in order to explore the business cases behind the endeavors to transfers this most elusive form of knowledge (or wisdom) (Polanyi and Sen, 2009; de Carvalho *et al.*, 2018; Massingham, 2018; Nonaka and Takeuchi, 2021):

Tacit or implicit knowledge develops over time by repeatedly applying, adding and sharing explicit knowledge in a variety of circumstances, interactions and settings. This enriches the skill set by refining relationship building and sensitivity to context and adds a layer of reflection on the owner's knowledge. For the recipient this is less transparent and takes longer to emulate (Polanyi and Sen, 2009). In this study, we will use the term *tacit* to facilitate reading - we acknowledge the view of authors that postulate that "…'tacit' knowledge is not tacit at all and is regularly articulated in conversation or manifested in gesture, glance, gaze and so on…" (de Carvalho *et al.*, 2018).

Figure 1 and table 1 show the identification, screening and inclusion of studies via Scopus searches - based on the PRISMA flow diagram framework.

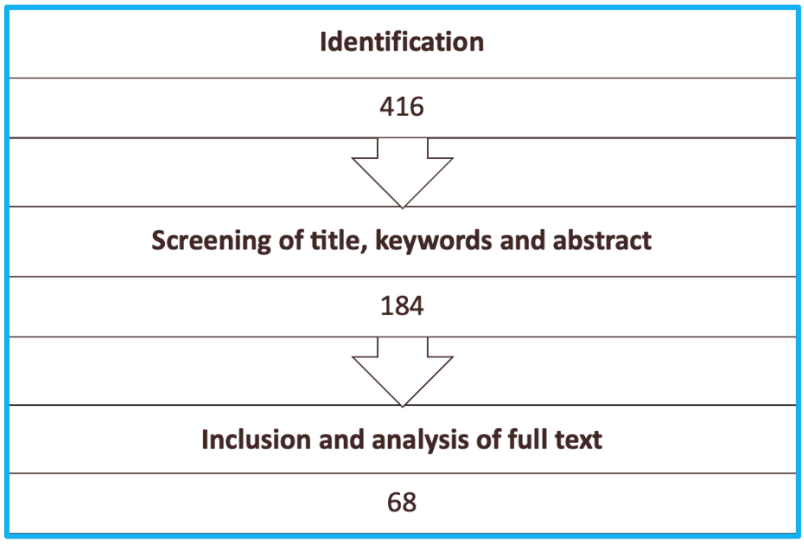


Figure 1: PRISMA Flow Diagram for Identification, Screening and Selection of Sources

Table 1: Identification of studies via Scopus based on the PRISMA flow diagram framework: Keyword combinations that provided results relevant within our research parameters

Identification		Screening	Inclusion
Keyword 1	**Keyword 2**	**Results**	**Relevant**
Knowledge transfer	intergenerational	60	11
	cross-generational	3	
	multigeneration	0	
	older workers	14	14
	senior experts	1	
	implicit knowledge	18	4
Intergenerational	collaboration	22	17
	cooperation	34	
	mentoring	166	9
	expertise	78	5
Tacit knowledge transfer	generation*	7	2
Tacit AND "knowledge sharing"	generation*	13	6
Totals		416	68

3. Literature Review

As our focus is the continued availability of *tacit* expert knowledge once this expert is no longer available within the organization, we are looking at the direction of knowledge *transfer* that is being investigated in the literature we analyzed. Obviously intra-team, inter-team and bi-directional knowledge *sharing* and knowledge *exchange* are vital for organizations and can profit from the findings of our paper. For the purpose of this article, we evaluated them as a side-benefit or supporting conditions for the intentional and successful *transfer* of the experts' *tacit* knowledge into the organization they left.

Various studies have looked at the methodology behind intergenerational knowledge transfer: We analyzed publications that approach this topic from an organizational perspective and a further stream of publications that look at the perspective of the individuals involved.

On an organizational level, Park et al. (2015) approach the transfer of tacit knowledge by analyzing how a parent company transfers knowledge to a joint venture. They find not only that performance is greatly enhanced by the successful transfer of tacit knowledge but that the maturity and preparedness of the receiver has an impact. "… Active transfers of tacit knowledge require both senders and recipients to commit resources to the transfer

process, but they are compensated with important performance improvements…" (Park, Vertinsky and Becerra, 2015). Knowledge transfer is deemed successful when the recipient is able to apply the transferred knowledge with satisfactory results (Scheuer *et al.*, 2023). Nurhas et al. (2022) as well as Perez-Encinas et al. (2021) confirm these findings in their analysis how senior business experts can accelerate the success of young founders (Perez-Encinas *et al.*, 2021; Nurhas, Geisler and Pawlowski, 2022).

This is a significant point as on an organizational level a well-performing Joint Venture benefits the parent company directly. When the knowledge transfer is between individuals the junior's career may benefit due to good performance. If the senior is an employee on their way into retirement the benefits may not be quite as obvious. Park et al. (2015) measured performance in their study on 2 levels: by obtaining individual perceptions and opinions and mapping these with financial data of the entity where available (Park, Vertinsky and Becerra, 2015; Merten, Hütt and Uygun, 2022). Scheuer et al. (2023) as well as Burmeister et al. (2020) looked at the individual benefit/cost equation of both Junior and Senior such as personal ambition versus perceived competence or increased fulfilment at work versus losing credit for work (Burmeister, Wang and Hirschi, 2020; Scheuer *et al.*, 2023).

The following presents an overview of established methods for intergenerational knowledge transfer and the cost/benefits mentioned in the literature:

Mentoring, tutoring, advising, and *coaching* are often being used interchangeably outside academia: to differentiate them is outside the scope of this article as here we are looking at the similarities regarding investments. They are understood as dyadic 1:1-formats that support the receiver in acquiring explicit and/or tacit knowledge in a more personalized way than classic teaching (Schmidt and Muehlfeld, 2017). For all of these formats the costs vary from the time both participants spend in 1:1 sessions instead of day-to-day work to actual bills external coaches invoice. Just as variable are the benefits of these exchanges - ranging from relationship and network building to getting answers for workday problems (Kaše, Saksida and Mihelič, 2019; Gadomska-Lila, 2020; Zhang and North, 2020; Wikström *et al.*, 2023).

With the focus on *tacit* knowledge, the following approaches are prevalent:

Intergenerational collaboration is seen as an effective and efficient way to offer junior employees an environment to absorb senior experts' tacit knowledge as it promotes engagement and successful communication which benefit the organization (Leon, 2020, 2023; Rui and Ju, 2022; Fedorova *et al.*, 2023; Richards, Becker and Stollings-Holder, 2024).

Role or job shadowing allows to absorb knowledge through observation (Sprinkle and Urick, 2018; Levallet and Chan, 2019; Scheuer and Loughlin, 2019) and "…is particularly effective for the transfer of tacit knowledge by revealing workflows, problem-solving techniques, decision-making processes, and interpersonal dynamics. Additionally, job shadowing encourages interactions with professionals across different departments and levels of seniority, helping to build networks throughout the organization. This can lead to valuable insights into the company's culture, bridging generational gaps, and fostering a more inclusive and collaborative workplace…." (OECD, 2024).

Leon offers *storytelling* as a powerful tool in cross-generational knowledge sharing (Leon, 2020) as it provides context, creates emotional connections, and captures complex information in an easily digestible format, making it more memorable and relatable which the Serious Games industry puts into practice (Kampa, Haake and Burelli, 2016). Researchers agree that Serious Games can currently only complement other formats of knowledge transfer as their quality and acceptance are still very diverse (Pfeiffer *et al.*, 2020; Allal-Chérif, Lombardo and Jaotombo, 2022; Al-Rayes *et al.*, 2022; Acampora *et al.*, 2023; Venemyr, 2024).

This portfolio of practices reflects that depending on the specific form of tacit knowledge different approaches might be appropriate and that individuals have different preferences to acquiring knowledge (Sprinkle and Urick, 2018).

4. Results and Contribution

There is an apparent gap in the literature regarding the quantifiable investment and outcome of tacit knowledge transfer. The aforementioned existing tools seem default measures and existing studies into their effectiveness either look at the costs OR at the benefits - a gap we seek to fill by proposing KPIs that could contribute to measure the Return on Investment (ROI) of Tacit Knowledge Transfer programs.

Suggested KPIs to evaluate cost and benefit of Tacit Knowledge Transfer across generations

Building on the findings from our Literature Review, we suggest the following KPIs to capture the social and financial benefits of tacit knowledge transfer from senior employees. We suggest KPIs for measuring both investment and benefits, especially focusing on quality metrics. Hence, tables 2 and 3 show Desired Outcomes and Expected Investment of Intergenerational Tacit Knowledge Transfer respectively.

Table 2: Desired Outcome of Tacit Knowledge Transfer

Desired Outcome	KPI	Item
Documented, retrievable and applied Tacit Knowledge	Knowledge Application Rate	Measure how often Juniors apply the tacit knowledge shared by Seniors in their work
	Knowledge Retention Score	Assess Juniors' ability to recall and explain key concepts shared by Seniors over time
	Quality Improvement	Calculate the reduction in errors or need for rework in Juniors' output following Tacit Knowledge Transfer
Interpersonal Trust	Quality of Relationships	Assess the strength and effectiveness of Senior/Junior relationships through surveys and feedback as trust is a known accelerator
Improved Team Collaboration	Team Effectiveness Score	Use team performance metrics and peer evaluations to measure improvements in collaboration post-Tacit Knowledge Transfer
Enhanced Employee Satisfaction	Employee Turnover Rate	Track Employee Satisfaction KPIs that can be linked to Tacit Knowledge Transfer programs
	Career Progression Rate	Track the percentage of Juniors who receive promotions or take on increased responsibilities within a specified timeframe after the program
Established Knowledge Transfer Culture	Program Completion Rate	Percentage of Senior/Junior pairs who complete the full program or meet all program requirements
	Cross-departmental Collaboration Index	Measure the increase in initiatives involving employees from different departments post-Tacit Knowledge Transfer
	Knowledge Sharing Capabilities	Track long-term cross-departmental cooperation post intergenerational projects
Growing Intellectual Capital	Innovation Rate	Track the relevance of new ideas, processes, or solutions developed by Juniors before and after Tacit Knowledge Transfer
	Revenue from New Initiatives	Track the financial impact of new products, services, or processes developed as a direct result of Tacit Knowledge Transfer insights
Increased Efficiency	Skill Improvement Score	Measure the increase in specific skills targeted by the Tacit Knowledge Transfer program through pre- and post-program assessments
	Problem-Solving Efficiency	Measure the time taken to resolve complex issues before and after implementing Tacit Knowledge Transfer programs
Increased Productivity	Task Completion Improvement	Measure the increase in the number of relevant tasks completed or the reduction in time taken to complete specific tasks post-Tacit Knowledge Transfer (higher relevance of completed tasks is an indicator that the junior can better asses the context of tasks)

Table 3: Expected Investment for Tacit Knowledge Transfer

Expected Investments	KPI	Item
Buying Lost Knowledge	Knowledge accessibility	Measure the cost for buying the lost knowledge (e.g. rehiring retirees, external consultants)
Long-term Knowledge Retention Investments	Sustainability of Knowledge Transfer	Assess how well Juniors retain and apply knowledge when needed
Lost Knowledge Costs	Knowledge Retention	Assess root-cause for problems in the field and the cost for solving them; map with lost knowledge
	Employee time invest	document team hours spent in knowledge transfer sessions

Expected Investments	KPI	Item
Program Development / Design / Deployment	staff time invest	document staff hours spent pre-program in selecting and matching knowledge transfer participants; potentially mentoring during the program and post-program assessing the program's implementation and impact

To be able to apply KPIs to steer any intergenerational knowledge transfer investment decisions organizations need to establish a clear baseline for each KPI and make impact factors and interdependencies transparent. In addition to regular internal progress reviews and feed-back organizations should consider comparing results against industry benchmarks and the organization's specific goals.

5. Discussion in View of the Literature

Tacit knowledge is considered to be very valuable (Dalkir, 2020) and seen as a strategic advantage in competitive markets (Pizzo *et al.*, 2022) though authors struggle to quantity that value. Even studies that argue for strategies and methods for successful tacit knowledge transfer (Chuang, Jackson and Jiang, 2016) or link the loss of tacit knowledge to declining customer and supplier relationship (Massingham, 2018) are not providing data for financial implications. A study that continues to be quoted dates from 2004: "According to International Data Corporation [IDC], Fortune 500 companies relinquish over $31.5 billion a year because they fail to distribute knowledge" (Ibrahim *et al.*, 2014; Wang, Zuo and An, 2017). We were not able to find this original study nor any updates from International Data Corp. or other sources (research which is apparently not open source nor readily available).

Research highlights the amplifier effect senior experts can have on junior colleagues regarding problem-solving approaches and successful cooperative behavior (Schniter and Shields, 2014; Kuyken, Ebrahimi and Saives, 2018; Fedorova *et al.*, 2023; Richards, Becker and Stollings-Holder, 2024), though measuring the benefits of the younger employee to be independent faster and more successful is challenging (Levallet and Chan, 2019; Wikström *et al.*, 2023).

Cecchi et al. (2022) document that in R&D focused environments managers actively encourage social interaction to support building relationships that facilitate the transfer of tacit knowledge (Cecchi *et al.*, 2022). Missing the opportunity to transfer tacit knowledge may result in younger employees spending more time and making possibly costly mistakes while building their own (Levallet and Chan, 2019; Kamps *et al.*, 2024). As this might cause frustration among the younger employee Burmeister et al. (2019) present data that links successful knowledge transfer to the intention to remain in the organization (Burmeister, Wang and Hirschi, 2020). This might be a valuable indicator for organizations that want to improve the KPIs of asset retention and fluctuation and reconsider the cutting of programs (Leon, 2020).

We perceive that with the proposed KPIs more attention will be given to the benefits of effective tacit knowledge transfer. Our new ideas, in our new context, could have a significant impact on how the subject is addressed in the future. KPIs are a useful management tool (see for example Farris et al., 2009) however we have not seen them applied in such a way before– to quantify an intangible asset - which tacit knowledge is (Farris *et al.*, 2009).

6. Conclusion

This research has addressed a critical and increasingly urgent challenge faced by organizations: the transfer of tacit knowledge from senior experts to their junior colleagues. Depending on the specific situation, focus and corporate identity an organization can choose from any number of methods for tacit knowledge transfer which all have their own benefits and drawbacks. As it is a challenging endeavor to quantify the cost of knowledge loss for specific organizations or projects, there is no template for a "most cost-effective approach" as the consequences of a senior employee leaving an organization go beyond the loss of specialized knowledge and the cost of training new employees. Tacit knowledge loss might only become apparent in the long run and effects might not always be able to be isolated to the lack of specific tacit knowledge.

Through an extensive literature review, this study highlights the absence of a comprehensive framework or standardized measurement approach capable of quantifying both the investment and returns of tacit knowledge transfer initiatives. The lack of robust metrics continues to make it difficult for organizations to justify resource allocation toward these programs and fully evaluate their financial and social impacts.

This study proposes KPIs specifically designed to capture both financial and social aspects associated with tacit knowledge transfer. Key Performance Indicators (KPIs) developed in this research cover critical dimensions such

as program completion rates, trust and relationship quality, knowledge application rates, innovation rates, and improvements in skill levels and efficiency. Equally important are the short-term costs of knowledge transfer initiatives, potential expenses related to reacquiring lost knowledge, and long-term investments necessary to sustain knowledge continuity.

Furthermore, the proposed framework places significant emphasis on the broader organizational impacts of successful tacit knowledge transfer, emphasizing enhanced employee satisfaction, improved team collaboration, accelerated career progression for junior employees, and strengthened organizational resilience. Financial outcomes, notably increased productivity, reduced errors, and innovation-driven revenue growth, are also systematically addressed, providing a comprehensive perspective on the strategic value of intergenerational knowledge initiatives.

By reflecting their own practices against the best practices summarized in this article, and the suggested KPIs organizations can take stock regarding the decisions that drive their own organization and develop actionable steps to enhance Senior/Junior knowledge transfer programs and improve the business cases behind them.

In conclusion, this research equips organizations with both a theoretical understanding and practical tools to navigate the complexities of tacit knowledge transfer. By applying the proposed Business Case approach and KPIs, organizations can better measure, understand, and optimize their investments, ensuring knowledge continuity, sustained competitive advantage, and robust organizational resilience into the future.

A limitation of our study is that it is only based on one database, and not several, as some authors suggest should be done. Albeit Scopus as a main social sciences database was seen to be a sufficient base for our study, especially as WoS has much duplication and overlap with Scopus.

Future research avenues identified in this paper include exploring the potential role and effectiveness of advanced technological solutions, such as Artificial Intelligence and Serious Games, in facilitating tacit knowledge transfer. These technologies hold promise for complementing traditional methods and potentially reducing the costs and enhancing the scalability of tacit knowledge transfer. Hence, more studies in the area are necessary.

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Ethical Declaration: All information needed is properly disclosed and no human subject data collection is involved in this research.

AI declaration: ChatGPT 4.0 was used for text optimization only and to make the flow of the text better and more formal.

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The Impact of an Inclusive Leadership Style on Generation Z's Willingness to Share Knowledge

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Abstract: In the knowledge-based economy, inclusive leadership strengthens employees' sense of belonging and psychological safety. Generation Z brings new values and expectations regarding managerial leadership styles, influencing their willingness to share knowledge. This article aims to examine the impact of inclusive leadership on Generation Z's propensity to share knowledge, considering demographic and organizational variables as well as the level of organizational identification, which plays a key role as a factor enhancing employee engagement and willingness to share knowledge in the workplace. Spearman's rank correlation test was applied to data from 318 anonymous online surveys conducted within Polish organizations. Statistical analyses were performed using Statistica 13.3 (StatSoft). The results revealed a positive impact of inclusive leadership on knowledge sharing, with stronger effects observed among women than men. Tenure and company size influenced perceptions of leadership. Organizational identification, particularly pride and sense of influence, enhanced the propensity to exchange knowledge. The findings confirm that inclusive leadership and strong organizational identification promote knowledge sharing among Generation Z employees in Polish organizations. They also highlight the importance of considering demographic and organizational variables such as gender, tenure, and company size, which moderate these relationships. This knowledge can assist leaders in creating environments conducive to open communication and knowledge exchange, crucial for the development of knowledge-based organizations.

Keywords: Inclusive leadership, Generation Z, Knowledge sharing, Polish organizations

1. Introduction

Inclusive leadership plays a crucial role in creating an environment that encourages the free expression of opinions and sharing of ideas, fostering a space where employees feel valued and have a sense of influence over the functioning of the organization (Abdelhay, 2024). A workplace that supports open knowledge sharing can be a significant source of competitive advantage, making the development of a culture based on knowledge exchange essential for organizational success (Jinyao, 2024). For this reason, inclusive leadership should be viewed as an adaptive process in which leaders flexibly adjust their actions, balancing a focus on people and tasks according to the changing context and current needs (Nishii, Leroy, 2022). Considering that an inclusive leadership style plays a key role in the knowledge-sharing process and can influence the increase of employees' identification with the organization, from the author's perspective, it becomes essential to identify the factors that support the active participation of Generation Z employees in transmitting key knowledge necessary for the effective functioning of the organization. The engagement of Generation Z employees in sharing critical knowledge is particularly important because they represent an increasing share of the workforce, and their digital skills and fresh perspectives can significantly enrich organizational resources and support a culture of team collaboration. To achieve the research objectives, a questionnaire was developed and distributed among Generation Z representatives via social media in the second quarter of 2025. A total of 318 anonymous participants from this group took part in the study. To verify the research hypotheses, a statistical analysis using Spearman's rank correlation test was conducted to examine the relationships between selected variables. The calculations were performed using Statistica 13.3 (StatSoft) software.

2. Literature Review

2.1 Inclusive Leadership Style in the Context of Knowledge Sharing

Inclusive leadership is an approach where leaders actively engage employees, demonstrate openness to diverse opinions, show respect and appreciation for individual contributions, and create a space for the free expression of ideas (Platania et al.,2025). Additionally, this type of leadership can be defined as a set of behaviors aimed at simultaneously supporting team members' sense of belonging and emphasizing their individuality in collaboration processes and achieving shared outcomes (Abdelaziz et al.,2022).Such leadership fosters trust and psychological comfort within the team, making it easier for employees to take on challenges, collaborate, and share knowledge and suggestions, which in turn strengthens their identification with the organization (Saleem et al., 2023). When employees perceive that their contributions are genuinely appreciated by the leader, they are more likely to follow clear and compelling guidance. Such recognition can enhance the leader's effectiveness both at the individual and team levels. When a leader combines inclusiveness with clear direction-setting, team members better understand their roles and see how they can effectively engage in achieving shared goals (Yoo

et al., 2022). Clarity of expectations, a shared vision, and a sense of shared responsibility strengthen relationships within the team and foster collaboration. In such a supportive environment, employees are more open to initiatives that require engagement and information exchange. Inclusive leadership reinforces employees' belief that sharing knowledge can bring them tangible benefits, which encourages greater engagement in knowledge-sharing activities. In an environment dominated by this leadership style, employees are more willing to share their resources and experiences with colleagues to support effective team functioning and contribute to achieving common goals promoted by collaboration-focused leaders (Tuyen et al., 2025). Knowledge sharing, understood as the process of making available to others the information, skills, and experiences one possesses, includes both explicit and tacit knowledge. It can be supported by favorable environmental conditions, intrinsic motivation, and individual employee characteristics, which ultimately translates into higher team effectiveness (Asghar et al., 2023).Knowledge sharing also involves disseminating one's cognitive resources to support others in learning and developing new skills. Moreover, it goes beyond simple information exchange by enabling organization members to better identify needs and respond to them more effectively (Zhang, 2025). Knowledge most often resides within individuals who themselves decide whether to share it. Although this process cannot be forced, it can be effectively supported and encouraged through appropriate organizational and leadership actions. When a leader actively promotes the sharing of information and knowledge, while simultaneously showing respect and appreciation for diverse opinions, their attitude becomes a model for other team members. Employees, observing such behaviors, are more likely to imitate them, support open knowledge exchange, and value diverse perspectives. As a result, an organizational culture develops where knowledge sharing is a natural and encouraged part of everyday functioning (Schoonus, 2018). However, if effective motivational mechanisms are lacking within the team, it is the leader's attitude—characterized by openness, commitment, and the ability to build trust—that can partially compensate for this deficit, encouraging employees to share knowledge despite limited systemic suport (Jiang, 2020).

2.2 Characteristics of Generation Z

Generation Z, as the first generation raised fully in a digital environment, has been shaped by rapid technological development and constant changes in social and informational contexts. They are deeply connected to the digital space, navigating it freely and intuitively, treating it as their natural environment (Fiza, 2025). Members of Generation Z are distinguished by their active listening skills, creativity, and strong focus on continuous development. They are accustomed to openly expressing their opinions and expect their voices to be heard and taken into account (Dorina, 2021). At the same time, members of this generation demonstrate growing social awareness, as they recognize that their decisions and actions can have a real impact on other people and on future generations' access to resources (Djafarova, 2022). Meaningful work and real opportunities for growth foster employee engagement and development. For Generation Z, a supportive work environment that aligns with their values is essential. Organizational justice, supervisor support, and effective information exchange between leaders and employees play a particularly important role in maintaining their motivation and engagement (Sono et al., 2024). Generation Z is characterized by a higher turnover rate compared to older generations, making traditional employee retention methods less effective in their case. As the youngest group currently present in the labor market, Generation Z presents a new challenge for organizations. Due to their relatively recent entry into the workforce, there is still a significant gap in both practical and academic knowledge regarding their behaviors, needs, and expectations in the workplace (Silva et al., 2022).

3. Methodology

The study examined which elements of an inclusive leadership style influence Generation Z employees' willingness to share knowledge within Polish organizations, taking into account demographic and organizational variables. Additionally, it analyzed the extent to which organizational identification supports knowledge-sharing readiness among this employee group, considering the demographic and organizational context. The study was purposive in nature and focused specifically on Generation Z, identified as a group of interest for the research objectives, with particular attention to individuals who are professionally active. A dedicated survey questionnaire was developed for the study and distributed online in the second quarter of 2025 via social media platforms. Participants completed the survey anonymously, and a total of 318 fully completed responses were collected. The characteristics of the research sample are presented in Table 1.

Table 1: Description of the research sample

Profile of the study group		N	%
Gender	women	163	51.26
	men	155	48.74
	total	**318**	**100**
Work experience	< 1 year	71	22.33
	1-2 years	161	50.63
	years	62	19.5
	>5 years	24	7.55
	total	**318**	**100**
Organization size	micro	90	28.3
	small	69	21.7
	medium	74	23,27
	large	85	26,73
	total	**318**	**100**

Source: Own research

For the collected research sample, a statistical analysis using Spearman's rank correlation test was conducted to examine the relationships between selected variables. Calculations were performed using Statistica 13.3 (StatSoft).

For the purposes of this article, the following research hypotheses were formulated and tested:

H1: There is a positive rank correlation between the level of inclusive leadership and the willingness to share knowledge among Generation Z employees.

H2: There is a significant positive rank correlation between the level of organizational identification and engagement in knowledge sharing.

4. Results

To verify H1, a Spearman rank correlation analysis was conducted between factors describing the perceived level of inclusive leadership and the declared willingness to share knowledge among respondents belonging to Generation Z. The obtained results confirm the validity of this hypothesis. Data related to this research area are presented in the table below.

Table 2: Relationships between factors of inclusive leadership style influencing Generation Z's willingness to share knowledge and selected demographic-organizational variables (p < .05)

Demographic-organizational variables	Category	Rho	Factors of inclusive leadership style influencing knowledge sharing
Gender	women	0.223	Encouraging all employees to share knowledge by the supervisor
		0.174	Acknowledgment of the employee's contribution by the supervisor
		0.159	Creating a space by the leader for free expression of ideas
	men	0.139	Encouraging all employees to share their opinions by the supervisor
		0.133	Demonstrating respect for diverse viewpoints by the supervisor
		0.137	Appreciation of the individual employee's contribution by the supervisor

Demographic-organizational variables	Category	Rho	Factors of inclusive leadership style influencing knowledge sharing
Work experience	< 1 year	0.138	Encouraging all employees to share their opinions by the supervisor
		0.201	Appreciation of individual contribution by the supervisor
		0.148	Supervisor's respect for different points of view
	– 2 years	0.207	Appreciation of the employee's contribution by the supervisor
		0.235	Encouragement of all employees to share their opinions by the supervisor
	3– 5 years	0.142	Supervisor's encouragement of all employees to share their opinions.
		0.137	Inspiration to collaborate resulting from my leader's behaviors
	>5 years	0.139	Encouraging all employees to share their opinions by the supervisor
		0.133	Demonstrating respect for diverse points of view by the leader
		0.137	Appreciation of the employee's contribution by the supervisor
Organization size	micro	0.139	Encouraging all employees to share their opinions by the supervisor
		0.133	Demonstrating respect for diverse perspectives by the supervisor
		0.130	Appreciation of the employee's contribution by the supervisor
Organization size	small	0.201	Encouragement by the supervisor of all employees to share their opinions
		0.139	Leader's demonstration of respect for diverse viewpoints
		0.182	Perception of appreciation of one's own contribution by the supervisor
	medium	0.141	Encouraging all employees to share their opinions by the supervisor
		0.140	Demonstration of respect for diverse perspectives by the leader
		0.148	Appreciation of employee contributions by the supervisor
		0.163	Leader's inspiring behavior that fosters collaboration
	large	0.168	Encouraging all employees to share their opinions by the supervisor
		0.159	Appreciation of the employee's contribution by the supervisor

Source: Own research

The Spearman's rank correlation analysis revealed that, in both the female and male groups of Generation Z, all relationships between inclusive leadership factors and willingness to share knowledge were positive. However, correlation coefficients were higher among women, suggesting that women respond more strongly to inclusive

leader behaviors. Specifically, the highest correlation among women was observed for the belief that "the supervisor encourages all employees to share their opinions" (rho = 0.223), whereas among men, this value was lower (rho = 0.139).

Similar trends were noted in the case of: – appreciation of employee contribution by the supervisor

- women: rho = 0.174
- men: rho = 0.137 – creating space for free expression of thoughts
- women: rho = 0.159 – showing respect for diverse points of view
- men: rho = 0.133

The analysis of the results revealed variability in the perception of selected aspects of relationships with supervisors depending on the length of work tenure. Employees with the shortest tenure (<1 year) rated all aspects of their relationship with the leader the lowest, which may be due to limited trust and a short adaptation period. In the 1–2 years group, ratings increased, especially regarding encouragement to share opinions, which may indicate a growing sense of freedom and engagement. Employees with 3–5 years of tenure more often recognized the inspiring role of the leader, although overall ratings were lower than in the previous group, possibly due to higher expectations of supervisors. The most balanced and stable results were observed among those with the longest tenure (>5 years), which may reflect a well-established, realistic approach to the relationship with their supervisor.

Respondents from small companies most frequently felt that their supervisors encouraged sharing opinions (0.201) and appreciated their contributions (0.182), indicating the highest level of engagement from leaders. In microenterprises and public sector organizations, these values were slightly lower but comparable, suggesting moderate support from supervisors. In medium-sized companies, the aspect of inspiring leader behavior (0.163) additionally appeared, distinguishing them from other groups. Respondents in large companies also felt appreciated (0.159) and encouraged to share opinions (0.168), although these levels were somewhat lower than in small companies.

To verify hypothesis H2, concerning the rank correlation between the level of organizational identification and Generation Z's engagement in knowledge sharing, a Spearman rank correlation analysis was conducted between these variables and selected demographic-organizational variables ($p < 0.05$). The results are presented in the table below. The findings indicate that, in most cases, there is a statistically significant correlation between the analyzed variables, confirming the validity of this research hypothesis.

Table 3: Spearman rank correlations between the level of organizational identification and Generation Z's propensity to share knowledge, considering demographic-organizational variables (p < 0.05)

Demographic-organizational variables	Category	Rho	Factors enhancing employees' organizational identification and influencing knowledge sharing
Gender	women	0.261 -0.166 0.174	Sense of pride in belonging to the organization Alignment of the organization's values with my own values Sense of my work's impact on the organization's success
	men	0.141 0.115	Identification with the organization's goals and mission A sense of pride in belonging to the organization
	< 1 year	0.132 -0.136 -0.134	A sense of pride in belonging to the organization Identification with the organization's goals and mission Sense of work impact on organizational success
	1– 2 years	0.226	Sense of pride in belonging to the organization

Demographic-organizational variables	Category	Rho	Factors enhancing employees' organizational identification and influencing knowledge sharing
Work experience		-0.174	Alignment of organizational values with my personal values
	3– 5 years	0.181	Sense of work's impact on organizational success
		0.147	Alignment of organizational values with my personal values
	>5 years	0.125	Sense of work impact on organizational success
		0.172	A sense of pride in belonging to the organization
Organization size	micro	0.116	A sense of pride in belonging to the organization
	small	0.142	Sense of impact of work on organizational success
		0.127	A sense of pride in belonging to the organization
	medium	0.132	Sense of work impact on organizational success
	large	0.122	Sense of impact of work on organizational success
		0.121	A sense of pride in belonging to the organization

Source: Own research

Based on Spearman's rank correlation analyses (with a significance level of $p < 0.05$), varied relationships were observed between the level of organizational identification and Generation Z's willingness to share knowledge, taking into account respondents' gender. Among women, stronger and more diverse correlations were recorded, both positive and negative. The strongest association was found between pride in belonging and readiness to share knowledge ($r_s = 0.261$). Surprisingly, a negative correlation also appeared between personal and organizational value congruence ($r_s = -0.166$). Among men, the correlations were weaker and less varied. The strongest relationship concerned identification with the organization's goals and mission ($r_s = 0.141$), followed by a slightly weaker association with pride in belonging ($r_s = 0.115$).

The length of tenure influences how organizational identification translates into the willingness to share knowledge. New employees (<1 year), being less emotionally engaged, may not perceive a connection between their role and the organization's mission. During the first 1–2 years of employment, enthusiasm and pride in their duties increase, but at the same time, initial doubts arise regarding the congruence between personal and organizational values. The highest willingness to share knowledge is observed among those with 3–5 years of tenure, for whom values and sense of impact are most strongly linked. More than 5 years of work experience among Generation Z corresponds to a stable and mature identification with the organization, which supports knowledge sharing based on experience and a sense of loyalty.

Spearman's rank correlation results indicate variability in the strength of the relationship between the level of organizational identification and Generation Z's willingness to share knowledge depending on the size of the company. In microenterprises, the weakest correlation was observed (rho = 0.116) concerning pride in belonging to the organization. This suggests that in very small organizations, identification with the company does not significantly translate into a willingness to share knowledge. In small companies, these relationships are somewhat stronger. Correlation values (rho = 0.142 and 0.127) indicate that both the sense of impact on the organization's success and pride in belonging are more important for knowledge sharing than in

microenterprises. Respondents from small companies may therefore identify more with the organization and more frequently exhibit prosocial behaviors such as knowledge sharing. A similar trend is observed in medium-sized companies (rho = 0.132 for sense of impact), suggesting that as the size of the organization increases, so does the importance of employee identification with the organization in the context of willingness to share knowledge. In large companies, correlations are stable and similar to those in medium-sized firms (rho = 0.122 and 0.121). This indicates that both pride in belonging and the sense of impact on organizational success remain significant motivating factors for knowledge sharing, although their strength does not increase substantially with company size.

5. Discussion and Conclusions

In light of the results obtained from the current study, the discussion on the role of inclusive leadership in shaping Generation Z's willingness to share knowledge finds confirmation and extension in existing scientific findings. These results align with a broad body of research indicating that inclusive leadership plays a reinforcing role in fostering employee engagement in the knowledge-sharing process.

Tayyab Saleem and his co-authors (2023) emphasize that inclusive leadership fosters an environment where employees are more open to sharing ideas and feel a stronger connection to the organization. Our results, especially in the context of a more pronounced response from women to inclusive leader behaviors, confirm that inclusivity can act as a catalyst for prosocial behaviors – including knowledge sharing. Nguyen Thi Tuyen and others (2025) demonstrate that inclusive leadership effectively supports knowledge sharing, especially in small and medium-sized enterprises. Our observations confirm this thesis — it is precisely in small companies that the highest leader engagement and a clearer translation of these actions into willingness to share knowledge were observed. This may result from the more personal nature of relationships and greater accessibility of leaders to employees. Research by Nouran Nabil Abdelaziz and her team (2022) shows that inclusive leaders not only promote fairness and equality but also actively engage employees in decision-making processes. This translates into a greater sense of value and belonging, which increases the willingness to share knowledge. In our study, women who responded more strongly to inclusive signals may experience a similar mechanism — a feeling of being recognized and appreciated, which boosts their activity in knowledge sharing. The conclusions presented by A. Mansoor and his co-authors (2021) emphasize the importance of relational aspects of leadership – building trust, strengthening the sense of belonging, and embracing diversity. These elements were also evident in our analysis, particularly in the context of differences between organizations of various sizes, where a more personalized approach by leaders in smaller companies translated into a greater willingness to share knowledge. Complementing this perspective are the conclusions of Anna Rogozińska-Pawełczyk (2023), who points out that effective inclusive leadership enables employees to satisfy their basic needs, such as recognition, autonomy, and influence on attitudes related to knowledge sharing. This leads to employees reciprocating the organization with proactive behaviors and engagement. The differences observed in our study regarding the willingness to share knowledge, depending on the level of organizational identification, can be understood in this context—as a result of employees' psychological needs being well or poorly satisfied.

The results of my own research not only confirm but also enrich the existing knowledge about the mechanisms through which inclusive leadership fosters knowledge sharing. They highlight the need to consider variables such as gender, length of service, organizational size, and level of identification with the organization as significant moderators of the effectiveness of an inclusive management style.

Ethics statement: The study was conducted in accordance with the ethical principles of research in the social sciences. Participation of respondents was voluntary and anonymous. The entire research process was conducted independently by the author of the article, in compliance with applicable data protection standards.

AI declaration: The author declares that no artificial intelligence tools were used in the preparation of this article for content generation, data analysis, or text editing. The article translation was carried out by an external entity without the use of AI tools.

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Exploring Knowledge Management Approaches to Enhance Documentation Management within the AI realms

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Abstract: Artificial intelligence (AI) technologies have an increasing impact on companies' digital transformation. On the one hand, it is expected that AI tools can support process automation and quality improvement, on the other hand, many professionals fear that AI systems will displace their roles. It is assumed that paperwork processes and workflow documentation are among the most tedious tasks for employees. However, proper workflow documentation is the backbone of effective company knowledge management (KM) and decision-making. In contrast with traditional documentation management systems (DMS) that struggle with retrieval, accessibility, and workflow automation, KM challenges hinder documenting and sharing insights gained during projects, with knowledge often hidden or lost post-project. Overcoming these barriers requires AI-driven systems to contextualize and structure unstructured knowledge for better inter-project collaboration and retention. By investigating KM approaches, the present research aims to identify and model the key features that will support job augmentation with intelligent document management processing. The study steps on the Automated Documentation Management System (ADMS) with an integrated ChatGPT-based assistant, which enables users to interact with documents through conversational queries, analysis, retrieval, and summarization requests. The first part of the paper explores KM approaches related to workflow documentation and project management. Next, a short overview presents the ADMS system functionalities for improving contextual understanding of the complex processes, data integration, and knowledge sharing. Based on this, a new application model is identified, supporting KM job augmentation. At the end, the discussion explores how advanced DMSs can support KM processes in companies to enhance quality, efficiency, and job augmentation, improving decision-making, collaboration in project management. By enabling seamless knowledge sharing, it preserves insights beyond project lifecycles, supporting future initiatives. As projects grow more complex and data-driven, AI integration in PM can transform how teams capture, share, and apply knowledge for sustained success.

Keywords: Knowledge management, AI, Job augmentation, Document management system

1. Introduction

Document management represents the backbone for explicit knowledge capture, storage, retrieval, and distribution within the organization (Hahn 2000). Furthermore, document management is one of the three main KM techniques along with knowledge sharing and training, and development (Neuenfeldt, 2023). However, today, document management systems are not only repositories for storing organizational knowledge bases and organizational memory, but they can serve as a fuel for company-focused solutions with artificial intelligence (AI), which can facilitate unique value creation, improving decision-making, customer centricity, and organizational competitiveness.

Document management systems differ from data management systems as they ensure that paperwork follows the main organizational processes. Documents align to organizational rules, official templates, business procedures, and authors' roles, but at the same time, they remain unstructured, complex, covering qualitative data, sometimes remaining difficult to find, review, analyse, retrieve, and adapt. With the adoption of advanced AI tools, document management systems can substantially extend the value of knowledge management practices in organizations. Especially for project-based organizations, proper document management can substantially improve knowledge externalization, storage, retrieval, and re-use. Another question is increasingly discussed, considering the impact of AI on job transformation. How AI tools within document management systems can support job augmentation, outperforming simple job automation?

The current research aims to explore how knowledge management approaches can support document management in the project management domain. While AI tools can facilitate many tasks related to project documentation and paperwork, these tasks reflect job augmentation and not job displacement. The paper steps on the Automated Documentation Management System (ADMS), which is still in a prototype version. Adoption of ADMS can enhance decision-making, reduce redundancy, and improve collaboration in project management. As projects grow more complex and data-driven, AI integration in PM can transform how teams capture, share,

and apply knowledge for sustained success. Due to the complexity and time-bound nature of projects, the application of KM within PM offers unique challenges and opportunities, especially in terms of capturing and reusing knowledge that is often lost at project closure.

2. Background Research

Document management significantly contributes to the company's digital transformation. Many organizations adopt “paperless” documentation processes, aligning with more environmentally friendly policies and company practices. Orlov (2024) summarizes that digital management systems support digitization of the physical documents, version control, collaboration, document search, improved protection and cybersecurity measures, workflow automation, and more. A company’s processes related to documentation management are critical for effective knowledge management. Activity documentation and organizational archives are key factors for knowledge retention and organizational memory. The good documentation design principles support documentation reuse even without software tools. For example, document metadata and description, ensuring proper version control, date and retention times, proper document categorization, author and contact details, audience, objective, and keywords, can help individuals find information without difficulties. As Jecan (2008) further outlines, one of the advantages of workflow and document management systems is that the system tracks events as they occur and monitors different types of behaviour, providing an audit trail as well as an easily understood and operated set of controls.

2.1 KM Perspective and Project Management

The evolving understanding of projects has led to the identification of multiple paradigms within project management. Shenhar and Dvir (2007) categorize these paradigms as follows: project as a process, project as an organization, and project as a strategic building block within organizational development. Since the mid-1990s, scholarly attention has increasingly focused on the temporary and goal-oriented nature of projects, conceptualizing them as temporary organizations (Midler, 1995; Maylor et al., 2006; Beaume et al., 2009). This unique, one-time, and complex task within the organization called attention to how knowledge is created, transferred, and preserved during and after project execution. Given the uniqueness and impermanence of projects, knowledge sharing (KS) has emerged as a critical focus at the individual, project, and organizational levels (Csepregi & Papp-Horváth, 2024).

In an earlier study related to project context, variables such as leadership, trust, and organizational culture were identified as major influencers of knowledge sharing, typically functioning as independent variables, with only a few operating as mediators (Csepregi & Papp-Horváth, 2024). Furthermore, tools that facilitate KS were also discussed in this context. Despite these enablers, several barriers continue to impede effective knowledge retention, particularly after project closure. These include insufficient technological infrastructure, challenges faced by geographically dispersed teams, difficulties in articulating tacit knowledge, and organizational constraints such as hierarchical structures and weak learning cultures (Nidhra et al., 2013; Shafiq et al., 2024). The loss of a key knowledge holder within a project is particularly disadvantageous, emphasizing the need for robust knowledge retention strategies (Shafiq et al., 2024).

To address these issues, a range of strategies has been proposed. Personalization tactics—such as mentoring, communities of practice, and face-to-face interactions (Morris, 2002)—enhance tacit knowledge transfer. Codification approaches focus on creating structured repositories and knowledge databases. Team-based strategies such as retrospectives and peer reviews, as well as technology-enabled solutions like collaborative platforms, have also proven effective (Barclay & Osei-Bryson, 2010; Nidhra et al., 2013).

The integration of KM practices into project management has been found to significantly enhance project outcomes (Yeong & Lim, 2010). Among the KM processes, knowledge creation and codification have been identified as the most impactful, followed by knowledge capturing, communication, and capitalization (Al-Zayyat et al., 2010). In response to this, several studies have examined the KM practices and digital tools commonly employed by project managers (Lierni & Ribière, 2008). These include systems that facilitate document management and knowledge retrieval through methods like semantic structuring, modular clustering, and visualizations (Becks et al., 1999). Computer-assisted text mining and ontology-based frameworks organize large textual databases, promote systematic reuse of project knowledge, and help prevent repeated errors (Coners & Matthies, 2018).

Another study evaluated the extent to which project management tools classified in the 2019 Gartner Magic Quadrant for Leaders support the capture, storage, sharing, and application of project knowledge, using PMBOK-defined artefacts as benchmarks. These tools were also compared with Confluence, which has been identified

as a robust platform for project documentation and knowledge sharing (Clemente & Domingues, 2023). The literature also highlights the value of integrated KM systems that span the entire project knowledge lifecycle, emphasizing the need for scalability, user-friendly design, and alignment with core project processes. One promising direction involves leveraging intelligent systems and association rule mining to support decision-making in project documentation control (Latypova, 2024).

2.2 Artificial Intelligence and Job Augmentation

Since 2022, the interest of companies in implementing advanced AI technologies in their activities has sharply increased. AI has the potential to both unify and differentiate companies' processes from a global perspective. From one point, it can be expected that many processes will be unified, facilitating inter-company transactions, standardization of business processes, and similarities in documentation. As discussed, AI for document management can use reinforcement learning technologies and constantly learn how to improve document organization, classification, and retrieval (Revanasiddappa, 2024). While the integration of AI in KM presents significant advantages, it also raises concerns about job displacement and the need for continuous skill development. Balancing technological advancements with human-centric approaches is essential to mitigate these challenges and maximize the benefits of AI in the KM context.

For example, Chen (2024) identifies that AI tools for knowledge capture and retrieval can automate different knowledge processes, leading to reduced manual effort and time spent on information management, significantly improving organizational performance. Even more, the automation of knowledge processes not only streamlines operations but also fosters a more collaborative environment where knowledge sharing is encouraged and facilitated (Chen, 2024). Other authors underline that AI enhances data processing capabilities, leading to better-informed decisions and innovative solutions within organizations (Jackson & Jackson, 2024).

Woolley (2024) states that AI tools can augment human cognitive functions such as memory and reasoning, fostering a collaborative environment that enhances collective intelligence in workplaces. The paper points out that applying AI to knowledge work is more complex than automating manual tasks. Knowledge work often involves less structured environments where creativity and problem-solving are crucial. This complexity highlights the need for tailored AI applications that can effectively support knowledge workers. Furthermore, the interaction between humans and AI agents creates a symbiotic relationship that empowers human learning and interpretative capabilities, facilitating continuous improvement in knowledge management practices (Stylos, 2023). Thus, organizations should invest in workforce development initiatives that equip employees with the necessary skills to thrive in a knowledge-based economy. This includes training programs that focus on enhancing analytical capabilities and fostering a culture of continuous learning. Therefore, the integration of AI-powered document systems directly addresses the most vulnerable phase of project knowledge flow—post-project closure—by enabling systematic knowledge preservation and accessibility for future projects.

3. Application Model of KM for Job Augmentation

3.1 AI's Role in Project Management and Job Augmentation

Unlike routine operations, project management involves knowledge-intensive, iterative, and often non-linear tasks—from planning and monitoring to reporting and closure—making it a prime candidate for AI-supported augmentation rather than full automation. Companies are increasingly investing in AI technologies, intending to increase job automation or displace workers. According to the Anthropic economy index, which is developed by one of the leading AI platforms - Claude.ai (2025), during 2024, the usage of AI extends more broadly across the economy, and about 36% of occupations use AI for at least a quarter of their associated tasks. Interestingly, the report finds that 57% of AI usage can be related to task augmentation, extending human capabilities (e.g., learning or iterating on an output), while 43% suggests task automation (e.g., fulfilling a request with minimal human involvement).

Concerning the knowledge domain, the report of Anthropic highlights that occupations with the largest adoption of AI consistently remain those in the “computer and mathematical” category. This category mainly is due to software engineering roles, and it contributes to about 37.2% of the queries sent to Claude, covering tasks like software modification, code debugging, and network troubleshooting.

In this perspective, project management differs from other jobs such as software engineering, as it reflects multiple roles and skills, and competencies. To investigate a job augmentation model for PM with AI, a specific system should demonstrate how AI's capabilities can automate knowledge capture, retrieval, and synthesis, addressing challenges posed by data overload and fragmented knowledge silos. As PM involves different

knowledge-related tasks, traditional management strategies are becoming less applicable as AI requires new skills. With the shift towards knowledge documentation and sharing, there is an increasing demand for workers to develop new skills that align with the requirements of a technology-driven workplace. This includes not only technical skills but also soft skills such as collaboration, critical thinking, and adaptability.

3.2 ADMS System

The ADMS system represents a document management system, enhanced by AI agents and supporting the main PM functionalities (Georgiev, 2024). The system aims to overcome some of the main problems related to PM and knowledge storage, providing suitable IT infrastructure to support employees in sharing contextual knowledge within complex PM processes and improving data integration (Figure 1).

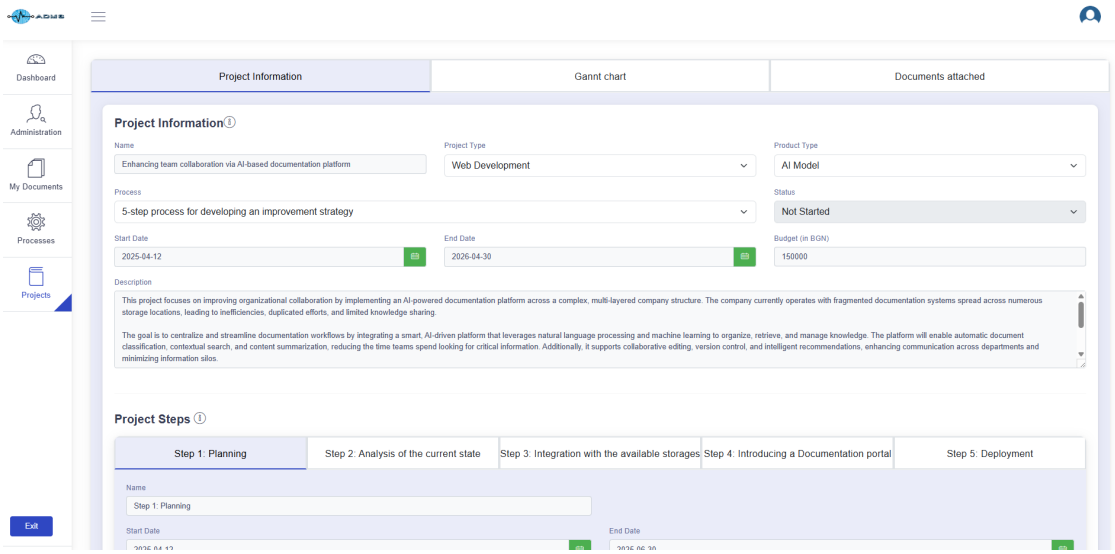


Figure 1: ADMS system screenshot for the PM domain

The ADMS system facilitates Project management processes by reflecting the logical sequence of actions that users can perform when creating, managing, and processing projects and related documents. The process begins with “Project View”, which allows users to access existing projects in the system. After the user selects a specific project, they can proceed to “Create Project”, which adds a new project to the system. The created project can be edited, and after it is finalized, it is launched, which activates it for further work. In addition to creating and managing projects, the system also allows working with documents within a given project. After reviewing a project, the user can upload documents, which can then be downloaded. After a document is downloaded, its summary can be performed, which is an automatic or manual extraction of basic information from the content. In addition to the core project and document management features, the system offers document analysis, which extracts additional information to assist users in processing the content. In addition, interaction with an intelligent assistant is available, which can provide additional analysis, recommendations, or automated actions based on the document content.

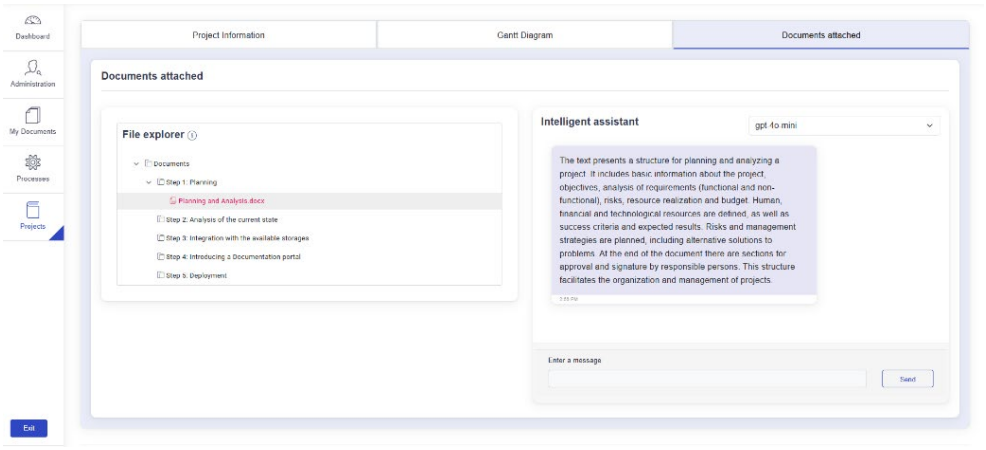


Figure 2: AI assistant, supporting information retrieval from documents

In the context of documentation management, the ADMS aims to facilitate access to various types of documentation by integrating intelligent agents into its functionalities (Figure 2). In this regard, several key results were achieved. First, a concept for building such a system was developed, outlining its role and importance for the optimization of processes related to knowledge management. Second, a study of functional and non-functional requirements was conducted, which gave a clear idea of user expectations and needs. Third, based on the analysis, an architectural model was proposed that integrates technologies supporting knowledge management through AI. Finally, a prototype of an ADMS with limited functionality was developed, which demonstrates the capabilities of the concept in real conditions.

3.3 Job Augmentation Model for PM

AI systems embedded in project management practices can particularly help document decisions, generate real-time project reports, extract information from past projects, and develop personalized recommendations for current tasks. Project management work is often related to specific organizational and individual knowledge and expertise. By implementing AI tools, all PM activities can be properly documented, allowing companies and individual employees to access and use their knowledge bases, improving knowledge capture and knowledge sharing.

The use of the proposed ADMS system leads to an increased organizational knowledge base, improving the capacity of AI tools in return. Figure 3 presents a PM job augmentation model, extending the understanding of companies on how AI tools can improve overall KM processes.

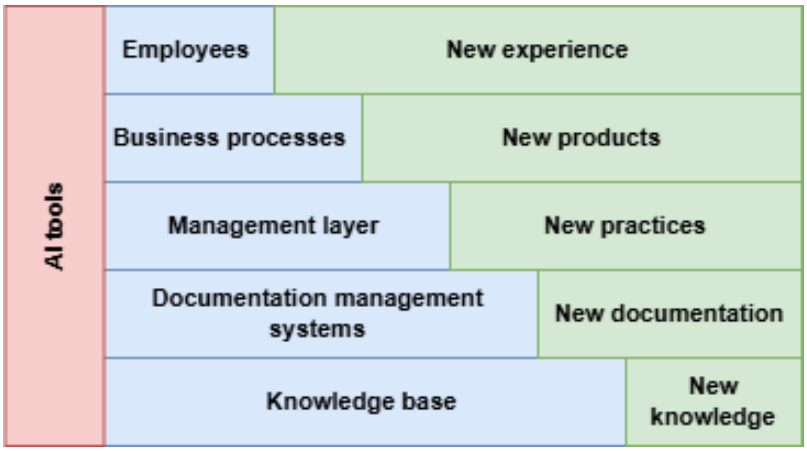


Figure 3: Job augmentation model in the PM domain

The model presents a conceptual multi-layered view of how AI tools can enhance knowledge management across various organizational levels, particularly within the context of project management. It emphasizes the progressive interaction between artificial intelligence (AI) and key organizational components, highlighting how AI contributes to resource optimization, process improvement, and strategic development.

At the employee level, AI tools act as facilitators for gaining new experience. Through intelligent assistants, recommendation systems, and real-time feedback mechanisms, AI helps employees understand complex projects more quickly, access just-in-time learning resources, and adapt to new environments or tools. This learning-by-doing dynamic not only accelerates onboarding and professional development but also ensures that individuals remain aligned with evolving project demands.

Moving up to business processes, AI enables the generation of new products by enhancing workflow automation, predictive analytics, and decision-making. Project managers can leverage AI to forecast project timelines, identify bottlenecks, and propose optimization strategies. AI-driven insights improve the overall agility of business operations, allowing teams to innovate continuously and deliver higher-value solutions with fewer resource constraints.

The management layer benefits from AI by integrating new practices into strategic planning and resource allocation. Managers can use AI to assess team performance, monitor project risks, and benchmark best practices from previous initiatives. By doing so, AI supports a more dynamic and informed decision-making process, where leaders can adjust project scopes or reassign tasks based on real-time data and predictive insights.

Documentation management systems, enhanced by AI, become more than static repositories—they evolve into intelligent systems capable of providing new documentation on demand. AI tools enable auto-tagging, context-aware document retrieval, and even summarization of key documents, which streamlines project knowledge access and reduces time spent on searching for information.

At the foundation of the model lies the organizational knowledge base, which is continually enriched with new knowledge as projects are completed and lessons are captured. AI supports this evolution by aggregating insights, detecting patterns, and facilitating knowledge reuse across teams and departments. This ensures that past experiences inform future projects, fostering a culture of continuous improvement and strategic foresight.

Overall, the proposed model demonstrates how AI acts as a catalyst for resource optimization and knowledge flow within project management, with a particular emphasis on job augmentation rather than job replacement. By embedding AI into project workflows, organizations can automate repetitive or time-consuming tasks, allowing human professionals to focus on higher-value activities such as strategic planning, creative problem-solving, and decision-making. This shift enhances productivity while also increasing employee engagement and satisfaction.

AI's influence extends across all organizational levels – from individual contributors to cross-functional teams and executive leadership – enabling each layer to operate more efficiently and with greater insight. For individuals, AI tools can function as intelligent assistants, supporting task execution, information retrieval, and contextual analysis. For teams, AI enhances collaboration by streamlining communication, aligning objectives, and surfacing relevant knowledge at the right time. At the organizational core, AI supports better resource allocation, risk management, and performance monitoring.

Crucially, this augmentation model empowers teams not only to work smarter and adapt faster but also to co-evolve with technological change, building resilience and fostering continuous innovation. It also supports a human-centric transformation, where AI strengthens human capabilities. These benefits are broadly applicable, regardless of the specific industry or domain, making AI-driven job augmentation a foundational principle for the future of project management and knowledge-intensive work.

4. Discussion

Advanced document management systems can support knowledge management processes in companies to enhance quality, efficiency, and job augmentation. ADMS enhances decision-making, reduces redundancy, and improves collaboration in project management as well. By enabling seamless knowledge sharing, it preserves insights beyond project lifecycles, supporting future initiatives. As projects grow more complex and data-driven, AI integration in PM can transform how teams capture, share, and apply knowledge for sustained success. For project teams, this translates into less time spent on repetitive documentation and more capacity for strategic thinking, issue resolution, and stakeholder engagement—all critical for successful project delivery.

In modern IT companies, document management has moved from static file repositories to dynamic, integrated platforms that use artificial intelligence for analysis and recommendations. The document flow is no longer linear - with DMS, information is automatically categorized, updated in real-time, and accessible through a centralized environment. This reduces the risk of knowledge loss after project completion and facilitates future developments.

The ADMS model supports transparent PM processes in organizations, reinforcing PM leadership and trust. It improves effective knowledge retention strategies, particularly after project closure, by facilitating tacit knowledge summarization, overcoming different organizational constraints such as hierarchical structures and weak learning cultures. Further, document management software transforms project management by supporting different roles in the team and optimizing the flow of documents. Project managers get quick access to key information through intelligent search and summarization, which speeds up decision-making. Business analysts can identify critical trends and dependencies, while developers and technical teams have access to up-to-date specifications and code documentation. In addition to improving efficiency, the Document Management system encourages collaboration by allowing teams to comment, edit, and share documents interactively. This advancement leads to more flexible knowledge management, providing a strategic advantage for innovative companies, and improved human-AI interaction, supporting knowledge workers in navigating complex information landscapes more efficiently.

5. Conclusion

Discussions surrounding job automation and displacement increasingly generate tension between employers and employees, fuelled by concerns about job security and the future role of human labour. While the potential for full automation continues to be widely debated, the technical feasibility of entirely replacing complex roles, especially those requiring contextual understanding, critical thinking, and collaboration, remains limited in many domains. As a result, a growing body of scholarly research advocates for a human-AI partnership model. Rather than aiming for full automation, this approach emphasizes job augmentation, where AI technologies support and enhance human capabilities, leading to more effective and resilient work environments.

In the context of project management, this augmentation perspective is especially relevant. Project management roles demand adaptable and intelligent tools capable of tracking project milestones, identifying risks, and ensuring visibility across dynamic workflows. The integration of artificial intelligence in ADMS significantly contributes to this need. By automating the generation, organization, and retrieval of project documentation, the ADMS facilitates seamless access to up-to-date information, enhances the accuracy of reports, and enables faster, evidence-based decision-making. This, in turn, improves overall productivity, reduces human error, and increases organizational competitiveness.

In addition, AI-driven DMSs enhance knowledge sharing and knowledge retention, critical aspects of modern project ecosystems where turnover, remote work, and distributed teams are common. Instead of replacing project managers or administrative staff, systems like ADMS help manage information overload, improve overall accessibility, and provide contextual support for complex decisions. In this way, AI acts not as a replacement for human expertise but as a complementary force that amplifies it.

For successful AI implementation, companies should focus on delivering higher-quality outputs, improving customer experience, and enabling innovation, rather than merely pursuing cost reduction and labour minimization. The proposed model outlines key layers of impact, emphasizing that newly generated knowledge should be evaluated based on its contribution to the organisation's efficiency. This strategic framing is essential for gaining employee acceptance and trust. Workers are more likely to embrace AI tools when they are presented as instruments that empower them to perform their jobs more effectively, reduce repetitive burdens, and enhance their strategic value within the organization.

Ultimately, by combining intelligent DMSs with a job augmentation approach, organisations can foster a culture of continuous improvement, where technology supports human strengths and unlocks new opportunities for growth and innovation.

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Ethics Declaration: This research did not involve human participants, animal subjects, or sensitive data, and therefore did not require ethical clearance.

AI Declaration: Artificial intelligence tools were used solely for editing and language polishing. No AI tools were used for data generation, analysis, or interpretation.

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Technologies as KM Tool for Sustainability in Hospitality: Practitioners Perspective

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Abstract: This study explores how hospitality businesses leverage technologies as Knowledge Management (KM) tools to enhance sustainable performance in this sector. By integrating artificial intelligence (AI) and other emerging technological solutions, businesses can mitigate negative environmental impacts, improve employee working conditions, and reduce operational costs. The study highlights the strategic role of technology in facilitating knowledge creation, sharing, and application to drive sustainability in the hospitality sector. The research is based on a narrative analysis of qualitative secondary data obtained from the Hospitality Technology Network and expert panel discussions at a leading industry conference in Poland, focusing on automation and technological advancements in the hospitality sector. The results indicate that AI and other technological innovations serve as effective KM tools, enabling hospitality businesses to achieve economic, social, and environmental benefits. Practitioners view these technologies as critical enablers of sustainable development, process optimization, and long-term competitive advantage. The study underscores the role of technology in transforming knowledge into actionable insights and facilitating sustainable business practices. This paper provides insights into the adoption and effective use of sustainable technologies, particularly for small and medium-sized hospitality enterprises (SMEs). By examining practitioners' experiences with KM-driven technological solutions, the study offers practical recommendations for hospitality managers seeking to enhance sustainability. The findings can serve as a knowledge base for SMEs aiming to integrate technology into their sustainability strategies. This research contributes to the discourse on KM and sustainability in the hospitality industry by identifying specific technologies and systems used by practitioners. By emphasizing the intersection of technology, KM, and sustainable business practices, the study offers a novel perspective on the digital transformation of hospitality businesses. The insights presented provide a foundation for further research and practical applications in the field of sustainable knowledge management.

Keywords: Technology, KM, Hospitality, AI, Practitioner perspective, Sustainability

1. Introduction

Emerging green technologies, serving as innovative tools for knowledge management (KM), are increasingly recognized as powerful catalysts for advancing sustainability (Shahzad *et al.*, 2020). Knowledge-based organizations supported by technology-driven innovation and social-driven innovation (Trunfio and Campana, 2020) and enhanced by company culture (Kucharska and Karwowska, 2025) reinforce the holistic perspective of sustainability drawn by Lozano and Haartman (2018). This perspective highlights the importance of identifying the factors that influence sustainability within organizations embedded in particular sectors, consequently encouraging the examination of sustainability through the lens of their respective industries. Sustainability's positive impact on a firm's competitiveness and survival makes this topic very attractive for practice and science (Gomez-Trujillo *et al.*, 2024). Following this line, this study aims to explore how hospitality businesses leverage technologies as KM tools to enhance sustainable performance.

The hospitality industry represents one of the most significant economic sectors (Pizam and Shani, 2009). Its uniqueness stems from the multifaceted nature of its services, which extend beyond the provision of food and accommodation to include entertainment, psychological comfort, and overall well-being (Brotherton, 1999). These core activities are inherently based on social interactions (Andriani *et al.*, 2019), making the industry highly human-dependent (Aman-Ullah *et al.*, 2022). Even in times of crisis, human capital remains a critical factor in ensuring the long-term resilience of hospitality businesses (Goll and Zieba, 2025).

Given these characteristics, the hospitality industry has demonstrated resistance to technological adoption and digitalization (Alfehaid *et al.*, 2024). The pace of integrating technological advancements remains relatively slow (Cheng *et al.*, 2023; Kumar, Kumar, *et al.*, 2024). Nevertheless, emerging technologies, including artificial intelligence (AI), big data, and the Internet of Things (IoT), enhance sustainable performance by facilitating more effective knowledge management (Bradu *et al.*, 2023; Elkhwesky *et al.*, 2024). When properly leveraged, these technologies enable knowledge-driven decision-making, allowing hospitality businesses to optimize resource consumption, minimize food waste, and enhance energy efficiency (Abdou *et al.*, 2020).

Technological advancements serve as KM tools, supporting industry practitioners in mitigating the sector's environmental footprint while simultaneously improving operational efficiency (Sharma *et al.*, 2023). These

technologies have the potential to enhance employees' working conditions, contributing to the social sustainability of the industry (Ghobakhloo *et al.*, 2021). However, there remains a significant gap in understanding which specific technologies are effective KM tools within the hospitality sector, and how they can be implemented to enhance economic, social, and environmental performance.

This paper aims to address this gap by examining emerging technologies in the hospitality market and analyzing their application through the lenses of KM practices. It provides insights into how industry professionals utilize these technologies to drive economic and social performance while reducing the sector's negative environmental impact.

2. Literature Review

2.1 Sustainability in Hospitality

The hospitality industry is a vital sector in the global economy, contributing significantly to employment, GDP, and regional development. The growing demand for accommodation and food services (Eurostat, 2024) also underscores the social importance of the sector, as it meets the needs for leisure, tourism, and local employment. Hospitality also presents substantial sustainability challenges, as its resource-intensive operations, including food service and accommodation, lead to high levels of waste, energy consumption, and water usage, as well as greenhouse gas emissions (da Costa Maynard *et al.*, 2020). Food waste is a particularly pressing issue, with the hospitality sector contributing approximately 12% of overall food waste in the European Union, while more than 70% of this waste is avoidable (Oliveira *et al.*, 2016). Additionally, the industry's dependence on natural resources exacerbates water scarcity, particularly in tourism-heavy regions, where water consumption from hospitality businesses significantly exceeds local averages (da Costa Maynard *et al.*, 2020).

One of the most promising solutions to these challenges is the use of technology. Technological advancements can enhance efficiency, reduce waste, and optimize resource consumption (Madanaguli *et al.*, 2022; Sharma *et al.*, 2023). AI-driven food waste tracking, smart management systems, and automated energy monitoring tools show the potential to improve sustainability performance while lowering operational costs (Elkhwesky *et al.*, 2024; Okumus, 2020). However, little is known about the extent to which they are adopted in practice (Huang *et al.*, 2020). The existing research primarily focuses on a broad view on sustainability issues in hospitality and how they can be addressed by technologies (Abdou *et al.*, 2020; Sharma *et al.*, 2023), although the emphasis is put on economic and environmental aspects of sustainability, while social aspect is rarely discussed (Goll *et al.*, 2025). While studies acknowledge the potential of technological solutions to mitigate environmental impact, they rarely explore the specific practical applications within hospitality businesses and management processes related to the usage of these technologies.

2.2 Technology as Knowledge Management Tool for Improving Sustainable Performance in Hospitality

Implementing knowledge management (KM) practices — encompassing knowledge storage, sharing, and conversion — significantly enhances the overall performance of hospitality firms (Brahami, 2020). These practices foster employee creativity (Sigala & Chalkiti, 2015) while improving job performance and satisfaction (Gürlek & Koseoglu, 2023). KM plays a particularly crucial role in hospitality businesses, especially during crises, by fostering long-term resilience and innovation (Goll & Zięba, 2022; Zayed et al., 2022). The use of technological tools enables organizations to effectively manage, store, and utilize existing knowledge, thereby maximizing the value of intangible resources such as human capital (Santoro & Usai, 2018). However, despite its potential, recent reviews of KM research in the hospitality sector reveal a lack of studies exploring the integration of KM practices with emerging technologies in hospitality management (Gürlek & Koseoglu, 2023).

Recent studies show that the integration of KM with blockchain enables organizations to develop green supply chains and meet sustainability regulations, suggesting that KM may play an important role in leveraging technology for sustainability (Sun *et al.*, 2022). The study by Tajpour *et al.*, (2022) proved that also other technologies, like social media, serve as KM tool that improves business sustainable performance. Using ICT tools is crucial for sharing knowledge within the organization which, if effectively managed, allows the reduction of the negative environmental impact of the business (Evangelista and Durst, 2015). The effective use of technologies relies not only on their availability and implementation, but also on how well hospitality managers and employees understand, integrate, and optimize these tools within their operations (Jones and Wynn, 2019). Therefore, KM is essential in bridging this gap, as it enables businesses to systematically acquire, share, and apply knowledge (Wellton and Lainpelto, 2021) in order to improve sustainable performance. Recent reviews dedicated to KM in the context of sustainability prove that point, showing that emerging

technologies serve as useful and effective KM tools for enhancing the sustainability of organizations (Ulhaq *et al.*, 2024). However, existing research does not investigate how technologies can be integrated with KM practices in the hospitality industry, even though, as suggested by Fauzi (2023), adapting technology within the KM perspective may have a crucial impact on society and the environment. Therefore, this paper aims to address this gap by explaining how technologies are leveraged by industry practitioners through KM practices to improve the sustainable performance of hospitality organizations.

3. Methodology

This study employs a qualitative secondary data analysis to explore how hospitality businesses leverage technology as a KM tool to enhance sustainability. The research is based on data collected from two key sources:

- The Hospitality Technology Network website – a platform dedicated to hospitality practitioners, which publishes industry-relevant content based on expert interviews, practitioner insights, and vendor reports. The articles reviewed were published between January 2023 and January 2025.
- Panel discussions from the MADE FOR RESTAURANT conference in Poland (November 2024) – a specialized event for restaurant owners and managers, focusing on technological change and automation in the hospitality sector. The conference recordings were transcribed and analyzed.

These sources were selected due to their practical orientation and industry credibility. The Hospitality Technology Network ensures reliability through its editorial team, consisting of industry practitioners and hospitality leaders, while the MADE FOR RESTAURANT conference serves as a real-time knowledge exchange platform, reflecting the experiences and expectations of hospitality professionals.

The data was examined using a narrative deductive approach (Heaton *et al.*, 2010), following the guidelines by Cheong et. al. (2023), allowing us to extract insights that align with the study's research objectives. Specifically, we sought to answer:

- What technologies are implemented in hospitality organizations, and how do they function?
- How are these technologies integrated with KM practices?
- What sustainability-related outcomes arise from using these technologies as KM tools?

Industry reports and practitioner discussions offer a holistic perspective, allowing us to bridge the gap between theoretical insights and practical applications.

4. Results

We present our findings in the form of direct answers to our research questions, as during the analysis of data we focused not on the emotions and personal experiences of practitioners, but rather on objective information about specific technologies and their usage in the context of KM. We present the specific technologies used in the hospitality industry and explain how they are used through KM practices, and what sustainability outcomes it allows to achieve.

Customer Mobile Apps

Hotels and restaurants design customer mobile apps that guests can use from home or during their stay. They enable knowledge acquisition by collecting guest preferences and usage patterns. The collected data is stored and analyzed to enhance service offerings. Moreover, they enable knowledge sharing by providing guests with instant access to relevant information, reducing the workload of hotel employees. Thanks to using such apps instead of typical informational brochures, hospitality businesses use much less paper, eliminating printing costs, and giving their guests instant updates on the offer, which enhances the guest experience.

Unified Property Management System (PMS)

Unified PMS integrates various operational functions within the hospitality business, streamlining processes through automated knowledge exchange across departments. The system is a form of knowledge storage, allowing seamless access across business units. The Unified PMS is often integrated with AI-driven analytics which serve as a knowledge utilization tool. AI facilitates logical storage and analysis of the data, optimizing managers' work and supporting them with information on demand, which is useful for strategic decision-making. Using PMS systems with AI-driven analytics significantly reduces the amount of paper documentation, facilitates business operations and employees' work conditions, and also gives the opportunity to enhance guest experience.

Digital training tools

Digital training tools are embedded in hospitality businesses' software systems. They allow employees to find needed information, and enhance their skills and competencies through standardized training programs (knowledge sharing). Managers can track their learning progress (knowledge acquisition), and store training records (knowledge storage). The knowledge gained by employees is applied in real time which leads to enhancing guest experiences. Thanks to the training platform, employees gain confidence through personal development, which also increases their job satisfaction. Using such a form of training instead of typical training allows to reduce training cost in the long-term perspective, and contributes to better environmental performance - not only because of not using paper for training but also by educating employees about sustainability practices which they implement at work after training.

AI bots

AI-driven customer support bots are integrated into hospitality communication systems, automating responses to guest inquiries. These bots are the first contact help for customers. They allow businesses to acquire knowledge on guest interactions. The AI interface streamlines escalation processes by directing complex issues to human agents and responding to customers' simple needs immediately, which reduces employees' workload and increases guest satisfaction.

AI supported Attribute-Based-Selling (ABS) model

ABS utilizes AI-powered analytics to offer guests a customizable stay by allowing them to select specific room attributes. This system acquires knowledge of guest preferences, analyzes demand trends, and automates price adjustments based on real-time data. As a result, companies increase their revenue through smart price adjustments, and optimize resource allocation, while improving guest satisfaction by offering tailored experiences, and lightening employees' workload as the booking is made automatically.

AI-Integrated Point-Of-Sales (POS) system

POS system can be integrated with AI-driven analytics to streamline order processing, payment transactions, inventory management, and customer interactions. Such a system allows to collect knowledge on sales in detail, and also track each order at each step. Thanks to AI the knowledge is analyzed and managers receive very specific information on demand, resource usage, and job performance. This knowledge is used to manage supply in such a way as to minimize waste generated and lower waste-related costs. Moreover, thanks to tracking the order at each step managers get insight into potential problems and adjust operations in real-time which improves the quality of service, and also enhances guest experience.

Smart rooms

Smart room technologies in hospitality utilize AI, IoT, and automation. These systems collect and analyze real-time data on customer preferences, and resource usage (e.g. temperature settings, lighting, water consumption). AI applies this knowledge to automate energy-efficient climate control, lighting adjustments, and appliance use, optimizing operations without compromising guests' preferences. Smart sensors detect occupancy and adjust settings, reducing unnecessary energy and water waste. This integration leads to lower resource consumption and operational costs while improving guest comfort. Additionally, automation reduces staff workload, allowing employees to focus solely on service quality.

Smart kitchen

Similarly to smart rooms, smart kitchen technologies also utilize AI, IoT, and automation. These technologies collect and store real-time data on cooking processes, energy consumption, and inventory levels. AI-driven systems analyze this data to provide chefs and managers with knowledge about food preparation, waste generated, and resources used. This knowledge is used to make decisions regarding the optimization of resource use and waste reduction. Smart appliances, such as energy-efficient ovens, refrigeration units, and dishwashers, adjust settings based on demand, minimizing energy and water consumption. Additionally, streamlined kitchen processes enhance employee workflow, and improve food quality which leads to enhanced customer experience.

5. Discussion

Our findings indicate that hospitality industry practitioners use technologies as fundamental tools for KM. The integration of AI into organizational software and systems significantly enhances KM processes. AI serves as a

KM tool by facilitating knowledge acquisition, analysis, and logical storage, thereby optimizing strategic decision-making, and enhancing sustainable performance. As noted by Gajić (2024), the integration of AI with KM contributes to improved environmental performance, aligning business operations with sustainability objectives. Through AI-powered analytics, hospitality practitioners can monitor resource consumption and automate data-driven solutions to minimize energy and water usage. Such insights support the argument of Dávideková et al. (2020), who highlight that technological advancements strengthen KM practices, ultimately enhancing both operational efficiency and environmental sustainability. Consistently, our findings align with those of Sahoo (2023), demonstrating that effective KM through technological integration translates into measurable improvements in environmental performance.

The results suggest that the knowledge stored and processed through technological solutions enables precise demand forecasting and more efficient supply management. This leads to significant cost reductions, thereby enhancing economic performance. Additionally, customer satisfaction and overall experience are markedly improved through the implementation of digital technologies. The utilization of AI and IoT for optimizing energy and water consumption further reduces operational costs, reinforcing the economic advantages of integrating technology with KM (Caputo *et al.*, 2019; Hassan *et al.*, 2018). The adoption of predictive analytics within KM supports revenue optimization strategies, ensuring that businesses remain competitive in the evolving hospitality market (Cooper, 2018).

POS systems, digital training tools, and PMS facilitate internal communication, enabling knowledge exchange among employees. These technologies play a pivotal role in knowledge sharing, as evidenced by M. Kumar (2024), by enhancing training methodologies and organizational learning capabilities. The implementation of digital training programs allows hospitality businesses to track employee progress, ensure standardized knowledge dissemination, and promote continuous professional development, hence enhancing organizational learning (Caputo et al., 2019). AI-driven technological tools provide managers with real-time insights into employee performance and competency gaps, allowing for targeted interventions and continuous operational improvements (Lubis *et al.*, 2024).

Beyond internal operations, the role of technologies in external communication is equally crucial. Digital platforms enable real-time interaction with customers, offering tailored services and instant updates. This not only enhances the guest experience but also serves as a conduit for sustainability awareness. By embedding sustainability information within customer engagement platforms, hospitality businesses actively contribute to environmental consciousness among guests. This aligns with Hassan et al. (2018), who assert that technology-mediated knowledge sharing fosters CSR and sustainability.

6. Study Limitations and Further Research Directions

The study presented here acknowledges several limitations. First of all, the study is based on qualitative secondary data gathered from a platform dedicated to practitioners interested in technology usage in the industry, and from a conference dedicated to automation and technological change in hospitality industry. That creates a risk that obtained data is biased, as both of them aim to promote technology usage by industry practitioners. Presented information may exaggerate the sustainable benefits of using specific technologies as KM tools. Secondly, our findings show what technologies are used, but not to what extent. The findings do not provide insights into how common are the KM practices. Additionally, our study does not present measurable sustainability outcomes of using technologies as KM tools in hospitality. Obtained results show in which areas of sustainability hospitality business performance may improve, but not how big this improvement is.

Future research can address this gap by comparative analysis of the sustainable performance of both hospitality businesses that utilize specific technologies as KM tools, and those that do not. A large-scale survey or industry report could assess the prevalence of KM technologies across different hospitality businesses and geographical regions. This would help identify which technologies are most widely used, and which types of hospitality businesses are more likely to adopt them. While our study highlights the potential benefits of integrating KM with technologies, future research could explore what motivates or hinders their adoption.

7. Conclusions

This study provides valuable insights for practitioners by identifying the types of technologies that hospitality businesses can effectively utilize. It outlines practical approaches for acquiring, sharing, and applying knowledge to enhance both service quality and the working conditions of employees. Furthermore, it offers concrete examples of technologies and their applications in the context of knowledge management (KM),

demonstrating how these tools can contribute to cost reduction, increased customer satisfaction, and a diminished environmental footprint. The study also emphasizes the potential for hospitality businesses to align operational efficiency with sustainability goals. The findings may serve as a useful reference for industry professionals seeking to implement more sustainable and knowledge-driven practices through the adoption of appropriate technological solutions.

Ethics Declaration: No ethical clearance for the research referred to in this paper was needed.

AI Declaration: AI tools (OpenAI and Grammarly) were used to improve the language quality of the paper. The tools were used to check the correctness of the text written and, if necessary, to correct grammar and any language errors. AI tool Scite was used as the additional search engine to find relevant literature.

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Leveraging Experience-Based Knowledge for Social Impact Analysis of Research and Development Projects in Banking

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Abstract: Banking projects are diverse and go beyond classic financial products and include advanced customer service tools, analytics, and AI. Large financial institutions are leaders of technological change, increasingly creating internal innovation labs that independently conduct research and development work using specialized teams, which helps them achieve a positive social impact and build a sustainable and stable competitive advantage in the long term, thanks to the rapid adaptation of solutions to changing market requirements. The issues relating to social impact analysis and assessment of R&D projects in banking are new, and a research gap can be noticed in this field. Publications on implementing such projects are mainly focused on their products and the time of delivering innovations to the market, not on the methods of managing project knowledge necessary for social impact analysis processes. There is, therefore, a need to build theoretical and methodological foundations for improving management processes and using experience-based knowledge in this area. This paper aims to propose a model inspired by case-based reasoning (CBR) and generative AI. The model can be helpful in supporting the solution of decision-making problems using historical knowledge, as well as considering the current specificity of projects and their environment. The presentation of the model is supplemented with examples concerning the social impact analysis of R&D projects in the banking sector, which prove that its use can improve the use of experience from such projects.

Keywords: R&D projects in the banking sector, Social impact analysis, Case-based reasoning, Generative AI, Knowledge management in projects

1. Introduction

Financial institutions are open to technological innovations and the financial products they offer are based on advanced IT customer service tools and artificial intelligence (AI) systems. The radical transformation resulting from the integration of such technologies enables the development of e-finance and the implementation of electronic channels that provide customers with efficient and innovative financial services (Najem et al., 2025).

The banking sector is moving away from services developed solely by external research institutions. Larger banks are increasingly establishing specialized internal teams to conduct research and development within their own innovation laboratories. This approach helps them respond quickly to changing environments and market demands, adapt solutions efficiently and flexibly, and achieve positive social impact. This is crucial for operating in accordance with the principles of sustainable development and building a stable, long-term competitive advantage.

For some time, relatively well-known research has been aimed at limiting the importance of solely financial profit and loss analyses and emphasizing the key concept of sustainability in project management, as well as long-term value creation, which relates to tracking the societal impact of projects (Carvalho & Rabechini, 2017). The literature also highlights the importance of stakeholder engagement and the need to consider the sustainability context in the management of research and innovation projects (Santos & Fernandes, 2024). Research issues relating to the implementation of R&D projects in banking and the analysis and assessment of their social impact are relatively new and, therefore, a research gap can be observed. Furthermore, existing studies primarily focus on the products of such projects and the delivery of innovative solutions to the market. Managing project knowledge supporting social impact analysis requires theoretical and methodological research to improve management processes and utilize experience-based knowledge for the social impact analysis of R&D projects in banking.

The use of such knowledge, the management of which can be supported by new IT and AI solutions, in analyzing the social impact of R&D projects should play a significant role in banking. The use of AI supports the functioning of knowledge management systems and improves the organizational performance and knowledge distribution within the organization (Pai et al., 2022). Generally, AI-based systems used to support knowledge management include neural networks, knowledge-based systems, expert systems, knowledge-based decision support systems, case-based reasoning (CBR), and generative AI. The CBR systems enable the use of past knowledge and experience to support decisions when solving new, specific problems. It is advisable to expand the capabilities of the CBR systems with generative AI due to their enormous potential for acquiring diverse knowledge and

flexibility. Hybrid systems allow for better performance and efficiency by combining the strengths of various AI paradigms, including CBR, generative AI and, particularly, large language models (LLM) (Bach et al., 2025).

This paper proposes a model inspired by CBR and generative AI that can be helpful in supporting decision-making by taking into account historical knowledge as well as the current specificity of R&D projects in banking and their environment. The presentation of theoretical considerations regarding the proposed model is enriched with examples of social impact analyses of research conducted within R&D projects in the banking sector. The practical implications of this research may be of interest to project managers and business practitioners.

2. Motivations and Origins of the Experience-Based Knowledge Model

Experience-based knowledge models can support flexible and adaptive solutions that can help meet the challenges of environmental volatility and technological change. Adaptive and agile models often utilize iterative solutions that effectively manage change and can provide a valuable response to the limitations of traditional approaches, which are less effective in conditions of radical change and high uncertainty. The creation of new models is supported by extensive research relating to the development of knowledge management concepts and innovative approaches that support project and organizational success through flexibility, adaptability, and agility.

Adaptability and agility based on knowledge can ensure the building of the ability to adapt to turbulent environmental conditions and create the basis for developing competencies related to assessing the environment and taking advantage of emerging opportunities, thus increasing the organization's chances of survival and achieving market success (Sarta et al., 2021). There is a growing interest in research on improving the adaptability and flexibility of organizations and increasing their resistance to negative external factors because globalization, technological transformations, growing resource shortages, and changing consumer needs pose significant threats to the long-term success and survival of various types of organizations (Yin, 2023).

In the context of flexible functioning and the adaptive capacity of an organization, the concept of responsible development, the ability to shape the future by making ethical decisions and introducing changes that consider the well-being of the most important stakeholder groups, plays an important role (Krajcsák & Bakacsi, 2025). Ethical issues and socially responsible decision-making relate to the social, economic, and environmental impacts of the undertaken activities, including research and innovation. In management theory, adaptability and responsible functioning in the context of achieving positive social impact should be linked to research on effective change management. For example, there is a need to identify challenges and barriers to effective change management, which can be addressed by applying flexible approaches to project management and building monitoring systems and knowledge that support drawing conclusions that guide adaptive changes in implemented activities (Van Assche et al., 2023).

In addition to adaptive methodologies and change management, agile methodologies are also among the inspirations shaping experience-based knowledge models. Their implementation is particularly justified for R&D projects characterized by significant innovation, complexity, and uncertainty. The results obtained as a result of their implementation are multidimensional and difficult to assess. The social impact is relatively difficult to estimate, and doubts may accompany a determination for the comprehensive success of long-term use of research results, for example, in the banking sector. Despite these difficulties, attempts are being made to address them by replacing traditional methodologies with agile solutions. The positive effects of such changes are relatively easily and quickly achieved by improving the efficiency of project teams, which improves the willingness to work, competencies, team stability, and the ability to adapt to the changing needs of research recipients (Ciric Lalic et al., 2022).

In general, the use of agile methodologies is positively perceived by managers for innovative and software projects and, among agile project success measures, not only process efficiency but also sustainable software product quality and stakeholder satisfaction occupy important places (Binboga & Altin Gumussoy, 2024). Sustainability aspects (i.e., social and economic dimensions) are largely based on improving reliability, the software usage life span, improving customer satisfaction, and reducing the long-term costs of software modifications (Khalifeh et al., 2020).

R&D project managers recognize the importance of learning from past experiences and the need to improve management practices aimed at absorbing useful knowledge (Vicente-Oliva et al., 2015). Improvement in this area may involve building experience-based knowledge models supporting flexible and adaptive solutions that can be applied through the implementation of various AI methods, including hybrid solutions inspired by CBR and generative AI.

3. Methodology

The following research question was formulated: What should be the model for a social impact analysis of R&D projects in banking? Based on a literature analysis, the lack and the need for such models were identified, both theoretically and practically. The need for such solutions was also confirmed by observations of R&D projects implemented in the banking sector. The challenges faced by this sector and its specific nature justify undertaking this area of research. The following research methods were used: a literature review, modeling using AI-based methods, observation of selected R&D projects in one of the largest banks in Poland, and case studies.

The modeling process employed solutions inspired by classic CBR supported by LLM, which operated according to a framework that utilized analogous past cases to solve new problems. This was inspired by the typical cycle consisting of the following four stages of experience-based knowledge acquisition: retrieve, reuse, revision, and retention (Lopez De Mantaras et al., 2005). Retrieve involves searching and identifying cases in the database that are most similar to the current problem. Reuse refers to reusing a solution, or parts thereof, found in historical cases for the current situation. Revise involves verifying the correct functioning of the identified solution and suggesting possible corrections. Retain is equivalent to saving a new case in the knowledge base for future use. As subsequent tasks are solved and solutions retained, the case database grows and experience-based knowledge resources increase, becoming increasingly useful in the social impact analysis of R&D projects in banking. According to previous research results for various CBR applications, building hybrid models based on combining CBR with other AI methods, particularly LLM, is recommended for solving complex problems (Bach et al., 2025).

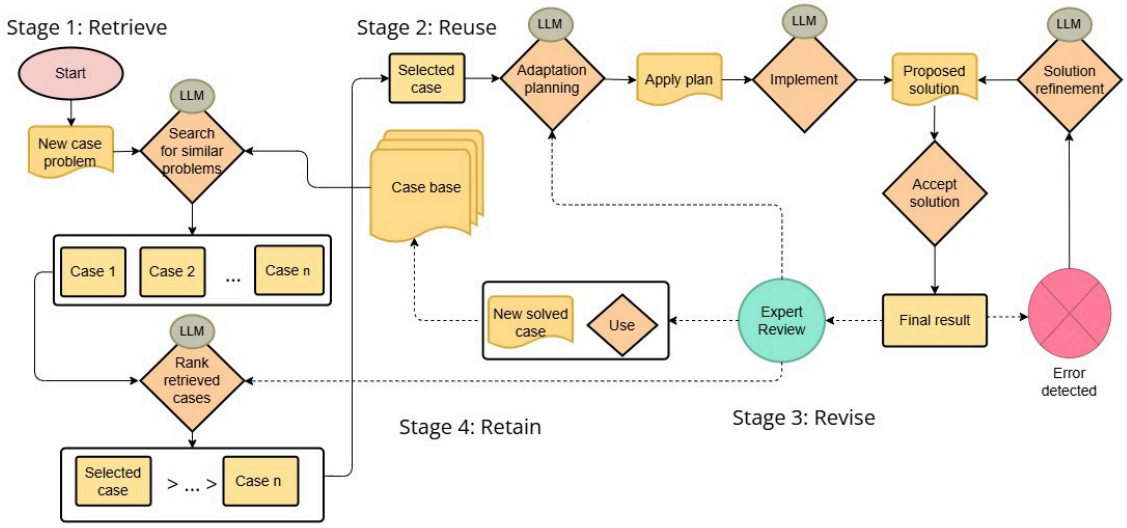
Case studies were used to conduct an initial theoretical validation of the model and lay the foundation for further in-depth research on its practical applications. Three IT R&D projects were selected for the case studies, carried out at a bank that plays a leading role in the Polish market in utilizing public funds for the planning and implementation of such projects. These projects involved developing systems for managing the accuracy and timeliness of bank customer master data using self-learning modeling, developing and launching banking services based on tokens and smart contracts using blockchain technology, and building neural language models supporting the processing and analysis of unstructured data.

In the description of the case studies, particular attention was paid to the following aspects:

- origin, initial motivation, and context of the project,
- project objectives and scope,
- project management methodologies and tools, and IT technologies used,
- how the proposed CBR and generative AI can be used to analyze the research project and shape it to increase social impact,
- possible implementation options for the proposed solutions at major milestones or project phases,
- how lessons learned from the past will be integrated into the current project implementation plan,
- proposed quantitative metrics or qualitative observations that reflect success in achieving positive social impact or difficulties and challenges in this regard,
- identified technical and management challenges,
- conclusions, recommendations, and scalability of the CBR and generative AI solutions.

4. Results and Discussion

Figure 1 presents a model based on the combined use of the CBR and LLM methods for semantic recognition of content contained in a case database that has collected knowledge from previous projects. The model enables the adaptation of the ongoing projects to new challenges, iteratively improving solutions, and then saving approved solutions in the case base.



Source: Own study

Figure 1: CBR and LLM integration for social impact analysis of the R&D projects

The model's operation is based on CBR-inspired stages described in the methodology section, the use of LLM, and it considers the role of human-in-the-loop (expert review). The first stage is retrieve, in which a new task emerges and its specifics are determined: goals, requirements, available data, and constraints. Individual cases in the knowledge base may contain, for example, metadata (i.e., title, date, author, and project domain), a problem description, the solution, the results of applying the solution, and lessons learned from the selected project (Das et al., 2021).

The search module is supported by a linguistic model that searches the existing database of cases for previous solutions that are contextually similar to the current problem. The result is a list of cases, each describing a previously solved problem. The model then selects the best case from several identified by the searching module. This can be undertaken by considering feedback from previous attempts, which are verified during the revise stage. If a particular case has already proven successful in a similar context or has proven ineffective, this affects its suitability classification accordingly. The model analyzes the cases, assessing them both for their similarity and any comments from previous experience. As a result, the case that best fits the given scenario is selected from the set of Case 1, ..., Case n. The selected (as best) case, identified in Figure 1 as the selected case, then moves on to the second stage, i.e., reuse, where it becomes a database that can be adapted to the needs of the current task. At this stage, a module is launched that develops a detailed implementation plan based on the selected case.

The next stage is revise, which verifies whether the results meet expectations. The system then enters a correction and refinement loop, where it makes further adjustments based on error diagnosis. The LLM can analyze what went wrong and implement the corrections. In Figure 1, the 'Accept solution' diamond and the 'Final result' block indicate the moment when the results are verified. If they are unsatisfactory, the next step is 'Solution refinement.' The revise mechanism can be more complex; for example, it can iterate between ranking and implementation attempts multiple times until a suitable case is finally found. The entire process, as part of the revise stage, includes room for human intervention (human-in-the-loop). This allows for the approval of a new case before adding it to the database or for deciding on the sufficient quality of the obtained results. Even in highly automated systems that support the creation of machine models, expert review could be necessary to confirm the compliance of the results with the adopted assumptions, for example, in the area of requirements for achieving social impact. The final stage is retain. When the proposed solution proves effective, a new entry is created in the case knowledge base, containing not only a description of the context and methods used but also information about any challenges and how to overcome them. This allows for future project analyses and evaluations to benefit from an increasingly rich source of experience-based knowledge for social impact analysis.

To conduct an initial theoretical validation of the model and lay the foundation for further in-depth research on its practical applications, three case studies were analyzed. The first case study relates to a project in the area of data quality management, specifically the use of self-learning modeling to manage the accuracy and currency of bank customer data. This project concept arose from the need to build a customer database created using

diverse data and to safeguard its current and accurate nature. The proposed solution should ensure effective management of the accuracy and currency of core customer data. Primarily, the goal is to develop a methodology for data cleansing, duplicate detection, and a model for predicting data aging in the central database. The key technology is self-learning modeling implemented using programming languages (e.g., Python), database management systems, and machine learning platforms. The CBR-inspired solutions proposed in this paper prove useful in identifying effective approaches to ensure data accuracy that, from a social impact perspective, serves to strengthen customer trust in financial institutions and facilitate contacts. A CBR-inspired approach can also be useful during the implementation of the solutions proposed in the project, i.e., during the stages of requirements analysis, management methodology selection, building a central customer database, testing, and monitoring. Generative AI can be useful in identifying inconsistencies and generating synthetic data for algorithm testing. During implementation, generative AI can be used during the stages of data analysis, algorithm testing, and data quality monitoring.

The proposed quantitative metrics that can reflect success in achieving positive social impact include a reduction in customer complaints and the net promoter score (NPS) for measuring customer loyalty and satisfaction. Qualitative metrics include employee feedback, case studies, customer feedback, and other stakeholder feedback. Technical challenges have been identified, stemming from integrating data from multiple sources, ensuring adequate data security in line with regulatory requirements, considering algorithm accuracy, and maintaining database performance. The project can be considered a significant initiative for improving data quality. It is recommended to conduct in-depth empirical research relating to the implementation of a model based on CBR and generative AI to utilize data improvement cases in customer interactions. The quality of the results returned by CBR depends on the size of the case database and the application of the appropriate LLM model. Both technologies improve in quality with increasing scale.

The second case study relates to a project involving the development and launch of banking services based on tokens and smart contracts using blockchain technology. The project was initiated by the need to acquire and gather new knowledge and conduct development work on the operation of tokenization services and smart contracts using blockchain technology. In addition to technical issues, it was deemed necessary to examine the legal framework for applying these technologies in the banking sector. The project focused on developing a new platform for providing financial services using the aforementioned technologies. Solutions inspired by CBR could help identify successful blockchain initiatives from the past. Generative AI, in turn, is useful in supporting modeling in accordance with CBR principles when adapting solutions found in the database for subsequent applications. During the implementation of the proposed solutions, design engineering principles could be applied, i.e., solving current problems by finding analogous cases. During the final product development stage, it may be useful to utilize both positive examples to encourage and negative examples to increase the security of potential customers. The use of generative AI to analyze the legal aspects of using selected technologies in banking is promising. The proposed model could be useful in tracking past blockchain projects that have encountered legal or regulatory issues, providing information about legal challenges and proposed solutions.

The proposed quantitative indicators include the number of customers using blockchain services, transaction volume, and reduction in transaction costs. Qualitative indicators involve customer reviews, expert opinions, and an assessment of the impact on reducing financial exclusion. The challenge here is measuring the social impact of blockchain technology. The following technical challenges were identified: ensuring platform security, achieving scalability, and integrating with existing infrastructure. Selected management issues included coping with changing regulations, building expertise, and shaping user adoption. It is worth noting the positive and negative social impact of this research.

The third case study concerns a project to build neural language models supporting the processing and analysis of unstructured data. The project arose from the need to develop language models for the Polish language in the financial sector, as well as a service platform for analyzing and generating banking-related issues. The project scope includes the creation of a universal platform architecture model, data models, and language models. A model inspired by CBR and generative AI is useful for leveraging lessons learned to develop competencies within a bank, including through knowledge transfer from the research unit participating in the project. The CBR concept can guide the implementation of operational rules and generative AI as an important source of domain knowledge. Increasing social impact is possible by improving accessibility, streamlining customer service, and improving financial literacy. Generative AI can facilitate improved access to diverse knowledge, create personalized solutions, and enrich real-world data through the generation of synthetic data. In the process of integrating lessons learned from the past with the current project implementation plan, a CBR model supported

by LLM could focus on solving emerging problems, for example, by searching for information about the model architectures used, data collection approaches, or model evaluation metrics.

The proposed quantitative indicators include reduced customer service times, an increase in the number of automatically resolved queries, and improved customer satisfaction. Qualitative indicators involve customer and consultant feedback and an assessment of the clarity of information returned by the model. Challenges here include the subjective nature of measuring the quality of model interactions, ensuring objectivity, and mitigating the possibility of prohibited behaviors (e.g., discrimination). Identified technical challenges involve adequate data quality, ensuring platform scalability, and integration with banking systems, while taking into account security requirements. Management challenges relate to the project's novelty and the lack of long-term proven approaches for managing such projects, i.e., learning by doing is a necessity.

The third project represents a strategic investment in AI technologies. Given the novelty and complexity of this field, it is recommended to implement solutions inspired by CBR and supported by generative AI to search for and propose solutions that have already been used. This can help reduce the likelihood of repeating errors that have already been made and whose solutions are known.

In the case of the three selected projects, there were difficulties when separating the effects relating to the social impact resulting from these projects, in the measurement of qualitative indicators that may be distorted by subjectivity, and due to limitations resulting from data privacy regulations. Additional difficulties in assessing social impact stem from the lag between project implementation and the positive changes that can be analyzed and assessed. Furthermore, baseline data on the situation prior to project implementation were sometimes unavailable during research. It is difficult to track changes related to social impact without conducting comprehensive comparative analyses. It is also important to remember the limitations resulting from the often conflicting social, technological, and economic aspects. IT projects that are economically beneficial can negatively impact interpersonal relationships and undermine trust in financial institutions. Openness to new technologies and AI solutions varies across different age groups of stakeholders.

5. Conclusions

The obtained research results provide concrete theoretical and applied implications for the new research area of assessing the social impact of research conducted within R&D projects in the banking sector. The latter is moving away from relying solely on research results conducted by external research institutions. Establishing internal research teams within banks and their own innovation laboratories helps them respond quickly to changing environments and market demands, adapt solutions efficiently and flexibly, and achieve positive social impact. This is crucial for operating in accordance with the principles of sustainable development and building a stable and long-term competitive advantage.

The proposed model, inspired by CBR and generative AI, addresses the unmet needs among theoreticians and practitioners of R&D project management in the banking sector and financial institutions. The achievements resulting from the research described here are noteworthy, especially due to the paucity of such research studies, and are clearly visible in the context of rapidly evolving technologies and the field of R&D project management. The proposed model makes an important contribution to the development of methodological foundations supporting the resolution of problems relating to social impact analysis and evaluation of R&D projects, particularly the development of applications of AI technologies that drive project knowledge management and solutions that improve the use of these technologies in experience-based knowledge processes. The research results also provide a sound basis for subsequent in-depth research on the implementation and validation of the proposed model.

The usefulness of CBR in societal impact analysis of R&D projects stems from the way it leverages past experience and the ability to build and practically utilize a database of experience-based knowledge. CBR allows for the reuse of proven solutions that have previously proven effective in solving similar problems. This is, therefore, a simple way to avoid or reduce errors in new attempts to solve similar problems. Adaptation and revision mechanisms enable the verification and improvement of suitable cases from the database, as well as their corrections if necessary. Proposed solutions become increasingly accurate as the experience-based knowledge pool increases. These resources enable forecasting and simulation of new solutions, improving their accuracy and social efficiency. Drawing on knowledge resources relating to specific past cases allows for the justification and explanation of obtained results with precedents. The proposed model supports learning from past experience and prevents the repetition of errors, facilitating reliable, well-considered, and well-founded decision-making. This research allows for the formulation of recommendations regarding future actions. First

and foremost, it is necessary to conduct research on a larger research sample, i.e., a larger number of projects implemented by various financial institutions. It is also advisable to expand the scope of the research to include financial institutions in various countries. Obtaining results from a larger number of cases enables comparative studies. It is also worth considering other AI methods that could be applied in systems that support the social impact analysis of R&D projects.

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AI declaration: Selected AI tools were used in the computer modeling described in this paper.

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Artificial Intelligence for Adaptive Planning of Healthcare Projects

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Abstract: Planning and managing healthcare projects involves making decisions in conditions of high uncertainty due to a complex and turbulent environment, technological transformation, and the use of largely subjective resources of tacit knowledge possessed by project managers as a result of accumulated years of experience. It is desirable to look for solutions that allow for the creation of flexible and agile systems supporting the management of updated knowledge resources, enabling dynamic adaptation to current problems and changing environmental conditions. One possible solution is using intelligent systems that would support adaptive planning. The paper aims to present an AI model for knowledge management in adaptive planning of healthcare projects, which are usually complex, expensive, and require efficiently updated interdisciplinary scientific knowledge. Additionally, such projects often only have generally formulated goals and planned results, which makes their definition, planning, and initial evaluation much more difficult. Thanks to the conclusions drawn from this research, it is possible to reduce the number of errors made during project planning, which usually significantly affect the implementation and success of projects. It is justified to develop interdisciplinary research conducted on the border of healthcare project planning and AI computing systems because expert planning methods dominate, and there is a lack of adequate support. Implementing this type of research and its further continuation allows for the creation of knowledge and methodological solutions related to introducing AI computation to healthcare projects to assist agile decision-making.

Keywords: Artificial intelligence, Healthcare project management, Adaptive planning methodology, Knowledge management

1. Introduction

In the scientific literature on healthcare projects, there are relatively few studies on the problems of planning, project management, and supporting the related processes with AI models that facilitate knowledge management. The attention of many authors is focused primarily on medical issues, e.g., those related to deep learning-assisted surgical systems (Kaleta *et al.*, 2023). In addition, there is a paucity of research on the importance of AI in creating adaptive and agile approaches useful for developing knowledge management models in healthcare project planning. It is worth filling this research gap, because following an Agile mindset is usually associated with achieving significant benefits that are qualitatively and quantitatively measurable.

When Agile Methodology and Agile Mindset principles are applied by teams during the planning and implementation of activities, it is possible to conduct healthcare projects adaptively and flexibly and achieve measurable benefits. These principles include procedures that strengthen flexible cooperation in interdisciplinary project teams operating in healthcare institutions, knowledge management, and learning that enables adaptation to internal and external changes to achieve high-performing results that meet the needs of diverse stakeholder groups. Knowledge about Agile Mindset is considered to be in its early stages of development, because there is a lack of research related to the conceptualization of this concept, and it occurs mainly in a tacit form, i.e., related to experts and project managers. Using this knowledge is associated with adopting an attitude that supports strengthening cooperation, empowered self-guidance, learning, knowledge management and customer co-creation in the conditions of the VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) environment (Eilers *et al.*, 2022).

The implementation of Agile principles, adaptive planning, iterative development and continuous improvement in a turbulent project environment can be particularly useful in managing healthcare projects in a situation where dynamic technological transformations in healthcare, frequent changes in legal regulations, European Union guidelines and growing requirements for patient care can be noted (Cordero, 2023). Agile mindset and adaptive planning principles are particularly desirable for healthcare projects, because they are usually very complex and expensive, have only broadly outlined goals and planned outcomes, and require rapidly updated, sophisticated, interdisciplinary scientific knowledge. There is a lack of research on AI-driven support for adaptive planning through tacit knowledge management, i.e., knowledge related mainly to healthcare project management experts.

The paper aims to present an AI model for knowledge management in adaptive planning of healthcare projects, which are usually complex, expensive, and require efficiently updated interdisciplinary scientific knowledge.

Undertaking this type of research is important because it creates a basis and directs further research processes related to proposing solutions related to introducing AI models to support decision-making processes in healthcare projects. The results of research related to intelligent decision support systems can help improve the quality of healthcare projects, reduce the number of errors made during project planning, improve their implementation, and increase the probability of achieving success measured by the satisfaction of diverse stakeholder groups.

2. The Essence of Adaptive Planning and Management in Healthcare

Adaptation can be understood as a way of shaping the future through the ability of an organization to make ethical decisions and actions regarding rapid and effective adjustment to changing environmental conditions by consciously implementing changes that take into account the well-being of important stakeholders (Krajcsák and Bakacsi, 2024). Adaptation is related to the management of changes, the effective implementation of which is difficult, e.g., as a result of the lack of leaders responsible for change management, inappropriate organizational culture, implementation of fragmented change management only at some levels, resistance to change, insufficient employee involvement, poor communication and improper integration of change management with other complementary approaches (Bassi and Shinde, 2024). Change management requires using appropriate adaptive methodologies, implementing continuous project monitoring processes, and a flexible response to situations described based on the values of monitoring indicators. A flexible approach to planning and implementing healthcare projects allows drawing conclusions that direct adaptive changes to the implemented activities (Van Assche *et al.*, 2023).

In the conditions of a turbulent environment and high uncertainty usually accompanying healthcare projects, adaptive planning based on iterative processes and agile approaches is therefore useful. By these approaches, a way of thinking is adopted that assumes moving away from rigid schedules and unchanging project documentation, in favor of introducing flexible and dynamic principles of adapting to changing circumstances. It is assumed that the rich scientific achievements related to the development of innovative business models and the concept of adaptation, which is known from the theory of strategic management, are used. The theory of organizational adaptation helps understand the possibilities of increasing an organization's chances to survive and achieve success through its ability to adapt to changing environmental conditions (Sarta *et al.*, 2021). There is a growing interest in the scientific community in conducting research related to the issues of adaptability of organizations and increasing resistance to external factors in connection with the occurrence of multi-faceted and diverse processes of globalization, technological evolution, growing shortage of available resources and increasing requirements of stakeholders (Yin, 2023).

The research results indicate a positive impact of replacing traditional project management methodologies with agile methodologies. This positive impact is manifested by improving the efficiency of project teams, increasing the ability to manage knowledge effectively, improving the interdisciplinary skills of team members and the ability to adaptively adjust to changing environmental conditions (Ciric Lalic *et al.*, 2022). Agile methodologies enable the introduction of useful adaptive solutions, the first successful implementations of which are known from successfully completed IT projects (Binboga and Altin Gumussoy, 2024). More and more bold attempts are being made to use these experiences for various types of projects with significant innovation, complexity, and uncertainty regarding the obtained multidimensional results, e.g., clinical trials and various projects implemented in healthcare. Digital health evolution, which implies the healthcare sector's transformative dynamics, requires understanding the essence of the value-based healthcare context and developing forward-looking research on innovative approaches and models of adaptive management of healthcare projects to achieve better outcomes (Vesty, 2024).

The use of models for adaptive planning is justified for healthcare projects because they are often implemented sequentially in long and expensive processes. Adaptive approaches enable the introduction of principles of flexibility in combining and implementing individual phases of these processes. This usually entails a significant reduction in the planning and implementation time of complex projects, simplifying planning processes of interconnected stages, and also enables substantial savings and a reduction in the size of the research sample for clinical research projects (Ma *et al.*, 2022).

Interesting and inspiring research on models for adaptive planning of healthcare projects concerns the possibility of using metaheuristic algorithms and AI methods. Such models are suitable for complex healthcare projects (e.g., related to clinical trials), which are characterized by multi-faceted dependencies that are difficult to analyze using traditional approaches (Zhu and Wong, 2023).

3. AI for Knowledge Management and Adaptive Planning of Healthcare Projects

The field of healthcare project management is constantly changing due to groundbreaking AI technologies and the dynamic development of data-driven project management. This development contributes to the emergence of challenges that project managers have to cope with. Currently, it is necessary to develop digital competencies of data-driven project managers, who are required to conduct analyses of diverse and uncertain empirical data to support making sometimes difficult decisions regarding improving projects towards ensuring long-term benefits. AI approaches, methods, and tools can contribute to improving the quality and effectiveness of the processes of adaptive planning, evaluation, and implementation of projects. Significant potential lies, for example, in mixed AI systems, which are based on integrating quantitative and qualitative methods, allowing for the analysis of complex and interdisciplinary projects with very different evaluation criteria (Grzeszczyk, 2018). In turn, basing on the systems approach and drawing inspiration from new achievements in generative AI and selected mathematical models (e.g., based on generalizations of rough sets theory useful in multicriteria decision analysis processes) allows for building knowledge systems supporting project evaluations (Grzeszczyk, 2024).

AI methods are also useful for building knowledge bases for pharmaceutical and medical device industry experts and implementing mechanisms to support the evaluation of pharmaceutical formulations and drug development processes (Bhupathyraaj *et al.*, 2023). Such constantly updated knowledge bases can be used by knowledge workers focused on using non-routine cognitive processes and innovative tools for analysis, evaluation, and idea generation, which may be useful in a specific situation of research processes in healthcare. The search for new decision support instruments in the field of clinical trials is of great importance because drug development is very expensive and time-consuming, and is often associated with a large number of failed research projects. AI can play a multi-faceted role in drug development projects and modernizing support systems for efficient drug delivery (Visan and Negut, 2024).

AI and knowledge management are fields related to learning and using knowledge. AI is generally based on learning and building knowledge bases, while building knowledge management systems allows for a better understanding of the usefulness of knowledge (Pai *et al.*, 2022). AI enables effective support for project planning and implementation in conditions of uncertainty, insufficient knowledge resources, and unpredictable events that require adaptation of originally assumed plans and schedules. Intelligent systems that enable dynamic and adaptive adjustment of project schedules in response to disruptions related to resource availability and problems with their substitutability are particularly useful in practice (Xu and Bai, 2024).

AI models are increasingly used in medical processes, diagnostics, medical data analysis, image recognition, e.g. from computed tomography, discovery and development of new drugs. However, there is still little significant research on management issues related to supporting the planning, management, and evaluation of healthcare projects using AI and intelligent adaptive methods. Providing this type of methodological support, especially at the planning stage and making ex ante assessments, is justified due to the complexity of many healthcare projects, which also require significant costs for their implementation. The lack of appropriate AI tools for knowledge management and adaptive planning of healthcare projects can contribute to errors during planning, which usually significantly affect the later implementation and success of the projects.

Adaptive planning of healthcare projects using AI models is helpful in the context of decision-making in conditions of high uncertainty resulting from a changing environment, technological transformation, and the use of largely subjective resources of tacit knowledge possessed by project managers as a result of many years of accumulated experience. AI can support the processes of improving the management of healthcare projects by providing a flexible approach to improving planning and decision-making, adapted to current problems.

AI models can support data analysis, knowledge discovery from empirical data, and predictive analytics. AI's usefulness comes from its ability to process vast amounts of diverse empirical data from various sources (e.g., patient records, clinical trials, medical studies). AI methods are used to identify patterns in data, support knowledge management, and predict project outcomes. Project managers can have this type of support in making decisions about the effective allocation of resources, even in conditions of significant risk and uncertainty. Decision support is the basic task of AI systems for knowledge management. This support is based on recommendations prepared using usually huge sets of historical data, best practices, and real-time analyses. The use of complex AI algorithms is especially useful in complex scenarios for which many variables must be considered.

AI can also support personalization, customization, and adaptation of project management strategies to the specific needs of different healthcare facilities, patient populations, and their changing needs. Adaptive

algorithms can keep up with these changes and facilitate adjustments to plans based on real-time data. This can ensure responsiveness to changing circumstances in the project environment. AI and knowledge management tools can facilitate communication, strengthen collaboration, and engagement among project stakeholders, including providers, patients, and administrators.

Typical AI applications also include automation of routine tasks, such as planning, scheduling, resource allocation, and progress tracking. Such AI models for expert knowledge management can help reduce the administrative burden on project managers and allow them to focus on more substantive and strategic activities.

Adaptive approaches, agile project planning and knowledge management systems are helpful in supporting real-time adjustments, continuous monitoring of project progress and external factors. The results of monitoring processes can facilitate flexible adjustments of project plans and schedules in real time and in an iterative manner. Additionally, AI models can support the generation and evaluation of multiple project scenarios useful for project managers who need to respond to unexpected and rapid changes in the project environment.

Support in tacit knowledge management can be primarily knowledge bases, domain knowledge repositories and knowledge-based systems. Knowledge bases usually enable rapid updating of interdisciplinary knowledge. AI-based knowledge repositories can be used to collect and store valuable experiences and conclusions resulting from previous projects. This allows for the provision of continuous learning mechanisms and continuous improvement of project management practices by using the growing collective expertise. AI systems can continuously collect and facilitate the implementation of current research results, clinical guidelines and scientific discoveries. Thanks to this, the knowledge bases being built remain constantly up-to-date and comprehensive, allowing for the inclusion of the latest achievements in healthcare projects.

Expert and knowledge-based systems enable the capture and codification of interdisciplinary tacit knowledge of experts and knowledge workers. These systems can be used to collect and process knowledge from experienced project managers, which can then be used to support less experienced project managers to ensure continuity and consistency in decision-making processes. Knowledge-based systems can support decision-making processes and have important implications for knowledge management. These implications include facilitating cooperation between project team members representing different knowledge areas and providing a comprehensive approach to supporting the management of complex projects requiring input from different knowledge areas. Efficient knowledge management, adapting knowledge bases to changing situations, can help identify emerging threats and effectively manage risk. Expert systems can suggest possible solutions based on current knowledge and create conditions for project managers to proactively adjust the implementation strategy of individual projects and entire programs implemented in healthcare. This is especially important in the case of many high-risk projects, the failure of which can affect programs (sets of projects) and the functioning of entire organizations. Using (timely) updated knowledge bases can significantly impact the likelihood of success in undertaken project activities.

The use of AI models for knowledge management and adaptive planning of healthcare projects increases the possibilities of using current knowledge systems, flexible response to the variability of the environment and effectiveness of achieving success. The combined use of agile methodologies, tacit knowledge management and ongoing updating of interdisciplinary knowledge based on AI enables the creation of a friendly environment in which healthcare projects can be successfully planned and implemented despite their complexity and significant uncertainty.

4. Methodology

The research process was carried out in two stages: analysis of the subject literature and developing an AI model for adaptive planning of healthcare projects. During the research carried out in the first stage, the Scopus database and keywords belonging to the following five concept areas were used: ‘AI models’, ‘adaptive planning methodologies’, ‘project management’, ‘healthcare systems’, and ‘decision-making’. The results of the literature research formed the basis for conducting a usability analysis of the adaptive approach, as well as a review of the possibilities of using available AI models for flexible and knowledge-based support of planned projects. The results of this usability analysis provided opportunities for finding and using AI systems in the model being built, which would support knowledge management useful in effective project planning. This allowed for defining the goal, which is to develop an AI model for adaptive planning of healthcare projects, which are usually complex, expensive, and require efficiently updated interdisciplinary scientific knowledge. The specific research goal directed the research process towards a preliminary analysis of AI-driven knowledge management models in terms of their usefulness in adaptive project planning in healthcare. The following research methods were used

to help conduct the planned theoretical analyses and in the empirical research process of the AI model for adaptive planning: literature review, direct observation of healthcare project planning processes, document analysis, modeling, and computer simulations.

The development of the model is based on a process approach to knowledge management, according to which the following processes can be distinguished: knowledge acquisition (extracting, structuring, and organizing knowledge), knowledge dissemination and knowledge application. Knowledge acquisition, its discovery, and improvement are carried out with the support of AI technology and knowledge-based systems. Dissemination of knowledge also mainly concerns specialized high-level knowledge obtained through the use of such technological solutions. Knowledge application means transforming discovered knowledge into decisions related to the continuous improvement of planned projects. Implementing the aforementioned knowledge management processes is crucial for organizations' success in innovative and design activities (Yusr *et al.*, 2017).

In the computer modeling and simulation processes, a rule-based system was used, which allows for the reflection of interdisciplinary achievements useful in supporting knowledge management. Knowledge-based systems are often performed using rules, which are one of the most important forms of knowledge discovered on the basis of empirical data. Many data and rule-based systems are useful for discovering new and potentially useful patterns, which are a desirable and understandable form of knowledge useful in adaptive project planning. In general, empirical data processing and knowledge discovery is carried out as a result of repeating the following stages: collecting and updating data, preprocessing, exploration of data, postprocessing, updating the knowledge base, improving the obtained results by knowledge engineers and experts, using the discovered knowledge in processes related to project planning. Drawing conclusions for a given iteration loop helps implement the principle of continuous learning and improvement. Preprocessing concerns preparing collected empirical data for the selected algorithm to determine patterns and knowledge. The Apriori algorithm for discovering association rules accessible in TIBCO Statistica 13.3 software was used in the computer modeling and simulation process. Postprocessing results support work on the form of knowledge that can be practically used. The above-mentioned stages create a feedback loop, within which the current data set and the current form of knowledge are applied. They are updated for the next iteration.

The chosen symbolic form of knowledge representation offers advantages over deep learning approaches based on neural networks. While deep learning models often produce complex, spatially distributed knowledge representations that are difficult for experts to interpret, symbolic methods generate structured, human-readable outputs. The selected approach facilitates the processing of diverse data, supports knowledge discovery, and enables the construction of interpretable patterns. Rule-based systems are particularly well suited for adaptive planning processes due to their clear and intuitive structure, typically expressed as: "If antecedent, then consequent." This conditional format effectively captures the relationships identified through empirical data analysis. Such rules often represent meaningful and non-trivial associations between variables within large datasets, making them both practically relevant and applicable. Moreover, generating symbolic knowledge using rule-based models is relatively straightforward. These models are especially valuable in the context of the rapidly expanding volume of information and knowledge associated with modern healthcare project planning and implementation. They offer robust support for analyzing empirical data, which is frequently ambiguous or imprecise, and can enhance decision-making by providing transparent, interpretable insights.

5. Results and Discussion

During the development of the model, it was assumed that the principles specific to adaptive planning processes and empirical data processing and knowledge discovery regarding rule-based systems, which were specified in the Methodology section of this paper, would be considered. Therefore, the first stage is the situation assessment and data gathering (Figure 1). This stage concerns the analysis and assessment of the project environment, operating conditions, and the needs met that are important for the local community and various groups of its stakeholders. The next two stages are related to preparing and implementing the knowledge discovery process using the rule-based system. The post-processing stage is necessary to organize the imprecise form of knowledge obtained after the application of the algorithm for inducing rules and ensures filtering of rules, as well as integration of knowledge to ensure its coherence.

The fourth stage is related to knowledge base extension and an alternative learning paradigm (Never-ending learning), which assumes that the system learns incrementally and continuously (Mitchell *et al.*, 2018). In the developed model, this paradigm is used for continuous iterative learning, modification of the knowledge base,

and adaptation of knowledge to current and changing situations concerning planned projects. After modification of the knowledge base, it is necessary to conduct its evaluation and ongoing improvement (stage five).

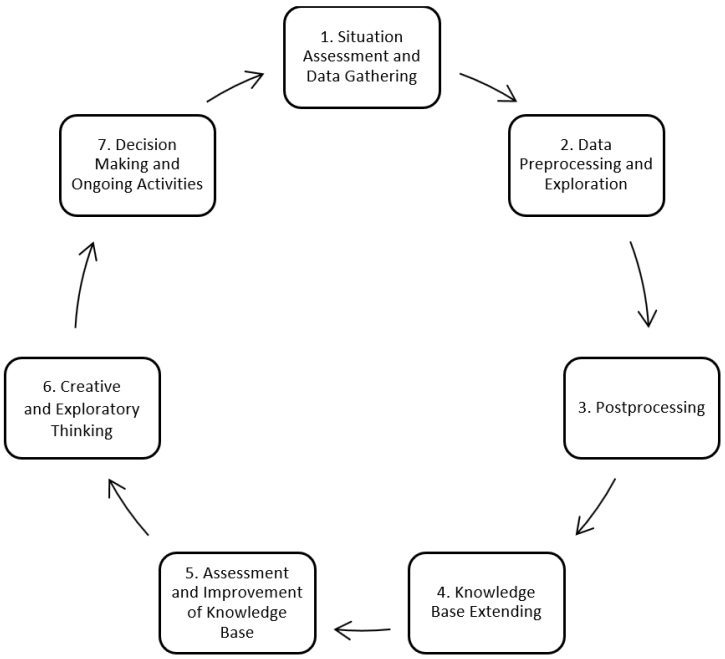


Figure 1: AI model for knowledge management in adaptive planning of healthcare projects (source: Own study)

In accordance with the idea of the adaptive approach, current decisions are made after considering strategic priorities (stages 6 and 7). Short-term plans and implementation of current activities should be consistent with the strategic management of projects and programs. In the case of complex projects in healthcare, in the face of significant uncertainty, technological transformations, and changing requirements, it is necessary to include exploratory thinking in the planning processes. There are positive experiences related to building innovative planning perspectives and the potential for alternative approaches to long-term planning in the provision of public services using planning interventions based on exploratory thinking (Malekpour *et al.*, 2016). Adaptive approach and change management aimed at ensuring lasting changes and effectiveness in the strategic approach to project success is one of the most important trends in healthcare project management. Research confirms the importance of strategic project and portfolio management in healthcare, which should be supported by organizations, e.g., as a result of launching a dedicated office equipped with appropriate decision support tools (Cristina *et al.*, 2024).

A significant advantage of the proposed model is its universality and practical usefulness for using a variety of empirical data that may come from interviews, project stakeholder surveys, and project documentation. The adopted iterative nature of the model enables the implementation of the principles of adaptive and agile planning. Individual cycles can be repeated many times, and the improved knowledge base can be used. The proposed solution, based on the AI model and knowledge management for adaptive planning of healthcare projects, is characterized by significant flexibility and scalability. This ensures the possibility of further model development and significant application potential.

6. Conclusions

This study addresses a critical challenge in healthcare: improving adaptive planning methods for complex and costly projects under conditions of high uncertainty. Project decisions—especially short-term ones—often carry long-term strategic consequences and must account for rapid environmental changes and ongoing technological transformation in healthcare institutions. AI models offer valuable support for such decision-making by enabling the analysis of diverse, large-scale datasets and integrating various types of knowledge.

A key challenge lies in incorporating tacit, subjective knowledge held by domain experts, project managers, and team members. This highlights the need for advanced AI-based models capable of continuous learning and dynamic adaptation, supported by ever-evolving, interdisciplinary knowledge bases. Such models can

significantly enhance adaptive planning by enabling real-time data mining, knowledge discovery, and knowledge management in intelligent adaptive systems.

The research supports the development of interdisciplinary studies at the intersection of project management and AI. While much existing AI research focuses on clinical applications and decision support for healthcare professionals, there remains a clear gap in applying AI and ICT tools to healthcare project and program management. Strengthening this area within management sciences is both timely and necessary.

The achievement of the research objective lays a foundation for advancing adaptive planning in healthcare through AI. Particularly promising are avenues exploring innovative planning paradigms, such as incorporating exploratory thinking and generative AI techniques. These can enhance strategic change management and contribute to long-term project success.

Future research should focus on refining these models and tools, with special attention to generative AI as a means of improving adaptability and innovation in planning processes. This approach holds strong potential for fostering more resilient, knowledge-driven project environments in the healthcare sector.

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AI declaration: AI tools were used in the computer modeling and simulation processes described in this paper.

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Analyzing the Societal Impact of Academic Research Using Fuzzy Inference Models

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Abstract: Improving universities' social impact is a significant problem in the higher education sector, which can be solved by appropriately shaping public policies, strategies of individual scientific organizations, and academic practices. Effectively conducting social impact analyses can support improving organizations' functioning mechanisms and individual academics' impact practices. These analyses can use data analysis methods and systems that are helpful for better understanding the positive or negative effects of decisions regarding selecting organizational impact strategies. The study of social impact and interactions between scientific organizations and their stakeholders is multifaceted and complex. Therefore, it requires the use of interdisciplinary approaches and sophisticated knowledge-based models. It is worth paying attention to fuzzy logic, which is useful in building such models and developing research on their application to support knowledge management necessary for conducting comprehensive analyses of the social impact of various scientific organizations. This is justified by the need to learn about the mechanisms of functioning systems of relations between scientific organizations and their stakeholders, as well as the types of influence occurring and knowledge exchange during the implemented interaction processes. The pace of changes in the scientific community environment forces an increase in openness for introducing analysis models adequate for the dynamic progress in developing new computational technologies. The main goal of this paper is to create a fuzzy inference model that helps support knowledge management for ongoing analysis and assessment of the social impact of research. The presented theoretical considerations, relating to the construction of the proposed model, are supplemented with a proposal for its implementation, which may later facilitate extensive verification studies based on empirical data. The obtained preliminary research results allow for the formulation of fundamental limitations, the overcoming of which creates a reasonable basis for further development of research on subsequent models of the analysis of social impact.

Keywords: Societal impact analysis, Social impact of academic research, Knowledge-based models, Knowledge management, Fuzzy logic

1. Introduction

Assessing research practices as sufficient is not simple because they refer to symbolic capital based on social recognition and knowledge (Bourdieu et al., 2004). An effective social impact analysis is crucial for improving research strategies by academic institutions and commercial organizations, and shapes the attitudes of individual researchers. Publicly funded institutions in the United Kingdom and Australia have considerable experience with social impact analysis and drawing practical conclusions. Various other countries have also recently introduced or accumulated experience with difficulties in understanding concepts, terminology, and conducting informed analysis.

Performing such analyses is not a straightforward task because the relationships between scientific organizations and their environment and stakeholders are complex and multifaceted. This entails the need to rely on expert opinions or complex methods and systems for data analysis. The problem of analyzing and assessing the societal impact of research is still insufficiently researched, and no proper solution has been found to date. The concept of "impact" is ambiguous and defined differently in individual countries that develop public instruments and assessment systems for improving scientific research supported by public funds. In the case of some systems, the importance of "engagement or partnerships" with nonacademic surroundings is emphasized (in the Netherlands and Poland), improving "outreach" (Portugal) or relationships with the "socioeconomic environment" (France) and, for others, the key terms are "third mission of the universities" (Belgium and Italy), "valorization" (Belgium and France), "knowledge utilization" (the Netherlands) or "knowledge exchange" (Hungary) (Bandola-Gill et al., 2021). Interesting methodological approaches, which can assess the socioeconomic impact of academic research, are being developed in countries where there are no nationwide research impact assessment systems that are modelled on the British Research Excellence Framework or the Australian Excellence in Research. Instead, specific proposals and solutions are being formulated and developed that improve approaches based on knowledge management and adaptive learning systems, the use of which is to support better practices for analyzing and realizing impact (Phipps et al., 2024).

It is noteworthy that, in this context, frequent attention is paid to issues relating to knowledge management. Among the many possible solutions, interdisciplinary approaches and complex knowledge-based models, e.g.,

using new computational technologies and AI, may look promising. The use of interdisciplinary approaches and AI technologies enables the implementation of knowledge-based systems, which allow for intelligent data analysis with the support of methods that help the generation of decision rules based on incomplete and uncertain empirical data. Among such methods, there are mathematically inspired solutions of a symbolic nature, such as fuzzy logic. Mathematical tools based on this type of logic are proven mathematical tools that are useful in many different applications and for creating models with interesting properties. They can support the collection and management of knowledge that is beneficial for the implementation of multi-aspect analyses of the social impact of research conducted by scientific organizations. The dynamic development of new computational technologies and artificial intelligence justifies the proposal to use such models. The use of fuzzy knowledge-based models enables support for knowledge management regarding social impact, exploration of highly complex relationships between scientific organizations and their immediate and distant environment, and learning about the mechanisms of knowledge exchange relating to the implementation of interaction processes.

The main goal of this paper is to create a fuzzy inference model that helps support a knowledge management scheme for ongoing analysis and assessment of the social impact of research. The knowledge used is represented in the form of fuzzy if-then rules. The knowledge base built from these rules can be continuously updated thanks to a feedback loop. Theoretical considerations concerning the basics of design and implementation of the proposed model are presented. The theoretical content is supplemented with practical remarks that may be useful during the implementation of later broader studies devoted to empirical verification of the proposed model. Conducting the preliminary studies described in this paper allows us to outline the limitations and challenges, which will possibly be overcome thanks to further progress in research on increasingly perfect models of social influence analysis.

2. Analyzing the Societal Impact of Academic Research

Increasingly more universities are preparing reports on their research, teaching, and service activities in the context of the United Nations Sustainable Development Goals (UN SDGs). This is seen as having real benefits, e.g., improving reputation, strengthening university engagement with stakeholders, supporting innovative research, and promoting transdisciplinary research ideas. However, it is not a simple task to achieve; comments from skeptics sometimes include accusations of greenwashing (De Villiers et al., 2025).

Among the UN SDGs, the social aspects of the activities of universities play an important role. In recent years, it has become possible to observe the growing importance of analyses concerning these aspects performed in terms of improving the quality of research and their significance for the environment of scientific institutions. In particular, growing interest is being aroused by the issues of the societal impact of research and performance-driven assessment technologies, which are conducted to improve the quality of research, and the rationality of decision-making regarding the expenditure of public funds for these purposes and stimulating the global competitiveness of research centers. The development of methodological foundations (i.e., research quality indicators and measures and methods of impact assessment) for the correct conduct of these analyses not only promotes the development of competitiveness but also facilitates the construction of a foundation for a responsible and measurable contribution to the knowledge-based economy. In addition, it helps in the commercialization of scientific research results at various levels: organizational, national, and international (Oancea, 2019).

nalyzing and assessing the societal impact of academic research is not an easy task. There are currently lively debates on understanding the basic concepts and terminology used. Key topics discussed in these discussions include the real possibilities of influencing nonacademic audiences and the negative consequences of improperly defining and formalizing impact for the purposes of analyses conducted within research funding systems. In particular, the unclear distinction of impact relating to outcomes (e.g., socioeconomic effects) or emphasizing the importance of selected processes (i.e., partnerships, engagement, or knowledge transfer, exchange, and utilization) (Bandola-Gill et al., 2021). It is worth paying attention to the aspect of streamlining the process of transferring generated scientific knowledge to society and improving the achieved societal impact as a result of increasing engagement with research stakeholders (Azagra-Caro & Boni, 2023).

Leading British solutions relating to the analysis and assessment of the impact of scholarly work outside of academia (the results of which are linked to public research funding) were introduced as part of the Impact Agenda and Research Excellence Framework 2014. The results of such analyses provoke lively discussions on science policy and the development of innovation, and even the possibility of formulating recommendations for decision-makers on how to democratize research impact assessments, supporting equitable and inclusive

research impact to increase equity in academic careers (Araci & Ozbilgin, 2025). The British solution has become a model to follow in various countries with significantly different public finance capabilities and science systems. The results of comparative analyses of, e.g., UK, Poland, and Norway indicate the need for further in-depth research on improving the methods used and adapting them to national realities, not only in terms of refining definitions and evaluation criteria but also aspects relating to specific features of academic culture (Wróblewska, 2024).

It is difficult to develop approaches, methods, and tools that support the analysis and assessment of social impact due to the aforementioned cultural diversity, difficulties in understanding the heterogeneity of cultural tools, and the need to take into account the existing nondeterministic mechanisms that prevent the simple application of patterns of thinking and behavior regarding explicit and implicit expectations (Williams & Michalska, 2024). Another challenge signaled in the literature is the need to move away from traditional and exclusively retrospective methods of analyzing the impact of research in the event of global or international crisis situations (e.g., relating to the coronavirus pandemic) toward iterative approaches enabling semiautomatic rapid ongoing assessment and the implementation of rapid responses of national research systems to crisis situations (Baaden et al., 2024). Intelligent systems using fuzzy logic are well suited to supporting the solving of poorly structured problems in an automated and expert-based manner. They are the subject of the next section.

3. Applying Fuzzy Inference-Based Models

Fuzzy rules can be used to represent and store knowledge from domain experts conducting multicriteria analyses and assessments of the societal impact of academic research. Empirical data from evaluators in such a situation constitutes the basis for discovering knowledge, which is then recorded in the form of rules. Knowledge recorded in this way reflects the experiences and hidden motivations of experts who make decisions in specific situations, based on reasons that are not always clear, and in specific conditions of a dynamically changing environment.

Fuzzy logic is the basis for the development of research relating to soft computational methods, which are very useful in cases where the studied problem is imprecisely described and difficult to estimate using quantitative methods. This is a typical situation for many issues in the field of analyzing social phenomena and problems. This type of logic allows for expanding the scope of possible research and complementing available approaches and methods that are important for fundamental support of the creation of knowledge systems, which are useful in supporting the solution of decision problems under conditions of uncertainty, for which domain expert knowledge is required.

Fuzzy logic facilitates the implementation of intelligent and complex systems operating in accordance with human-like reasoning. It finds numerous applications in solving problems requiring interpretation, analysis, and evaluation of phenomena relating to the inherent ambiguities concerning social aspects, for which it is necessary to use imprecise and uncertain data (Sekhi et al., 2025). The aforementioned properties of fuzzy logic mean that it is suitable for implementing multicriteria analysis and evaluation processes of the societal impact of academic research, for which deterministic methods based on two-valued logic and classical set theory are inappropriate. Classical solutions do not accept the uncertain assignment of objects to sets, generalizations, and gradation of estimated values of variables. In the case of classical set theory, objects should be precisely and unambiguously assigned to sets. For the newer theory of elements, this approach is different, and some objects may partially belong to defined sets. In the case of analyzing the societal impact, it is necessary to use ambiguous and incomplete data, as well as to use inference tools under conditions of uncertainty. Fuzzy methods are used to solve many problems, the solution of which is impossible or unprofitable using standard mathematical models.

Fuzzy logic is the basis for proposing approaches to reasoning based on imprecise conclusions and building knowledge bases about objects characterized by fuzzy attributes; knowledge is represented using fuzzy if-then rules. Knowledge recorded in databases is understandable to humans thanks to readable forms. This formal representation of knowledge assumes its recognition in the form of information granules. Knowledge granularity and fuzzy information enable its practically useful modeling using the following categories of sets: classical (crisp) and fuzzy. Such a view of sets constitutes, as well as granulation, knowledge organization, and causation, the basis of human-centric computing analogous to human cognition (Zadeh, 1997). Granular fuzzy logic systems can be used to store various types of knowledge and effectively support knowledge management processes thanks to the previously developed mathematical tools and algorithms for learning, discovering, and

generalizing knowledge, on the basis of which it is possible to infer and draw practically useful conclusions (Pedrycz & Song, 2012). Granular fuzzy rule-based models often achieve high levels of accuracy, significant interpretability, prediction intervals with sound robustness, and high granular performance (Pang et al., 2022).

In the granular rule modeling systems discussed here, fuzzy sets are the basis for designing and implementing knowledge-based fuzzy systems. Knowledge is represented in the form of if-then rules constructed with antecedents and consequences: IF x is A THEN y is B. In these rules, x and y are variables that have linguistic values A and B in accordance with the concept of fuzzy sets (Zadeh, 1965). There is a vast literature available on the applications of artificial intelligence supporting knowledge management processes (Girón et al., 2025). AI technologies are generally used for intelligent information processing and, within such applications, various research areas relating to fuzzy reasoning can be observed (Zhang, 2025). Fuzzy logic is the basis for the development of systems supporting knowledge management in various areas, e.g., supply chain management (SCM) (Ettahiri & Elmaallam, 2019), demand forecasting in SCM (Subramanian et al., 2025), knowledge-based stakeholder analysis (Grzeszczyk & Kuchta, 2021), performance measurement systems (Lee & Wong, 2017), formulating actionable recommendations based on analyses of complex decision-making scenarios for infrastructure projects (Hajimirzajan et al., 2025) and benchmarking the knowledge management performance in companies (Kale & Karaman, 2011).

The most commonly used solutions based on fuzzy logic include fuzzy inference models, which are known for their use in fuzzy control and generating decision rules useful in various applications in decision support systems. For the years 2004–2024 and the keywords “fuzzy inference systems” and “decision support systems,” 417 results were obtained for the search conducted in April 2025 in the Scopus database (including Article Title, Abstract, and Keywords). An upward trend is noticeable in this time series, illustrating the number of publications. The largest number of publications was assigned to the fields of computer science (60%) and engineering (43%). Relatively few in decision sciences (6%), business, management, and accounting (6%), and social sciences (5%). This results in significant research potential regarding the applications of fuzzy inference systems in decision support in business, management, and economics.

Fuzzy inference models are suitable for solving classification and regression problems, enabling the discovery and accumulation of knowledge from imprecise empirical data in a way inspired by human reasoning. They are well suited for representing nonlinear relationships between input variables and output variables, and for solving decision problems involving subjective factors, attitudes, and circumstances, e.g., regarding mergers and acquisitions processes for acquirer and deal-specific factors (Campbell et al., 2016). Fuzzy logic also supports analyses where variables are not precisely defined. Fuzzy inference models are also a proven tool useful for implementing effective prediction methods and management control systems for enterprises (Nasiboglu & Nasibov, 2025; Nicolas et al., 2021).

Intelligent fuzzy inference systems require defining input and output linguistic variables, as well as the knowledge base, which is built on fuzzy rules. Their operation requires converting crisp input values into fuzzy values. The operation of a typical model is based on three stages of the following sequence of actions: fuzzification, inference, and defuzzification. The first stage concerns determining the membership grade of crisp input datasets, while the second stage involves the resulting membership function based on the input membership grades. The last stage concerns outputting crisp values corresponding to the modified membership function of conclusions (Gomes & Basilio, 2024).

Knowledge-based fuzzy systems operating in accordance with the idea of fuzzy inference models are useful for supporting the analysis and assessment of the societal impact of research. This is particularly justified due to the complexity and variability of the problems studied, the turbulent nature of the organization’s environment resulting from, among others, the frequently changing requirements of sponsors and regulations, as well as the growing competition between scientific institutions. The high pace of change and the dynamic nature of the processes of analysis and assessment of social impact require the provision of tool support for experts in the form of intelligent systems based on the discovery and collection of domain expert knowledge. The processes of managing this knowledge are very complex, requiring the processing of ambiguous, inaccurate, and uncertain data. Progress in this type of research can be achieved through experiments with a selected model of fuzzy logic, which is the subject of the next section of this paper.

4. Methodology and Results

Research was performed to find answers to the following research question: What is the need and possibility of using fuzzy inference models for analyzing the societal impact of academic research? Finding answers to such a question allows for obtaining the effects of a theoretical, cognitive, and application nature.

The following assumptions were adopted for the developed fuzzy inference model:

- a multi-aspect approach, which ensures taking into account various quantitative and qualitative variables,
- universality of the model expressed in terms of the possibility of its application at various levels—individual research teams and entire organizations,
- primacy of the learning process over the static use of knowledge resources,
- feedback allows for continuous updating of the knowledge base and dynamic adaptation to occurring changes,
- based on a systemic approach integrating interdisciplinary solutions,
- two-stage design—from a general model to a formalized form facilitating its implementation,
- preliminary experiments covering implementation and initial verification using empirical data,
- knowledge base regarding objects characterized by fuzzy attributes with knowledge that is represented using fuzzy if-then rules,
- use of the Sugeno-type model as a fuzzy inference system,
- fuzzy logic allows for taking into account the ambiguity and uncertainty characteristics of different expert opinions regarding the societal impact of research,
- empirical basis for model verification is experience relating to knowledge discovery and multicriteria analysis.

The integrative nature of systems research offers valuable opportunities for developing models that draw on interdisciplinary approaches to address the complex challenge of assessing the social impact of research (Grzeszczyk, 2025). To support this effort, new socio-technical decision support systems should be designed to meet the evolving demands of a paradigm shift toward decision-making frameworks that systematically incorporate social and ethical considerations (Raza, 2022).

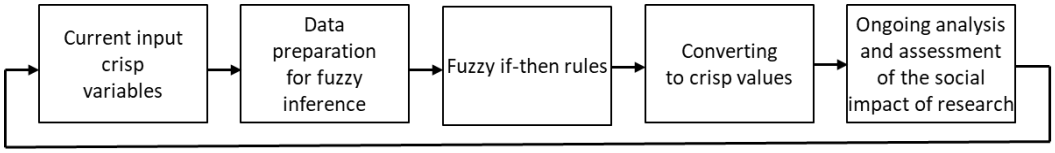


Figure 1: Fuzzy inference model for ongoing analysis and assessment of the social impact of research

The results of the modeling processes were presented in the form of a model of the system for collecting and sharing technological knowledge based on specific mathematical and computer solutions (Figure 1). Data analysis using the method based on fuzzy logic allows for taking into account the ambiguity, vagueness, and uncertainty characteristic of empirical data relating to different expert opinions on emerging technologies. In particular, the Sugeno-type model was used as the fuzzy inference system.

The process begins with current input crisp variables, which represent measurable indicators relevant to societal outcomes. These inputs undergo data preparation for fuzzy inference, where they are transformed into fuzzy numbers through a fuzzification process. Using fuzzy if-then rules, the inference engine evaluates these fuzzy values against expert-defined logical conditions that model the relationships among social factors. The resulting fuzzy outputs are then translated back into interpretable, actionable figures through defuzzification, a process of converting to crisp values. These outputs represent the assessed impact in a form suitable for reporting or policy guidance. The final step, ongoing analysis and assessment of the social impact of research, involves interpreting these results in context and using them to inform strategy or resource allocation. A feedback loop links this final stage back to the beginning, enabling the refinement of rules and input variables based on observed outcomes, thus enhancing the relevance and accuracy of future assessments. This cyclical process supports dynamic, evidence-based evaluation in the social sciences.

The model implementation was performed using the fuzzy logic toolbox from MATLAB Software, which implemented the Sugeno knowledge base in accordance with available best practices (Sivanandam et al., 2007). The use of proven mathematical and computer tools based on fuzzy logic when designing a formalized

form of the model creates conditions for further development of methodological research relating to subsequent implementations and further improvement of the proposed solutions.

The problem of assessing social impact is largely heuristic in nature because the processed empirical data originates from, e.g., experts who make decisions based on personal experiences reflecting subjective hidden knowledge. Knowledge gathered in the knowledge base is created mainly as a result of its discovery from empirical data in the learning process. Knowledge is saved in the base in the form of fuzzy if-then rules and is continuously updated thanks to the use of a feedback loop. The experimental implementation of the model and the obtained preliminary results from its examination confirmed the practical usefulness of the proposed solution.

5. Conclusions

As part of the research synthetically presented in this paper, a model based on the Sugeno-type fuzzy inference system was developed, which is used to support the analysis and assessment of the societal impact of academic research. Theoretical considerations were enriched with a proposal for experimental implementation and application of the model. The conducted research aimed to find an answer to the research question regarding the possibility and validity of using fuzzy logic models in this field. The use of a systemic approach facilitated the interdisciplinary theoretical analysis of the model, as well as the demonstration of its practical usefulness during empirical experiments.

Advances in artificial intelligence and machine learning may influence the development of further methodological research in this field. In future processes for improving the proposed model, it is worth examining other available information technology solutions, developing subsequent models toward integrated solutions that are characterized by the desired features of dynamic, holistic systems, and to a greater extent, taking into account diverse groups of stakeholders. These considerations require an approach enriched with various types of feedback, so that the developed model not only provides correct analysis results but is also a source of recommendations facilitating the taking of actions improving the societal impact of academic research.

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AI declaration: AI tools were used in the modeling processes described in this paper.

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Effective Knowledge Creation and Transfer in e-Learning Using SECI Model

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Abstract: With the growing use of e-learning in corporate environments, it is essential to explore its potential and limitations in the context of effective knowledge management. This study investigates how online courses facilitate the creation and transfer of explicit and tacit knowledge, employing the SECI (Socialization, Externalization, Combination, and Internalization) model as a theoretical framework. Based on exploratory interviews with e-learning designers conducted in early 2025, the study reveals that each SECI phase requires different strategies and tools. In the socialization phase, "learning by interacting" is key. Online interactions must be thoughtfully designed and moderated, as the lack of spontaneous dialogue can reduce learning effectiveness. In the externalization phase, "learning by exchanging" is essential, yet can be hindered by limited incentives, LMS constraints, and the absence of open environments for knowledge sharing. Including motivators like graded forum activity can help. The combination phase emphasizes "learning by creating," but assessing creativity online—especially in large courses—is challenging. This can be addressed through collaborative tasks and AI-supported feedback. The internalization phase focuses on "learning by doing," requiring opportunities for practical application, such as XR simulations or prototype development. A key insight is that the main barrier to applying the SECI model in e-learning is not technology itself, but limited instructional design expertise. Technology should support, not drive, the learning process. These findings offer practical guidance for trainers, instructional designers, HR specialists, and leaders aiming to improve e-learning strategies for knowledge management.

Keywords: e-Learning, Online learning, Knowledge management, SECI model, Instructional design

1. Introduction

E-learning refers to the use of digital technologies and internet-based resources to deliver educational content, support interaction, and facilitate learning processes independent of time and location (Garrison 2003; Moore et al, 2011). The global corporate e-learning market size is calculated at USD 10.20 billion in 2025 and is forecasted to reach around USD 14.63 billion by 2034, accelerating at a Compound Annual Growth Rate (CAGR) of 4.09% from 2025 to 2034 (Precedence Research 2024). An increasing number of organizations worldwide are adopting e-learning as a strategic tool for employee training, driven not only by the need to reduce training costs but also by the demand for greater flexibility in terms of time and location. E-learning enables scalable and consistent delivery of content, making it particularly effective for training geographically dispersed teams operating across different institutions, regions, or even countries. Moreover, it facilitates access to high-quality instructors and educational materials (Wysłocka 2015, Strother 2002, Woźniak-Zapór 2013), which traditional training methods may not consistently provide. Several factors contribute to this growing trend, including increased employee mobility, the prevalence of remote and hybrid work arrangements, broader societal acceptance of digital technologies (Koderi and Kesuma 2023) and the rapid adoption of artificial intelligence, which can significantly improve the quality of remote learning through personalized learning, adaptive assessment and intelligent tutoring (Pattnayak 2017). For this reason, e-learning has become a common component of corporate training programs (Grabania-Mukerji 2011). Companies recognize e-learning as a tool for employee development, increasing productivity (Czarnecka 2015) and the COVID-19 pandemic has only accelerated its implementation (Milic et al 2020, Gamage et al 2022).

Meanwhile, the use of e-learning goes beyond just a tool to support the acquisition of employees' knowledge and skills. In combination with an integrated online learning environment, it has the potential to support knowledge management processes, including creation and transfer of knowledge within an organization. However, accomplishing this requires diagnosing how e-learning can support those processes, as well as identifying specific areas where barriers exist and determining effective strategies to overcome them. Though limited, recent studies increasingly highlight e-learning's potential to support organizational knowledge management (KM). Integrated e-learning significantly enhances knowledge management and positively influences innovation performance (Lau & Tsui 2009, Oloruntoyin 2020, Zahari et al 2024). By combining e-learning platforms with knowledge management practices, organizations can capture, organize, and distribute both training content and organizational knowledge more effectively. E-learning enables organizations to systematically record, store, and archive valuable knowledge, ensuring its accessibility for future use. An online

learning environment facilitates the efficient dissemination of information across diverse organizational levels, departments, and geographical locations. Additionally, online analytics and assessment tools enable managers to evaluate the effectiveness of their training initiatives, measure knowledge retention, and adjust content to meet evolving organizational needs (Derouin et al 2005). Also artificial intelligence can revolutionize e-learning, but collaboration between educators, learners, and technology developers—as well as attention to ethical and pedagogical aspects—is essential (Tanjga 2023). Recent studies highlight that e-learning has become a powerful medium for disseminating knowledge, stimulating innovation, and enhancing organizational intelligence (Soltani et al 2019).

Although research on e-learning continues to grow, a notable gap remains regarding how it specifically supports KM processes within organizations. The above gap has widened even further in recent times, due to the rapid development of AI. Our research contributes to the discussion on knowledge capture, transfer, and development processes, particularly in the context of courses and e-learning platforms, which are becoming increasingly significant tools in organizational knowledge management strategies. In particular, we aimed to demonstrate how online courses facilitate the creation and transfer of both explicit and tacit knowledge. The perspective taken behind the SECI model allowed the identification of key learning phases along with a set of tools and best practices that can be effectively implemented in an online environment. They also made suggestions for AI-based tools. Additionally, we identified significant barriers and challenges that can hinder participants' acquisition of knowledge. The findings offer insights into knowledge conversion and practical guidance for managers.

2. Literature Review

2.1 E-Learning and SECI Model in Knowledge Management

Numerous definitions of Knowledge Management (KM) can be found in the literature. This study adopts the perspective that KM is a systematic process of acquiring, sharing, and effectively utilizing knowledge to achieve an organization’s strategic goals, while recognizing that continuous innovation emerges from the dynamic interplay between tacit and explicit knowledge (Davenport & Prusak 1998, Nonaka & Takeuchi 1995); these form the theoretical framework for this research.

One of the key theories in knowledge management is the SECI spiral model, which explains the processes of knowledge creation and transfer within organizations through the dynamic interaction between tacit and explicit knowledge (Nonaka & Takeuchi 1995). Importantly, these modes do not represent a one-time sequence; rather, each cycle builds on the previous one, allowing knowledge to evolve and deepen through a spiral process that leads to increasingly sophisticated levels of understanding (Nonaka, Toyama, & Konno 2000). The first phase – Socialization – refers to the process of transferring tacit knowledge through shared experiences, observation, imitation, and informal interaction. Externalisation is the process of converting tacit knowledge - personal, context-specific, and hard to formalize - into explicit knowledge that can be communicated and shared with others. Combination constitutes the process of synthesizing and systematizing different pieces of explicit knowledge into more complex and organized sets of information. Finally, Internalisation describes how tacit knowledge is created from explicit knowledge.

Despite its wide application in organizational contexts, there are relatively few studies focusing on the adaptation of the SECI model in e-learning environments. However, several works suggest that its application is both feasible and beneficial. Research indicates that e-learning can effectively support all four SECI processes (Wenhua & Fuhsu 2011, Ahmad et al 2012, Romadhon et al 2022). Empirical evidence further suggests that implementing SECI-based strategies in e-learning environments can enhance cognitive, affective, and psychomotor domains of learners, leading to improved overall educational outcomes (Prasetya & Taroreh 2018).

The SECI model has been applied to evaluate e-learning effectiveness, enhance knowledge management in online environments (Wenhua & Fuhsu 2011, Haag & Duan, 2011), and is increasingly recognized as a suitable framework for analyzing such processes in e-learning systems (Romadhon et al 2022). Moreover, specific metrics and frameworks have been developed to detect and measure SECI processes in virtual environments, enabling more systematic implementation and assessment (Battistoni et al 2011, Luoma et al 2008).

One study highlights that e-learning can foster collective knowledge creation by enabling interaction and collaboration, helping turn tacit knowledge into explicit (Kasem et al., 2015). Researchers have also proposed adaptations of the model, such as the EC-I framework, to better align with individual knowledge development in online learning. The framework focuses on the processes of Externalisation and Combination and the outcomes of Internalisation while excluding Socialisation as less relevant in the online context (Haag & Duan,

2012). Nonetheless, it has become evident since the COVID-19 pandemic that under some conditions, socialisation in e-learning environments is possible. JIhan & Kantola (2012) present a framework of hybrid e-learning, focusing on four key activities: Absorb (acquiring knowledge), Do (practical application), Connect (linking new knowledge with prior experience), and Create (generating new solutions). It should be noted, however, that the proposed categorization is not exhaustive; the selected activities are illustrative rather than comprehensive.

Although the scientific literature provides a few isolated references to the potential use of the SECI model for knowledge management in e-learning, many aspects remain unexplored and insufficiently defined. In particular, there is a noticeable lack of clarity regarding the conditions necessary for the model to function effectively in real online environments. As a result, e-course designers often lack insights into how to plan e-learning experiences that effectively support knowledge creation and transfer processes within companies or institutions. Common barriers also need to be clearly identified, along with practical strategies to overcome them. It is also essential to define structured instructional design recommendations to guide the effective integration of the SECI model into e-learning contexts.

3. Methodology

In our paper, we refer to the results of a study aimed at answering the following research question: how can the SECI model be applied in e-learning design for effective use of both tacit and explicit knowledge in an organization? Our intention was to assess the applicability of the SECI model to e-learning and primarily to explore how the various phases of the model can be effectively implemented in online environments. Additionally, we aimed to identify the primary tools and technologies supporting each phase and to pinpoint the issues and challenges associated with their implementation.

To answer the research question posed, we conducted an exploratory qualitative study. The sampling was purposive and based on typical cases. E-learning course designers were selected for the study, with the main criteria for sample selection being their experience in developing e-learning courses, including years of experience, the number, and type of courses they had designed. The study was conducted in the first quarter of 2025 and included three employees from the Faculty of Management and Economics at Gdańsk University of Technology. Respondents were experienced academic e-learning designers, each with 4–10+ years of experience, specializing in management, programming, and finance, and having designed between 5 and over 10 online courses. The study was based on in-depth, semi-structured personal interviews based on three thematic areas: 1) Conditions for the implementation of each phase of the SECI model, 2) Barriers to implementing a phase of the SECI model, and 3) Directions for developing the SECI model in e-learning. The interviews lasted an average of 70 minutes, and respondents were entitled to confidentiality and anonymity. The primary technique for data analysis and interpretation was conventional qualitative content analysis (Hsieh & Shannon 2005). During this analysis, three main thematic axes emerged within each phase discussed: the key resources and tools, barriers and methods for overcoming them. Then, within these categories, we identified even lower subcategories that allowed us to better understand the specifics of each phase and the conditions that must be met to make the learning process as effective as possible. Due to the nature of these phases and the KM processes occurring in it, we characterized each phase according to the dominant form of learning that came out of the research. Thus, the first phase, Socialization, is based on *learning through interaction*, which occurs between participants during e-learning. Externalisation is a phase that relies mainly on knowledge sharing, which promotes *Learning by Exchanging*. The third phase, Combination, is related to *learning through creativity,* while the fourth phase favours *learning through doing*.

4. Results

Socialization refers to the process of sharing tacit knowledge through common experiences, observation, imitation, and informal interactions. In traditional environments, this typically occurs through direct interpersonal contact, such as mentoring, informal group work and spontaneous face-to-face discussions. In e-learning contexts, however, Socialisation presents a greater challenge due to the lack of physical presence and informal meetings. The key activity that stimulates knowledge transfer in this phase is defined as *Learning by Interacting*. Interaction is a key element of meaningful learning, especially in online environments where traditional face-to-face communication is absent. As our research has shown, some foundational conditions for fostering this process are relatively straightforward to implement, like enabling students to exchange perspectives and engage in reflective dialogue (Tab. 1). In well-designed online courses, interaction can take various forms, including peer-to-peer discussions, collaborative tasks and participation in online communities.

The findings suggest that, despite the availability of digital tools, meaningful interaction in online learning encounters several significant barriers. One major challenge is the difficulty in building natural, spontaneous interactions that typically occur in face-to-face settings. The absence of informal spaces and unplanned conversations often leads to a sense of isolation among learners. Additionally, students may feel reluctant to share ideas publicly due to fear of negative evaluation, especially on discussion forums. Another barrier is the generally low motivation for online teamwork, which can result in passive participation or uneven task distribution. These issues are typically exacerbated when learners are unfamiliar with each other, or when there is no active facilitation from the instructor to encourage trust and engagement within the group. To address the challenge of limited spontaneous conversations and interactions, one effective strategy is to create informal communication spaces, such as dedicated chat channels on platforms like Discord, Slack, or MS Teams. This allows spontaneous conversations and peer interactions to emerge naturally. Virtual co-working spaces can simulate the sense of presence and encourage casual encounters that often lead to the exchange of tacit knowledge. To ease initial interactions and reduce social barriers, icebreakers, interactive activities and rotating small group tasks can help learners become more comfortable and engaged. Additionally, providing structured opportunities for peer feedback and personal introductions supports a sense of belonging. To address learners' fear of judgment, the use of moderated discussion forums, anonymous Q&A features, and collaboratively developed team norms can cultivate a psychologically safe environment. Sustaining motivation in online teamwork can be achieved by forming small teams with clearly defined roles, integrating gamification elements, and designing long-term projects tied to real-world outcomes. Regular monitoring of progress also reinforces commitment and accountability, further enhancing the socialization process in virtual learning contexts.

Externalization is the process of transforming tacit knowledge into explicit knowledge that can be expressed, communicated, and shared with others. In traditional learning environments, this process often occurs through discussions, presentations, and written work, where learners articulate their understanding and make it accessible to their peers and instructors. This not only supports individual cognitive development but also contributes to the collective creation of knowledge. A key activity supporting this phase in e-learning is *Learning by Exchanging*, which emphasizes the importance of mutual engagement in transforming explicit knowledge into tacit understanding. Our research has revealed that in online learning environments, this process is facilitated through structured opportunities for learners to share insights, discuss interpretations, and collaboratively solve problems (Tab. 1). Some foundational conditions include the integration of communication tools—such as forums, chat functions, and video conferencing—within learning management systems, as well as the intentional design of collaborative activities that require critical thinking, knowledge sharing, and reflection. Research highlights that barriers in the externalization phase, such as difficulties importing data from external platforms, can hinder effective knowledge integration by limiting seamless aggregation and reducing the richness of shared content. Another common barrier is the lack of motivation to share knowledge, often stemming from limited incentives, unclear expectations, or the absence of a collaborative culture. Additionally, a lack of trust in peer-generated content can further impede knowledge exchange, as learners may question the credibility or accuracy of materials created by others, leading to reduced engagement. Addressing these issues is crucial for enabling meaningful knowledge transfer. To address common barriers in digital learning environments, various effective solutions can be implemented. For challenges related to importing data from external platforms, institutions can utilize tools that support automatic data synchronization, interoperability, and manual upload templates to streamline processes. When facing low motivation to share knowledge, strategies such as peer-to-peer teaching, graded contributions, and creating a culture of recognition can foster active participation. Establishing a shared and evolving knowledge base, along with peer feedback mechanisms, further encourages engagement. To overcome a lack of trust in peer-generated content, it is essential to implement clear evaluation criteria, assign content moderation roles, and use tagging or verification systems to ensure quality and credibility.

Combination is the process of organizing and integrating explicit knowledge to form more comprehensive understandings. In traditional learning, it occurs through tasks like group reports or projects that merge data and perspectives. Combination involves reconfiguring existing knowledge by sorting, adding, and connecting it in meaningful ways, often resulting in new documents, presentations, or models. In e-learning environments, Combination is closely aligned with process of *Learning by Creating*, where learners apply and synthesize knowledge through active, task-based engagement. From our research, we found that digital tools enable the facilitation of this integration through collaborative assignments, shared documents, and interactive projects (Tab. 1). Activities such as co-authoring reports, developing shared knowledge repositories, or designing user guides help learners reorganize and expand upon previously acquired knowledge. When structured effectively, these tasks can foster deeper understanding and enable the collective construction of new knowledge products.

The findings demonstrate that the combination phase in e-learning faces notable challenges, particularly in assessing learners' creativity and originality in open-ended or exploratory tasks. This challenge is amplified in large-scale online courses, where scalability issues limit the instructor's ability to provide personalized feedback or closely monitor individual contributions. Furthermore, organizing group work in online settings often proves problematic, as learners may struggle with coordinating schedules, dividing responsibilities, and maintaining consistent communication. To address these challenges, a proposition of possible solutions have been identified. Designing group tasks with staged or milestone-based assessments can improve the structure and monitor progress over time, making evaluation more manageable and transparent. Utilizing collaborative editing tools - such as cloud-based document sharing platforms with version tracking - supports real-time and rotational contributions, fostering a more seamless integration of individual efforts. Another effective strategy involves encouraging learners to create user-facing materials such as tutorials, guides, or handbooks, which naturally promote synthesis and application of explicit knowledge in a practical, useful format. Finally, supporting assessment with AI-assisted tools can enhance scalability by automating part of the evaluation process (e.g., detecting redundancy, structure, grammar, or originality), thereby allowing instructors to focus on qualitative aspects such as creativity and critical thinking.

Internalization is the stage of the SECI model that explains how explicit knowledge is transformed into tacit knowledge. Traditional learning environments focus on individuals absorbing and embodying explicit knowledge, such as documents, manuals, or online courses, and transforming it into tacit knowledge through practice, reflection, and experience. A key activity supporting the Internalization phase within the SECI model in e-learning is *Learning by Doing,* which focuses on active engagement and practice. Our research has indicated that in online learning environments, this involves applying theoretical knowledge in practical contexts such as simulations, interactive exercises, case studies, or real-world projects (Tab. 1). These activities help learners internalize concepts by experiencing them firsthand, allowing knowledge to be absorbed through a combination of action and reflection. Foundational conditions for effective learning by doing include well-designed digital tasks that mimic real-life scenarios, clear feedback mechanisms, and opportunities for self-assessment. This experiential approach ensures that knowledge becomes embedded in the learner's own cognitive framework, enhancing both retention and the ability to apply skills in future situations. A significant barrier in the Internalization phase of the SECI model is limited personalized feedback, which prevents learners from adequately reflecting on and assimilating new knowledge. Without personalized guidance and constructive critique, learners may struggle to fully internalize complex concepts, resulting in superficial understanding. Additionally, technical and cost-related difficulties in providing practical experiments and simulations further impede experiential learning. To overcome these barriers, educational practitioners can adopt targeted strategies such as AI-supported evaluation systems, structured peer-review activities, and regular online mentoring sessions. These solutions ensure that learners receive timely, individualized, and meaningful feedback. Practical challenges related to cost and technology can be effectively addressed through leveraging ready-made simulation platforms, integrating comprehensive case study-based assignments, and utilizing virtual laboratory environments, interactive STEM simulation tools, and augmented or virtual reality educational platforms.

Table 1: Implementation conditions, barriers, and solutions in each phase of the SECI model

Phase	Resources and tools	Barriers	Solutions
Socialisation: *Learning by Interacting*	Team communication tools Video conferencing platforms Collaborative tools Platforms for sharing personal profiles Discussion forums Interactive tools for live quizzes	Lack of spontaneous conversations and interactions	Informal chat channels Virtual co-working spaces Icebreakers Rotating small group work Peer feedback Personal introductions
		Fear of being judged	Moderated discussions Anonymous Q&A and feedback Co-created team norm
		Short-lasting motivation for online teamwork	Small groups with clear roles Gamification elements Regular progress monitoring

Phase	Resources and tools	Barriers	Solutions
			Long-term projects with real-world outcomes
Externalisation: *Learning by Exchanging*	Collaboration forums Shared spreadsheets Blogs and reflective journals Platforms with breakout rooms Mind-mapping tools Data transformation tools Online presentations Video/audio recording tools Peer feedback platforms	Difficulty importing data from external platforms and tools	API-based integration tools, Automatic data synchronization, Platforms that support interoperability, Manual upload templates
		Low motivation to share knowledge	Graded contributions Peer-to-peer teaching Culture of recognition and sharing
		Lack of trust in peer-generated content	Clear evaluation criteria Content validation tools Moderators or content curators Tagging and verification systems
Combination: *Learning by Creating*	Project management platforms Collaborative documentation tools Visualization tools Video production editors Shared knowledge base	Difficulties in assessing creativity	Designing group tasks with staged assessment Creative portfolios
		Challenges with multi-user evaluation	Collaborative document editing AI-supported evaluation Rubrics based assessment
		Problems with self-organization of online teamwork	Creation of guides and instructions Contribution tracking systems Partially AI-assisted evaluation
Internalisation: *Learning by Doing*	Virtual laboratories STEM simulation platforms Video conferencing platforms Interactive prototyping apps Peer evaluation tools	Limited personalised feedback	AI-supported evaluation Peer-review Online mentoring sessions
		Technical and cost difficulties in providing experiments and simulations	Ready-made simulation platforms Case study-based assignments

Source: Authors

The key findings of the study are mapped in the figure below (Figure 1), further distinguishing a set of desirable resources, tools, and activities common to all phases analysed.

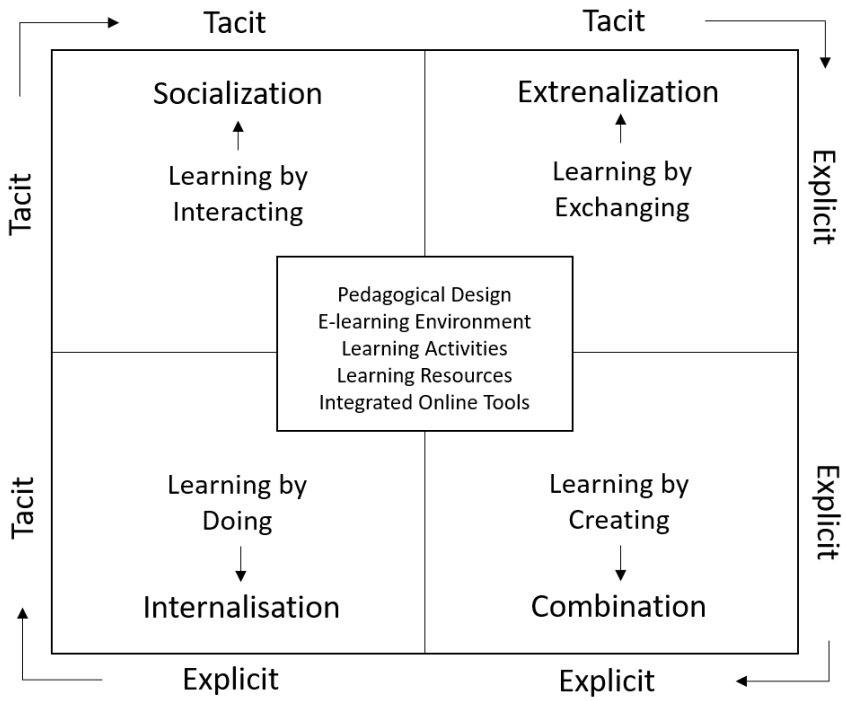


Figure 1: SECI Model for E-learning. Source: Authors elaboration

5. Conclusions and Discussion

Our research expands the existing understanding of KM processes within e-learning environments. It integrates themes related to the explicit and tacit conversion of knowledge while examining e-learning through the lens of various learning modalities. By bridging these perspectives, our study provides a more comprehensive view of how knowledge is created, shared, and internalized in digital learning contexts. Furthermore, it explores the dynamic interplay between formal and informal learning processes, emphasizing the role of technology in facilitating knowledge transfer and collaboration. Through this multidimensional approach, our findings contribute to both theoretical discussions and practical applications in the field of e-learning and knowledge management. Our research also carries significant practical implications. The framework adopted from the SECI model has identified key phases of the learning process, along with a set of tools and best practices that can be effectively implemented in online environments, among which were also tools based on AI. By systematically mapping these phases, our study provides actionable insights into how organizations can optimize knowledge conversion and dissemination in digital learning settings. By bridging theoretical models with practical applications, our research offers a valuable roadmap for educators, e-learning course designers, and managers seeking to enhance knowledge management strategies in digital education.

Our study represents an exploration of the designated area and, as such, creates a foundation for further, more in-depth research. Consequently, it has several limitations, including a small sample size, high contextual dependency, and limited research tools, which prevent broad generalizations. However, it provides valuable insights that can serve as a basis for future studies. Future research should focus on evaluating the effectiveness of the SECI model in e-learning environments. Importantly, future studies should also explore how emerging AI tools—including adaptive learning paths, AI-supported feedback systems, and AI-driven content generation—can enhance each phase of the SECI model, thereby advancing knowledge management in digital education. There is also a need to develop and test innovative didactic methods, experimenting with various instructional strategies tailored to the specific dynamics of online learning. Additionally, conducting case studies of SECI model implementation across various corporate sectors could provide valuable insights into its adaptability and impact in non-academic contexts. Such studies would contribute to a deeper understanding of how knowledge creation processes can be enhanced through e-learning across diverse organizational settings.

Ethics statement: Ethical clearance was not required for the research.

AI statement: AI (ChatGPT) was utilized to assist in refining grammar, enhancing language clarity, and improving overall readability. Authors confirm that AI tools did not contribute to generating the research data, analysis, or

core intellectual content presented herein. The final responsibility for the content and its accuracy rests solely with the author.

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The Magic of One-Day Music Camps: How Reproduce the Magic in Academia?

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Abstract: Music camps are intensive one-day seminars where students are tasked with creating lyrics, composing melodies, and producing a song within 11 hours. This experience is demanding for both the students and the faculty. Faculty members must be experienced and adept at monitoring the progress of the various groups, providing different inputs based on each group's advancement. The music camps follow a sequence of activities designed to facilitate song development and production within the given time frame. Over three years of longitudinal study on the music camp practice during the first year of the Bachelor program in Music Business and Production at the Business School of the University of Inland Norway, students have unanimously agreed that it is a highly effective learning experience. Is this possible to utilize in other parts of academia? What needs to be considered if this approach is to be successfully implemented? Hence, how can this approach be applied to other courses and curricula? In this paper we explore the possibilities and seek to suggest some possible solutions for successful integration it into different curricula.

Keywords: Reflective practice, Knowledge sharing, Supervision, Evaluation

1. Introduction

The Bachelor of Music Business and Production program at the University of Inland Norway provides students with a comprehensive education that prepares them for various roles in the music industry, such as artists, singer-songwriters, managers or producers. A key pedagogical feature introduced in this program is the organization of one-day music camps. These camps begin at 10:00 AM with a presentation of the "theme of the day" and conclude with a listening session where students receive feedback on their work, which should include a song recording and lyrics. Throughout the day, students receive feedback and guidance to aid their development.

Students report that these pedagogical approaches have significantly enhanced their understanding of the curriculum (Vold et al., 2022). However, it is not only the students who benefit; the lecturers have also become reflective practitioners by examining their own behaviours, actions, and practices (Vold et al., 2024). This process resembles action research, where both researchers and participants engage in a co-generative learning experience (Greenwood and Levin, 2007).

Another aspect discussed about these camps is how they simulate the "real world." Students in the Bachelor program gain valuable experiences that they can carry into their future careers. Observing this pedagogical activity over several years and recognizing its impact on student learning outcomes led to the idea of applying its framework to other courses beyond the Bachelor of Music Business and Production. To explore this possibility, a detailed analysis of the activity and its specific features was necessary.

1.1 The Camps

The major outline of the activity is about preparations prior to the camp, then to conduct the camp, and then there were reflective activities to evaluate the camp:

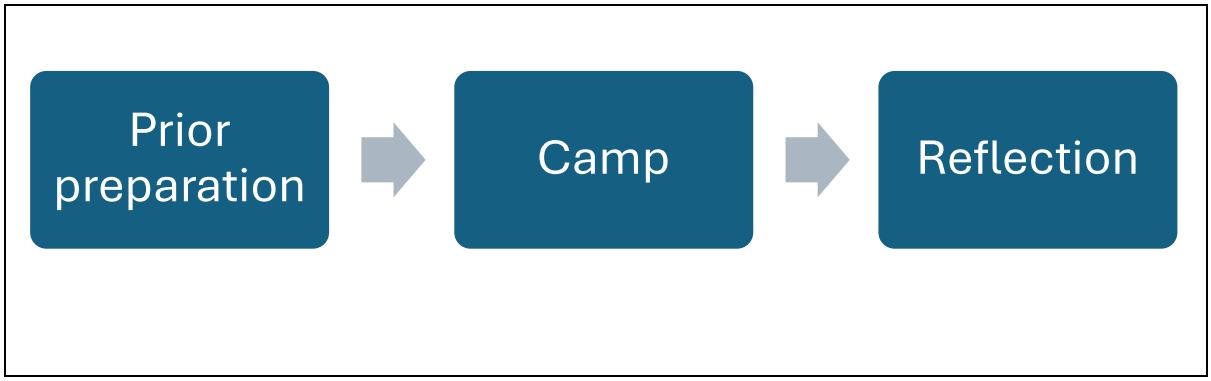


Figure 1: Outline of pedagogical activity

These activities contain sub-activities. The prior preparation includes an overview of the participants and dividing them into groups based on their (self-reported and observed competencies), and sometimes to lecture on a certain genre and then prepare an assignment based on the learning take aways from the lecture:

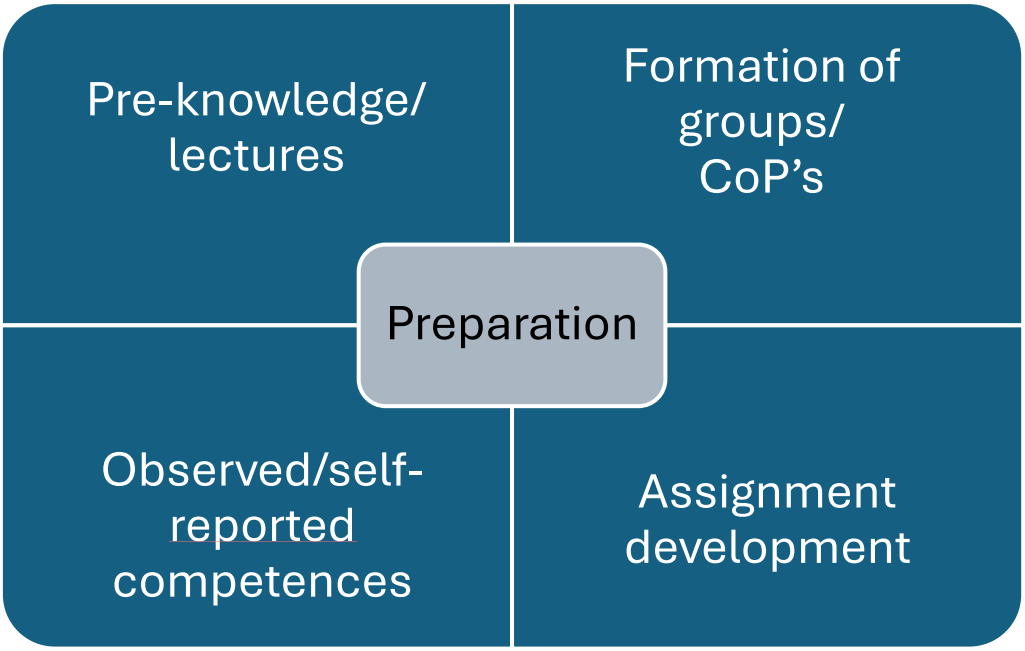


Figure 2: Preparation phase

The camp typically begins at 10 AM and concludes at 9 PM. The lecturers' activities include presenting the assignment, supervising student progress, evaluating the work, providing feedback, and conducting a brief reflective summary after the camp. For the students, the focus is on interpreting the assignment, collaborating with peers in designated groups to develop a song with lyrics that adhere to the genre's "rules," and submitting the completed work.

Table 1: Timetable for camp

Approx. time	Activity – lecturers	Activity - students
10AM – 10.30 AM	Presentation of assignment and outline of the day	Receiving and Interpreting assignment
10.30 AM – 7PM	Supervision based on experiences from previous camps	Working on the assignment in the designated groups
7PM		Handing in the product(s)
7PM-8PM	Evaluate products to provide feedback	
8PM – 9PM	Listening session with feedback	Listening session with feedback
9PM	Round up	

The reflection that occurs after the camp is an activity initiated by the researchers. Lecturers have found this very beneficial, as it has contributed to their development as reflective practitioners (Vold et al., 2024). In fact, their awareness of the timelines, students should follow to complete their tasks has improved, enhancing their understanding of the processes involved in song development.

1.2 Research Question

Our research is ongoing, and we are still investigating possible implementations and therefore, we have still not obtained satisfying answers to all our questions. Our primary research question is:

How can the camp activity be implemented in other courses?

This leads to additional practical questions:

- What curriculum would be suitable for this type of activity? (RQ 1)
- What constraints will apply to the different activities (as shown in Figure 1)? (RQ2)
- What supervision guidelines should be established for the activities in this particular course curriculum within a camp setting? (RQ3)

Additionally, since the research on music camps has supported the lecturers' growth as reflective practitioners, another question arises:

- How can reflection processes after the camps be integrated into the overall program, rather than being isolated as a research activity? (RQ 4)

In the following sections, we will present the theoretical framework that has informed our study, followed by an explanation of our data collection methods. We will then present our results and discussion before concluding and suggesting areas for further research.

2. Theoretical Foundation

Here we will present the theory that has enlighten our study.

2.1 Communities of Practice

The groups can resemble communities of practice, as they are organized based on self-reported and lecturer-observed skills relevant to the tasks at hand. Each group must possess diverse skills, as few individuals excel in all areas. Therefore, the groups require members to produce, write lyrics, and develop melodies. Depending on the task, one person may be central to the community, while others will participate legitimately on the periphery (Lave and Wenger, 1991). Consequently, lecturers must tailor supervision to the various individuals within the group.

Translating this concept to different course settings means having a detailed overview of the tasks and their components. Tasks may consist of parts that require specialized competencies or skills, necessitating groups composed of students with diverse abilities. This means students must be informed about the required competencies and skills to self-report, and lecturers must observe these skills if possible.

Music Camp and its organization function as a "training ground," according to Senge (1992). It highlights how organizations establish setups for practice and reflection on results. "Such training grounds are integral to core activities in music, theater, sports, and certain professions that use simulation as practice through specialized laboratories. A cockpit crew, for example, can learn critical skills in safe environments using simulators. The genuine learning advantage is the ability to test new methods and approaches without the risk of negative outcomes" (Paulsen, 2021).

Activities at Music Camp closely align with Paulsen's theory of groups as learning workshops (Paulsen, 2021). Natural arenas for testing ideas are not always accessible to those not established in the music industry, often leading to uncertainty and risk. Having access to environments where one can test, experiment, and learn—even from mistakes—is undoubtedly beneficial. Music Camp serves as a training ground where practice situations can be explored through trial and error. Developing knowledge about what works and doesn't in a supportive group environment fosters psychological safety, a crucial prerequisite for learning.

The figure below illustrates a possible way of working within the groups. By analysing the problem, proposing solutions, selecting and testing a few ideas, and then discussing the outcomes (experience sharing), students can generate ideas for moving forward.

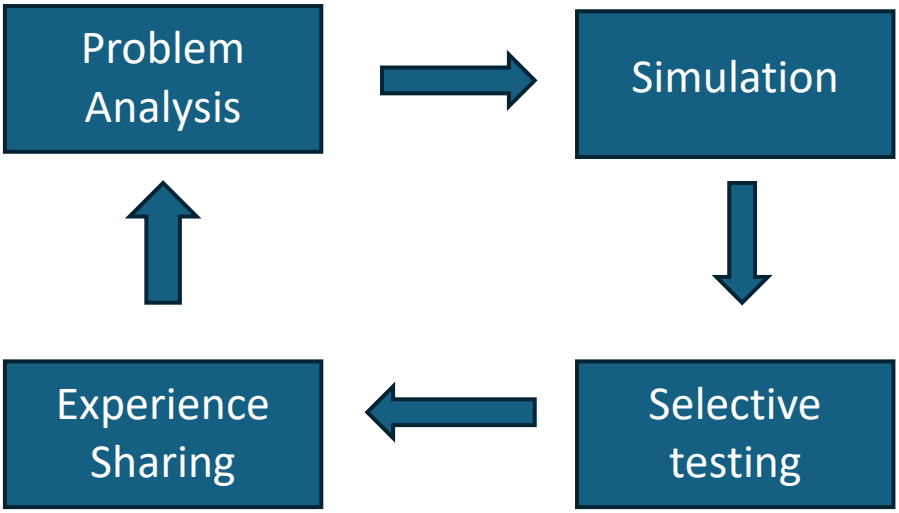


Figure 3: Adapted from Paulsen (2019)

2.2 Dialogue

Working in groups, or "communities," requires dialogue. In the music camps, this dialogue is structured by the lecturers, who establish rules for group interaction. The most prominent rule is to avoid negativity towards emerging ideas. If a group member disagrees, they must explain their reasoning in a friendly manner and offer a counter-suggestion. This ensures that all ideas are considered rather than being immediately dismissed. The dialogue resembles a democratic dialogue (Gustavsen, 1985, Gustavsen, 2016), where participants are equals and engage in give-and-take interactions to "generate decisions that provide platforms for joint action" (p. 190). Democratic dialogue also involves encouraging active participation from all group members and recognizing when another argument may be superior to one's own (Gustavsen, 2016). These moments from Gustavsen (2016) are largely in accordance with several of Habermas's 5 principles of good communication, where the first requirement is generality. The participants cannot exclude anyone who has an interest in the matter concerned. The second is autonomy. All parties expect to have the same possibilities to express their opinions and criticize the validity of others' statements. The third requirement is about ideal role taking. The members of the group must be willing to understand others' validity. The fourth requirement is power neutrality. The difference of power must be neutralized among the participants. The fifth requirement is transparency. All parties must be open about their goals and aims, and avoid strategic operations such as hidden agendas, manipulation and power struggle (Eriksen and Weigård, 2003). Establishing psychological safety is crucial for enabling this dialogue (Edmondson et al., 2016). This should be part of the community's rules and can also be integrated into how lectures are organized in the traditional classroom setting. Creating a "safe environment" for active participation in both digital and physical classrooms is essential.

2.3 The Importance of Reflection

Reflection is essential to learning. Teaching students about reflection and its impact on comprehension and development is crucial. According to Di Stefano et al. (2016), reflection enhances one's "ability to deal with a task" and improves "understanding of the task to drive actual performance."

Kolb (1984), building on Dewey (1938), described the "experiential learning cycle," where active experimentation requires abstract conceptualization and reflection to achieve learning outcomes. Moon (2004b) defined reflective learning or writing in an academic or educational context as involving a deliberate and clearly defined purpose, with intended outcomes related to learning, action, or clarification. This process often begins with an explanation of the reflection's purpose or subject matter and usually culminates in a documented form, such as a written piece, which is shared with others and subject to evaluation. These elements can significantly influence the nature and quality of the reflective exercise.

Donald Schön's seminal work has laid the foundation for understanding reflection. His exploration of the reflective practitioner and the timing and methods of reflection has profoundly impacted our comprehension of reflection as a learning tool. Reflecting in, and on, learning—whether in action, on action, or on action in action (Schön, 1987, Schön, 1991)—has proven invaluable for translating learning into a work setting.

Therefore, it is vital to facilitate reflective processes to support learning in a way that allows students to apply their knowledge effectively in their workplaces.

3. Methodological Approach

The work and discussions presented in this paper are the result of research and reflection conducted over several years (2021-2025). We are a group of three researchers who have been studying a BA-degree program in music business and production, focusing primarily on the music camps component. In their second academic year, the program organizes five camps. Each student group consists of approximately 20-25 students, and while the groups change annually, the teaching team of 4-5 instructors remains consistent.

Our research has employed a qualitative approach using a longitudinal design, observing the teaching program at all stages of the music camps (Patton, 2002). In addition to observations, we have conducted formal recorded semi-structured interviews and informal individual conversations. This includes group discussions with both students and teachers during the sessions (Patton, 2002, Dalen, 2011). Between sessions, we engaged in informal conversations and interviews with some of the teachers to facilitate discussions and learning reflections. Through these interactions, we gained insight into the organization and structures that underpin the music camps' practices.

To explore how the concept of these camps can be adapted to different academic settings, we have chosen to interview students and engage in discussions among ourselves as researchers. Given our involvement in teaching various courses across different study programs, we bring diverse perspectives on implementing this pedagogical activity.

Regarding the focus of this paper, it is also important to highlight the skills and experience we have accumulated as teachers over many decades. This expertise enables us to apply the experiences gained from the music camps to other academic practices.

4. Results and Discussion

The results of the investigations indicate that students greatly enjoy the music camps and achieve significant learning outcomes from them. They emphasize the importance of having group members with diverse qualifications, which mirrors the dynamics found in communities of practice (Lave and Wenger, 1991), where different types of knowledge can be applied to various components of the tasks.

Students also report that the strict communication rules have been beneficial. Since they are familiar with one another and have collaborated in the classroom, they have established the psychological safety (Edmondson et al., 2016) necessary for leveraging the camps as a pedagogical tool. However, there remains a need to remind them of the rules about refraining from negative comments on suggestions and only discarding ideas when the group collectively agrees on a better alternative. This aligns with Gustavsen's (2016) concept of democratic dialogue, which fosters the development of novel ideas into potential final outcomes.

Our observations have highlighted several additional issues that warrant attention. For instance, there may be differing motivations for engaging in tasks during a camp. Bachelor students in the music production program are likely to possess a passion for music and have developed artistic creativity. Consequently, their motivation to participate in a camp may be driven by both intrinsic factors (such as the desire to be creative) and extrinsic factors (such as mandatory attendance). In contrast, students enrolled in less creative programs may exhibit greater external motivations compared to internal ones. This discrepancy may influence how students approach tasks within the camp, necessitating greater effort from the instructor to foster student engagement.

A more instrumental approach may be required to support motivation. While intrinsic motivation promotes learning as students engage in activities for their own sake, extrinsic motivation, which involves providing incentives, can also facilitate their development (Valerio, 2012). This aspect should be further explored through the framework of Self-Determination Theory (Ryan and Deci, 2017).

Additionally, we have observed that students exhibit hesitance when it comes to presenting in the classroom. In the context of the music camp, the presentation of a product is significant, as it fosters interpersonal connections among students and enables them to evaluate their own performance in relation to their peers. However, it appears that some students are reluctant to speak publicly, presenting a concern that must also be addressed.

In the following sections, we will endeavor to address the various research questions we have posed:

Regarding Suitable Curriculum (RQ1):

The lecturers have proposed curricula that connect with students' professional lives, including organizational theory, learning organizations, knowledge management, and qualitative methods. These subjects allow students to build on prior experiences (Dewey, 1938). Consequently, this makes it easier for them to relate the curriculum to their existing knowledge and follow Kolb's experiential learning cycle in theory, though not in practice (Kolb, 1984).

Regarding Applicable Constraints (RQ2):

The lecturers emphasize the necessity of preparing students and designing assignments so that they are perceived as relevant. They express concerns about how to observe students when suggesting group formations. Allowing students to organize groups independently reduces the lecturers' control over the diversity of skills and knowledge within the Communities of Practice (Lave and Wenger, 1991).

Regarding Supervision (RQ3):

The lecturers believe they need to conduct some testing to effectively organize supervision, as they lack experience with ensuring students in the beforementioned curricula can complete assignments within the camp's scope.

While students recognize the significance of reflection in learning (Moon, 2004a, Moon, 2004b, Schön, 1987, Schön, 1991), they admit to not spending enough time on reflective practices, nor do lecturers emphasize it sufficiently.

Addressing Reflection (RQ4):

These issues must be tackled by the teachers and facilitated both during and after the camp. It is crucial for teachers to agree on facilitation methods and develop questions that encourage reflective processes (Schön, 1987, Schön, 1991).

Students are hesitant to suggest that this educational activity could be applied to other courses. This may stem from the intrinsic link between the camps and the creative process of music development, making it difficult for them to envision this pedagogical approach in a broader context. They also do not offer suggestions for other courses where camps could be implemented, indicating a challenge in conceptualizing the broader potential and application of camps.

Conversely, researchers and lecturers involved in the music camps are more inclined to see them as a valuable pedagogical tool. This perspective may arise from viewing the groups as akin to teams or even communities of practice, enabling broader implementation possibilities. One suggestion that emerged was to apply this approach in courses such as Knowledge Management and Qualitative Research Methods. However, these suggestions involve shorter camps of 2-3 hours, while maintaining the same guidelines for execution and supervision.

4.1 Suggested Outline of Utilization of “Camps” in Other Courses

Our recommendations for using camps as a pedagogical tool begin with a facilitative introduction to the course. The teacher should clarify the course objectives, explain the rationale behind the chosen pedagogical approaches, and initiate the students into reflective exercises.

Observing students during group work is crucial, and this can be integrated into the lecture sessions. Additionally, having students self-report on their experiences and problem-solving methods can be beneficial for organizing groups during the camps. While students typically form their own groups, it has been essential in the music camps to ensure diverse expertise within each group.

Establishing psychological safety in the classroom is also important (Edmondson et al., 2016), and in that connection it`s important that the person responsible for teaching actively works to establish a safe culture. This can be achieved by setting communication rules aligned with the principles of democratic dialogue (Gustavsen, 2016). Introducing Paulsen's (2021) suggested approach (see Figure 3) can further promote a positive atmosphere for group work.

To introduce the "camps," a case can be developed beforehand with student input or by inviting an organization to propose issues for resolution.

As the groups, now resembling communities of practice, get to work, lecturers need to stay aware of their progress and timing throughout the process. Encouraging reflection is key to fostering reflection in action and on action in action (Schön, 1987, Schön, 1991).

When the session concludes, it is important for students to present their results. As an additional task, they should be encouraged to reflect on their outcomes and consider how these results might be implemented in an organization. They could also be challenged to reflect on their process.

5. Conclusion

Although the students did not propose other applications for camps as a pedagogical tool, the teachers offered ideas that we deemed worthy of further exploration. Drawing from our theoretical foundation, observations, interviews with both students and teachers, and longitudinal research, we have developed an outline for implementing a camp in other courses. We recommend initially testing this approach either as a voluntary activity or in a condensed format (2-3 hours) before introducing full-day camps in other courses. Additionally, we emphasize the importance of evaluating the various outcomes of this initiative. In this way teachers can engage in a co-generative learning process with the students.

5.1 Further Studies

The proposed shorter version of a camp will be tested in the autumn of 2025 in the courses "Learning Organizations" and "Qualitative Research Methods." In-depth interviews will be conducted with the students participating in the camps to assess their perceptions of the camps' relevance to their own workplaces, their learning outcomes, and their overall views on this classroom approach.

We must also address the challenges encountered related to motivation and reluctance to present and propose strategies to effectively manage these issues.

Ethics declaration: All participants in the study have been informed about the use of the data and of their rights to withdraw their statements and for each project we have referred to, an application to our ethics committee have been sent and approved.

AI declaration: We declare that this paper is written by the authors and that the content is original and not produced by using AI tools. However, in order to ensure that the standard of English is met, we have used an AI tool for proof reading.

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Knowledge Sharing in an Academic Institution: A Case Study on Joint Course Evaluation

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Abstract: There is an increasing demand in academia for working more effectively. As budgets are tighter and lecturers struggle to find time for all administration tied to each course, we need to work differently, but without losing opportunities of sharing knowledge amongst the lecturers that make up the community of practice that represents a study program. One way of sharing knowledge and to help strengthen the community feeling amongst the lecturers on a study program, is to join forces regarding course evaluations. Often courses can be viewed as connected, particularly within the same study program. Hence, to save time for the students and for faculty staff, it is thus possible to organize for a joint evaluation form. In this paper we will present the students' and the lecturers' feedback on using a joint evaluation form that comprises evaluation for two courses within the same study program for two different study programs; "Organization, leadership and digitalization" and "Knowledge Management", both part time study programs, but with a rather high number of students (approximately 250 and 90). We will investigate how this affects the knowledge sharing amongst colleagues lecturing at the same study program. Our qualitative research approach has consisted of observations and group interviews. One of the most interesting findings was that the students got an improved understanding of the connection between the courses and allowed utilizing their own work background in both courses, the latter enabling them to understand better what happens in their workplace. For the faculty staff it facilitated for more collaboration and a stronger sense of being in a community of practice.

Keywords: Knowledge sharing, Evaluation, Student feedback

1. Introduction

For several years, student evaluations have been conducted jointly for two courses in the autumn semester and two courses in the spring semester within the Knowledge Management study program at Inland Norway University. Initially, this approach was implemented primarily to save time for both students and faculty. The evaluation reports are part of the university's efforts to support quality assurance in its academic programs. In the spring of 2024, this was also introduced in another study program; The Organization, Leadership, and Digitalization study program for part-time students. In this

Amid the ongoing economic challenges in the academic sector in Norway, time efficiency has become a key consideration when discussing the reallocation of resources—prioritizing teaching over administrative tasks, even as administrative demands, such as reporting, continue to grow. This situation may appear paradoxical; while increased reporting may initially seem counterproductive, it could potentially lead to time savings in the long term. To achieve such efficiencies, it is crucial to maintain a clear overview of task allocation to identify opportunities for optimizing resource utilization.

This raised an important question: are there additional benefits to consolidating evaluation reports beyond simply reducing their number?

Our research question thus became:

> *How can joint evaluation forms for two courses enhance knowledge sharing and cultivate Communities of Practice among faculty members?*

Our initiative emerged from a collaborative academic environment where lecturers have engaged in joint research for several years. However, in some study programs, collaboration among lecturers is limited, and many guest lecturers are only present on campus during their teaching sessions. Consequently, academic collaboration often appears fragmented and reliant on informal, personal connections.

1.1 The Study Programs

The Knowledge Management study program is a part-time, half-year program consisting of four courses: two in the autumn semester and two in the spring semester. The program is delivered in a HyFlex format, allowing

students to participate either online or in person. The courses are delivered as two-day seminars and three seminars per semester. The students are primarily adult learners, most of whom are employed.

The three lecturers involved in the program collaborate closely, regularly discussing the program's progress as well as engaging in joint research. For several years, a joint evaluation has been conducted for both courses in each semester—one evaluation for the two autumn courses and another for the two spring courses.

The Organization, Leadership, and Digitalization study program is also a part-time program, primarily catering to working students. Unlike the Knowledge Management program, its courses are delivered in a seminar-based format and are not available online. There are five two-day seminars per semester. In the spring semester of the first year (in a two-year program), a single joint evaluation has been conducted for the two courses. Additionally, two semesters ago, students requested a joint mandatory assignment for the courses "Digital Workforms in Organizations" and "Project Management." As a result, students were given the option to complete either separate assignments for each course or a combined assignment that addressed both courses.

2. Theoretical Foundation

Communication among lecturers within a study program is desirable but not always achievable. Certain structures exist to facilitate this communication, such as one mandatory meeting per semester. However, the agendas for these meetings often do not allow for collaboration or joint research opportunities. Additionally, some lecturers only participate online due to varying contract types, with some colleagues only coming to campus for lectures while attending other meetings virtually. Communication in organizations involves sharing information to achieve specific goals (Brønn, 2024). For lecturers in a study program, these goals include coordinating deadlines for assignments and addressing issues related to the program.

Enhanced communication can also lead to the formation of Communities of Practice (CoPs) (Lave and Wenger, 1991). Within CoPs, scholars can share knowledge and learn from one another through shared interests and interactions aimed at learning and improvement. Potential benefits include problem-solving, skill development, and the creation of new connections between practices, competencies, meanings, and technological advancements (Bicchi, 2024).

Communication also plays a critical role in Nonaka and Takeuchi's SECI model (Nonaka, 1994, Nonaka and Takeuchi, 1995). To share tacit knowledge, individuals must engage in socialization and externalization before the recipient can combine and internalize the conveyed knowledge. However, CoPs are not solely about facilitating learning and knowledge sharing; they are also essential for fostering innovation and value creation (Nicolini et al., 2022). In the context of innovation, potential outcomes of CoPs include generating new ideas, fostering innovative behavior, and improving work practices.

One significant issue to consider is the proximity of interaction among CoP members (Nicolini et al., 2022). The question of proximity has become increasingly relevant during and after the COVID-19 pandemic, particularly with the rise of hybrid work arrangements. To sustain the social interaction that defines CoPs, it is essential to explore whether proximity can be maintained in Virtual Communities of Practice (Ergan et al., 2014). Alternatively, the question may be whether physical proximity is a prerequisite for maintaining the essence of CoPs in virtual environments.

3. Methodological Approach

This study is a qualitative case study conducted during the academic years 2024 and 2025. The primary aim was to explore whether reducing the number of evaluation reports offers any benefits. Data for the study were collected through both formal and informal group interviews, as well as personal reflective notes on evaluation practices and the experiences of teachers and students with these practices.

The informants consisted of a strategic sample of approximately 40 students from two different courses, and 5 student representatives. Additionally, 3 faculty members were interviewed to gather their perspectives on the use of common evaluation schemes. The discussions and reflections were integrated with theoretical studies in an abductive process. The data have been analyzed using thematic analysis.

This approach provided valuable insights into the processes of evaluation in education, as well as the meanings, emotions, and reflections of the various participants. These insights align with what Geertz (1973) refers to as "thick descriptions." The outcomes of these processes have led to the establishment of new practices for collaboration and education.

4. Results and Discussion

In this section, we present the findings from our investigations and the corresponding discussion. The results are divided into two subsections: one focusing on the findings from the students and the other on the findings from the faculty staff.

4.1 Students as Informants

The interviews (both formal and informal) with students confirmed our initial assumption: students found it time-saving to complete a single evaluation form for multiple courses. This sentiment was shared by students across both study programs. The student informants, who volunteered for the study, were also engaged in group work—both for mandatory assignments and during seminars.

Interestingly, many students in the "Knowledge Management" study program reported using the curriculum interchangeably across courses. They attributed this to recognizing connections and overlaps between the courses. One quote from a student group was: “We collaborated and combined the literature to be able to answer both mandatory assignments in each course. Hence, we have used the literature interchangeably”.

Another notable finding pertained to the joint assignment in the *Organization, Management, and Digitalization* study program. Students in previous cohorts had initiated the joint assignment for the courses *Digital Workforms in Organizations* and *Project Management.* Both the previous and current cohorts found the joint assignment useful, as it helped them better understand the relationship between the courses.

One of the student representatives observed: "We quickly realized that the assignment highlighted two complementary perspectives on the same case: the 'what is needed to solve the case' perspective, as addressed in the course *Digital Workforms in Organizations*, and the 'how to implement it' perspective, as explored in the *Project Management* course."

Additionally, students felt that the study program was thoughtfully designed and that the collaborative efforts of the lecturers reassured them that the courses were carefully planned to support their learning outcomes.

An unexpected finding was that students also gained an understanding of how the faculty staff collaborated. Students from both past and present cohorts expressed an awareness of the joint efforts among the lecturers.

Building on this observation, the second round of data collection with current students provided further insights. Students described their perception of the lecturers’ collaboration, not just within one program but across both programs, as resembling a Community of Practice (CoP). Students explained that they saw the lecturers as actively seeking to improve their work practices and foster innovative behavior, aligning with Nicolini et al.’s (2022) description of CoPs. This perception arose from students’ understanding that the lecturers conducted joint research and shared knowledge about best practices to facilitate better learning opportunities and enhance the workplace relevance of the study programs.

Moreover, students noted that the lecturers' communication and proximity—despite being in different physical locations—also reflected a Virtual Community of Practice (Ergan et al., 2014). This was particularly evident as two faculty members worked primarily online and were based in different locations, yet maintained close collaboration.

4.2 Faculty Staff as Informants

Discussions with faculty staff confirmed that their collaborative efforts resembled Communities of Practice (CoPs). However, they were unaware that students had observed and recognized this dynamic.

The faculty staff acknowledged that their collaboration was driven by a desire to test innovative and nontraditional methods, which facilitated knowledge sharing and communication. This aligns with the original definition of CoPs, as described by Lave and Wenger (1991). The primary goal of this collaboration was to enhance both the students' learning outcomes and the workplace relevance of the study programs.

One key initiative involved designing assignments that allowed students to draw upon their professional backgrounds. Some of these initiatives had been tested prior to this study, and it was the sharing of tacit and explicit knowledge among faculty members that enabled new approaches to enhancing relevance. Here the SECI-model was employed as we firstly discussed our experiences based on our previous experiences with lecturing and evaluation(socialization), then we were clear about sharing our knowledge with each other (externalization), before reflecting together on our new experiences and how this would change our previous knowledge (combining) and then we sought to change our practices based on our new tacit knowledge

(internalization) (Nonaka, 1994; Nonaka and Takeuchi, 1995). As part of this process, findings from initial investigations were documented and developed into research papers. This collaboration not only generated new ideas but also improved the faculty staff's work practices (Nicolini et al., 2022; Bicchi, 2024).

5. Conclusion

The collaborative efforts and knowledge-sharing practices among faculty staff were recognized by students as resembling Communities of Practice (CoPs). Faculty members indeed formed CoPs to conduct research on innovative and time-saving initiatives, such as joint assignments and evaluations. These efforts began with the development of assignments that allowed students to apply their workplace experiences, alongside investigations into how students perceived these initiatives. Faculty staff, through their collaboration, effectively shared both tacit and explicit knowledge, leading to the establishment of CoPs.

The students' recognition of these collaborative efforts was unexpected but positive. They perceived the lecturers' joint actions as contributing to the relevance of the study programs and enhancing their learning outcomes.

5.1 Future Research

The students' perception of faculty collaboration has inspired further research and new initiatives to broaden collaboration and share insights with other faculty members. Until now, collaboration has primarily occurred among faculty teaching in the same semester. Future research will explore the potential for extending CoPs to include collaboration across an entire academic year or even across the entire study program. This will involve engaging additional scholars from both study programs to investigate how such collaboration impacts learning outcomes across the full program. We will aim to use more evaluation forms (mid-term assessment as well as end evaluation) provided students on the last day of seminars in order to increase the number of respondents. Also, we will do the interviewing during each seminar with both the student representatives and group interviews with the students attending both physically and virtually.

AI declaration: In this paper, we used the language model GPT-4 via Sikt AI-chat at the University of Inland Norway, as well as Google Translate, to identify and correct grammatical errors, improve sentence structure, and receive suggestions for synonyms to avoid repetition. This was done in accordance with the general guidelines from the university library. We have not used chatbots to generate academic content, but solely to refine our own text.

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Navigating Between Order and Chaos: Temporal Organizing and Event Time in Hackathons

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Abstract: Hackathons are temporary collaborative events that have the potential to accelerate innovation. While temporal pressure – which boosts creativity – has been studied from the hackathon participants' perspective, it is less clear how hackathon organizers orchestrate the temporal aspects of hackathons. Therefore, this research investigates the temporal organizing dynamics in hackathons, using a qualitative case study approach. We identify temporal organizing in hackathons as consisting of three main structuring processes: temporal preparation, temporal sequencing, and temporal condensation. We analyze how time pressure is used for creativity and the temporal structuration mechanisms that facilitate collaboration and innovation. Further, we examine how subjective and objective notions of time are intertwined in these accelerated innovation events and how the temporal design benefits the actors. Our research contributes to the literature on hackathon organizing and temporal organizing, and it contributes to practitioner insights on innovation contest management in time-restricted settings.

Keywords: Temporal organizing, Objective and subjective event time, Orchestration, Time-Constrained innovation, Knowledge creation, Creativity

1. Introduction

Hackathons are accelerated innovation processes in which individuals develop new ideas, products, software, or solve other types of challenges in an extremely limited time frame (Lifshitz-Assaf et al., 2021). The events can be held onsite with in-person attendees, fully online, or in a hybrid format, and typically span one to three days (Heller et al., 2023). Typically, hackathons are perceived as unstructured and creative innovation processes, where ad hoc "timing of tasks and knowledge flows is critical for effective innovation outcomes", and the "temporal dimension of coordination is particularly important" (Lifshitz-Assaf et al., 2021:687). Hackathons are about developing new solutions in a competitive environment and emphasize collaboration, flexibility, and speed (Flores et al., 2018).

Hackathons often bring unfamiliar solvers together to quickly solve complex challenges. The ability of temporary solver teams to swiftly exploit and leverage their team members' expertise is crucial for successful co-creation and innovative outcomes (O'Toole et al., 2023). Despite the growing popularity of hackathons as a tool for accelerated innovation, research on their temporal organizing dynamics remains limited. Prior studies have focused mainly on how hackathons are organized to attain their goals within settings that involve coordination mechanisms that boost creativity, interaction, and flexibility (e.g., Haefliger et al., 2025). Studies have also focused on the outputs of hackathons—such as the novelty of ideas generated—rather than on the underlying processes that enable successful coordination in time-constrained conditions (Lifshitz-Assaf et al., 2021). Furthermore, while prior work has examined the role of time pressure for creativity (Amabile et al., 2002), studies have not specifically looked at the mechanisms by which hackathon organizers can structure time to facilitate both collaboration and innovation. In addition, there is a call for research to understand how time is experienced subjectively in different types of organizations (Bansal et al., 2025).

Prior research has emphasized how time pressure and condensed work schedules can enhance creativity by fostering rapid experimentation (Amabile et al., 2002). However, while time compression can drive innovation, it also introduces significant challenges related to coordination, cognitive overload, and stress (Elsbach & Hargadon, 2006). To better understand such temporal organizational dynamics, hackathons provide a unique context to explore how different actors make sense of time. The different types of actors involved (solvers, mentors, partners, and organizers) also have different assumptions and expectations regarding temporal sequencing and rhythms. This results in varied subjective time perceptions, but actors also respond differently to objective decisions on how time is or should be managed (Shipp & Jansen, 2021).

Based on the research opportunity discussed above, we examine the following research questions: *How are temporal organizing processes effected in hackathons, and how do they affect temporal perceptions and dynamics of the participating actors?* To address this question, we collected rich qualitative data from five different hackathon events, including field notes, observations, and 23 interviews from the actors involved.

The findings illustrate how organizers set up temporal structures that are experienced differently by the various hackathon actors. Our insights build on the literature on temporal organizing (Bansal et al., 2025; Mosakowski & Earley, 2000; Reinecke & Ansari, 2015; Shipp & Jansen, 2021) and contribute to our understanding of hackathon organizing by identifying three different mechanisms for temporal organizing in hackathons. Temporal preparation, sequencing, and condensation help to achieve clarity, yet organizers need to carefully consider the intertwining of objective clock time and subjective, experienced time in using these mechanisms.

2. Theoretical Background

2.1 Hackathons as Temporal Events

Hackathons are short-lived collaborative innovation contests, also described as time-intense (Beretta et al., 2022) or ephemeral (Endrissat & Islam, 2022). There is a considerable amount of research done *with* hackathons, using them as examples or means in the research approach, but less *on* hackathons, focusing on the innovation format (Falk Olesen & Halskov, 2020). Hackathons have been viewed as tools to accelerate innovation in organizational culture (Komssi et al., 2014), as reflecting design activity simulating real-life settings (Flus & Hurst, 2021), popular formats to accelerate creativity (Falk et al., 2025), coupled open innovation processes where actors participate in collective intelligence generation and get value from that (Attalah et al., 2023), or as promoting entrepreneurial orientation and practices (Cavallo & Burgers, 2025). The events bring diverse people together who do not necessarily know each other from before, and who are organized in temporary teams to work on or solve a problem (O'Toole et al., 2023).

Participants in hackathons have been found to experience time pressure (Lifshitz-Assaf et al., 2021), but the organizational decisions leading to those temporal perceptions, as well as the implications of those, are little explored. In broad terms, successful collaboration in temporary teams is associated with efficiently using individuals' expertise, storing and retrieving knowledge, and aiming for productive task coordination (O'Toole et al., 2023). In this regard, hackathons can provide a setting for 'ad-hoc problem solving' which enables non-routine solutions under time constraints (see Ritala, 2013). We expect that this can lead to creativity-inducing time pressure and can be facilitated by deliberate temporal organizing mechanisms by hackathon organizers. At large, the time compression that occurs during events such as hackathons has been shown to affect participants' perceptions of time (Lifshitz-Assaf et al., 2021), yet temporal perceptions beyond participants' perceptions have been less explored in prior research. To gain deeper insight into such issues, we draw from temporality literature in the following section.

2.2 Temporal Organizing

In temporality literature (Bansal et al., 2025; Mosakowski & Earley, 2000; Reinecke & Ansari, 2015; Shipp & Jansen, 2021), the notion of time in organizations has been primarily distinguished as objective or subjective time. *Objective time* refers to time that can be precisely measured and that is not related to individual perception, but external to it (Mosakowski & Earley, 2000). 'Chronological time' or 'clocktime' are terms used to describe objective time, which is seen as unitary, thus, it can be interpreted in only one way, mechanical, related to exact measurement, and as constantly progressing and linear (Bluedorn & Denhard, 1988). *Subjective time,* i.e., how individuals and collectives experience the past, present, and future (Shipp & Jansen, 2021), is key for understanding temporality beyond objective time, yet it has not been studied much in management research (Bansal et al., 2025). Objective and subjective time are closely related in that subjective time is seen as enacted through the actions of perceiving (objective) time, mentally 'traveling through time', and interpreting time (Shipp & Jansen, 2021). Time can also be experienced as *events*, as different *rhythms,* and as *cycles*. From a hackathon perspective, *event time* refers to the perception of time as shaped through events instead of linear clock time (Lifshitz-Assaf et al., 2021). In fact, event time can be "crafted in ways that completely diverge from, or even contradict, objective time" (Shipp & Jansen, 2021:306). Accordingly, in hackathon events, we refer to event time as the way time is experienced as shaped by an event itself, by its rhythms and its cycles, rather than by the clock time (Shipp & Jansen, 2021).

An underpinning tension related to theorizing time refers to an inclination towards thinking in dualities: for instance, Bansal et al. (2025) mention the duality between objective time and subjective time as specifically prominent in management research related to temporality. However, calendar and clock-based objective time

and experiences, and perceptions and interpretations based on subjective time, are described as a conspicuously interrelated duality. Another concept from temporality literature concerns the *periodization* of time. Periodization relates to how perceived time is divided into distinct parts, using *punctuation points* (Sadeghi et al., 2025). In a similar vein as with subjective and objective time, periodization may result in dualistic interpretations, e.g., different individual and collective temporalities, creating so-called pluritemporal modes and possibly creating temporal demands (Blagoev & Schreyögg, 2025; Sadeghi et al., 2025) – a manifestation of the inherent tensions in dualities.

It is important to note that while dualities such as subjective and objective event time can be conceptually separated, in practice, such dualities are often fundamentally interrelated and complementary concepts, even if they would be in contradiction (Farjoun, 2010; Bansal et al., 2025). Therefore, it is valuable to explore how objective and subjective time intertwine during hackathons, going beyond the participants' perspective to better understand their pluritemporal aspects. Temporal structures established through social practices such as periodization can contribute to the perception of continuity and discontinuity, shaping the actions of the actors involved (Sadeghi et al., 2025). Furthermore, interpretations of events by management are seen as temporally linked to organizational change actions (Kunisch et al., 2017), hence, the timing of events affects decisions or evaluation deadlines, and actions. From a hackathon perspective, it is unclear how such different temporalities and their inherent dualities are created with periodization and how these are managed in the processes of organizing hackathons, striking a balance between the competing demands of objective (clock) time and subjective (event) time, which in turn may be perceived differently by organizers, participants, and other actors involved.

3. Methodology

We conducted a qualitative field study of hackathon events, organized by the same professional hackathon organizing firm.

3.1 Empirical Context

The empirical setting was a series of five innovation contests organized by a professional Finnish-based hackathon organizer. The hackathons are short-term events that usually last two to three days. The events usually take place during weekends, rarely during weekdays, and focus on specific challenges that need to be solved. The solutions developed are presented and evaluated by the end of the event, followed by the handover of a prize and an award ceremony. The first author collaborated closely with the hackathon organizer, which allowed us rich data access. Beyond interviewing different actors, the researcher participated as an observer in five hackathon events. While the organizer uses all three hackathon formats, onsite hackathons, hybrid, and fully virtual or online events, the researcher observed only onsite and hybrid hackathons. The organizer focuses on both technology-oriented and issue-oriented hackathons; the competitions can, for example, focus on business concepts, circular economy-oriented challenges, or on technology-focused 3D-interaction using smart devices.

3.2 Data Collection

Our main data source is derived from interviews with actors in a series of five hackathon events, all organized by one hackathon organizer. The events were all either fully onsite or in hybrid mode, which included an onsite and an online part. One of the researchers spent three months (September to December 2022) with the hackathon organizer. The 23 qualitative individual and group interviews were held in English, took place from September 2022 to May 2023, and lasted between 16 and 91 minutes. They were audio recorded and transcribed, and complemented with informal conversations, observations, and field notes. The interviewees were either solvers, coaches, partners, or from the organizing team. In the interviews, semi-structured questions were asked to understand the interviewees' views on the organization of hackathon events. Based on the responses, the temporality aspects emerged inductively. Participant observations during the events yielded further data and evidence and deepened our understanding of the empirical context. The observations were mainly done during the hackathon events, but also during the organizer's planning work, team meetings, pre-event webinars, and event preparation activities, as well as during post-event activities and the event evaluation phase.

3.3 Data Analysis

Following an inductive qualitative approach (Gioia et al., 2013), first-order codes were established and later incorporated into second-order themes. An open coding approach was used to analyze the interview transcripts

in NVivo, to establish first- and second-order codes. This took place over several months, and the coding process required iterative decisions on what temporal aspects to focus on. Initially, the first author open-coded the interview transcripts to identify temporal aspects. A critical review by the first, second, and third authors led to the removal of some codes and the recombination of several second-order themes. Joint discussions about the aggregate dimensions were held among the team. In multiple meetings, the coding structure was refined and eventually led to a new aggregate dimension for subjective temporal elements, named 'subjective event time'. Multiple rounds of coding and reviewing followed until no new insight could be drawn, and the data structure was finalized. In a subsequent step, additional aggregate dimensions to 'temporal organizing' were identified. The review then led to 'temporal organizing' as comprising three processes, namely three aggregate dimensions, 'temporal preparation', 'temporal sequencing', and 'temporal condensation'. The fourth aggregate 'subjective event time' was then included in a separate aggregate named 'benefits of temporal design', reflecting the benefits of 'creative pressure', 'learning and network expansion', and 'procedural clarity'.

In our analysis, we refer to the hackathon event organizer as the *orchestrator*, and the actors participating in solving the challenges as *solvers*. In the interviews, solvers are frequently referred to as *participants*, though this needs to be distinguished from other participating actors such as *partners* or the organizations that collaborate in organizing the event. In the interviews, *partners* are occasionally referred to as clients, yet in our analysis, we do not distinguish between the two. We use the terms 'mentors' and 'coaches' interchangeably to refer to actors engaged in coaching the solvers.

4. Findings

We identify three mechanisms for temporal organizing – temporal preparation, temporal sequencing, and temporal condensation – and the benefits of temporal organizing. *Temporal preparation* is a mechanism used by the event organizers in collaboration with the client(s) and partners in the earlier stages of organizing the hackathons to clarify time resource distribution and to create temporal structures for the event in question. *Temporal sequencing* is enforced throughout the organizing process to punctuate event phases and their specifics. *Temporal condensation* is mainly used during the event to create a sense of urgency for participants and to set tight deadlines for solvers, mentors, and evaluators. Finally, *the benefits of the temporal design* include creative pressure, learning and network expansion, and procedural clarity.

Figure 1 provides an upfront summary of the results and demonstrates how temporal organizing mechanisms are used to affect the objective and subjective temporal dynamics and eventually lead to benefits of temporal design.

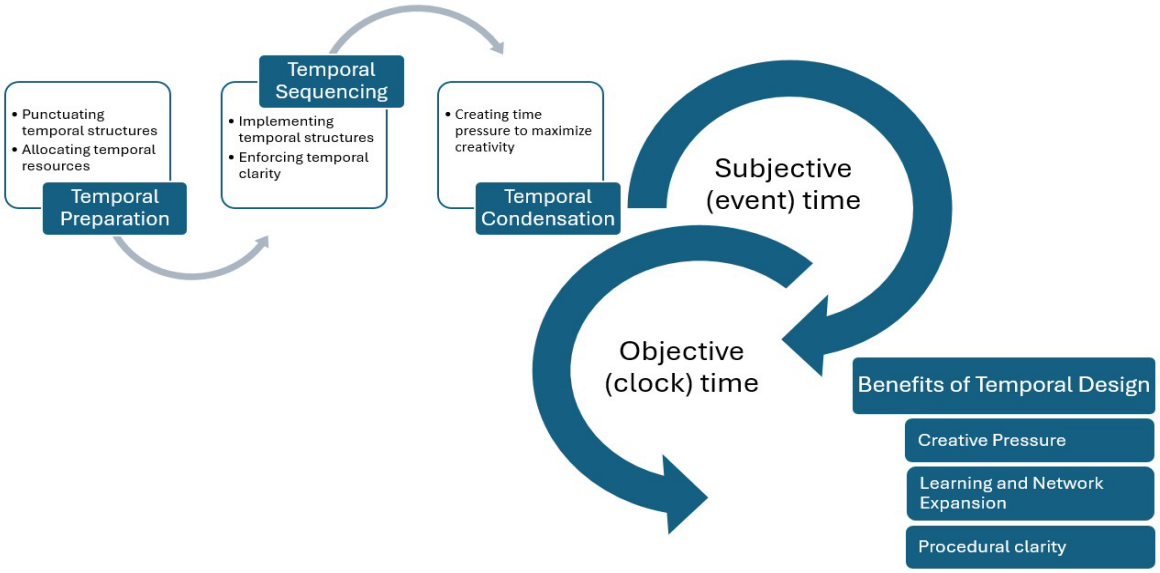


Figure 1: Conceptual model

4.1 Temporal Organizing Mechanisms

While hackathons are short-term events that usually last only a few days, these intense happenings may need long-term preparation. Preparatory activities mainly take place among the organizing team in collaboration with the client(s) and partners. Successful event organizing relates largely to the planning that goes into it.

4.1.1 Temporal preparation

The organizer initiates the planning of the event, collaborates with client(s) and partners, and involves them in the planning process. An event format is then elaborated according to their expectations. Preparation involves *planning the event*, including aspects such as understanding and including partner expectations, establishing partners' and clients' extent of involvement and time invested, discussing and deciding on the event design, and advertising the event. While the *preparation time is long, the actual event is fast*. Although short-lived, hackathon events often involve long-term planning and preparation over several months. Yet the event itself usually lasts only a few days or a weekend.

> *"The set-up of a hackathon is a big project. It starts maybe half a year at least earlier, so it doesn't happen in one day" (Partner 5).*

Knowing this, the organizer sees pre-event activities as just as important as the ones during the event phases. Emphasizing support for teams' and partners' preparation, the organizer provides a structure that guides them well ahead of the event. Registrations for an event often take place within the last few days before the registration deadline. With planning done and preparations in place, *solvers' decision on participation often clusters to the last minute*. Around half of the solvers register relatively late, as they often need to organize both their work life and private life before deciding to participate. After registration, solvers are not automatically enrolled for the hackathon event. *Selecting teams* capable of solving the challenges is a step taken by the organizers. Oftentimes, *team formation* takes place under time constraints.

4.1.2 Temporal sequencing

Throughout the planning and the implementation phases, a *temporal sequencing* process guides the structure of the activities taking place. An *efficient design and flexible format, adapted to stakeholders' interests,* provides a context that aligns and adapts to stakeholders' evolving needs. Efficient information flow supports partners in making the most of their time onsite. Similarly, being managed flexibly is appreciated by solvers. Collaboration is structured by the organizer, by defining interactions early in the planning phase and by *facilitating collaboration* among the actors. For fast-moving events such as hackathons, *temporal clarity* is paramount. Defining goals, time schedules, checkpoints, and processes contributes to promoting clarity. Transparently communicating the resources needed, schedules, and expected contributions brings clarity and is reassuring for all attendees.

> *"So, everybody knows (that) when you have a sort of clear time schedule and how much resources needed and when." (Organizer 1)*

So-called 'checkpoints' represent punctuation points, set by the organizer to structure the events. These checkpoints are built into the program to guide collaboration and are perceived as useful. Temporal clarity is, therefore, a high priority for the organizers and the solvers and contributes to a positive experience.

4.1.3 Temporal condensation

Temporal condensation happens mainly during the hackathon event phase. Its focus is on the shortened time frame, the optimal use of time and efficiency, and speedy processes to reach innovation goals quickly. Yet despite the acceleration, the organizers are aware of the lengthy 'development runway for innovations' taking longer than the short time available during an event.

Advancing efficiency is crucial in condensed event settings. Thus, *optimizing time investment and structuring for efficiency* are among the organizer's priorities. This includes communicating openly about temporal and other resources needed for the work ahead. For instance, it is crucial for the organizer to know that the client can spend time on a hackathon project. Efficient organizing and acknowledging solvers' time investment are important for solvers as it shows them that their benefits are considered, and their contribution is valued. In the planning process, a suitable temporal framing is set up. In this negotiated process between the organizer, client, and partners, finding common ground can be challenging. For example, in a *discussion about temporal framing* between the client, partners, and the organizer, a two-week period had initially been debated. This was the

client's original intention. Technology experts then argued for a weekend time span instead. Following the experts' advice, the client decided on the shorter time frame. Likewise, *event design affects condensation* in hackathon settings. Overnight work or staying late are prevalent features in this time-limited format, affecting the event's experience. The main *goal is to achieve innovation results fast.* A short, continuous time frame is seen as suitable; therefore, the events are shortened by design. While they are experienced as hard and focused work by solvers, the upside is seen in the events having a predetermined, foreseeable end.

> *"You have only this amount of time to solve a problem, come up with a solution for some broad thing, make something with it." (Team 3, solver 7)*

Innovating in a fast context is challenging, regardless of teams' talents. Yet, coming up with solutions and potentially winning a prize is exciting for solvers. Essentially, achieving results quickly adds to a positive experience for solvers and partners alike.

4.2 Benefits of Temporal Design

The temporal design that structures the event's activities, interactions, and outcomes yields benefits regarding creative pressure, learning and network expansion, and procedural clarity. A fast pace and a short time frame are considered efficient and productive. *Creative pressure* is built by keeping the preparation time for solvers relatively short. For example, the organizer keeps the time between team selection and event start short to maintain the solvers' interest.

> *"If we have a bit more time, great, but then if we start having too much time, people drop out, because they lose interest, because it's happening too slow for them." (Organizer 5)*

Solvers like to test their capabilities and develop new business concepts. To them, a short time frame and creative pressure are attractive and accelerate testing and learning. Moreover, the speedy format can produce feelings of stress and urgency due to pacing. Solvers might drop out early or decide not to join at all if the challenge feels overwhelming. As such, time is of essence in hackathons, not only for solvers but also for coaches who might only attend part-time. Technological challenges may cause delays and increase pressure, forcing solvers to prioritize. Partners were impressed by how solvers did not get stuck and overcame technological problems, and by the solutions delivered.

Interaction among the attendees generates benefits for *learning and network expansion*. Among mentors and teams, among mentors themselves, and with partners, interactions led to learning and networking opportunities. Some coaches had previously attended hackathons as solvers and were therefore well acquainted with the temporal pressure.

Organizing complex, rapid programs gets easier through iterative learning. An accelerated temporal design is thus enabled by previous organizational learning. Positive perceptions and exceeded expectations contribute to an event's *procedural clarity*. Partners expect the organizer to bring efficiency to the process; for example, planning of onsite logistics early on is seen as advantageous. Role clarity additionally contributes to partners' positive perception. Finally, framing innovation competitions towards future outcomes adds clarity. For example, instead of awarding a prize for the best (past) service provider, hackathon prizes award outcomes with the best potential for implementation or benefit for potential users. Framing awards as forward-looking, instead of backward-oriented accolades, benefits the way the innovation format and the prize are perceived.

5. Discussion and Implications

In this study, we addressed the research questions: How are temporal organizing processes effected in hackathons, and how do they affect temporal perceptions and dynamics of the participating actors? Temporality in hackathons has mainly been explored in terms of time pressure from the participants' perspective (Lifshitz-Assaf et al., 2021). We build on this research by exploring how hackathon organizers create temporal structures for hackathon events and what mechanisms they use to do so (Pentland et al. 2025). We identify three mechanisms for temporal structuring, namely temporal preparation, temporal sequencing, and temporal condensation. The mechanisms help organizers intertwine subjective (event) and objective (clock) time (Shipp & Jansen, 2021) by planning and applying objective time structures and orchestrating the different subjective time perceptions of participants, mentors, evaluators, and even clients. This reinforces an ecosystem approach on such temporary collaborative events (Poblete et al., 2022; Jensen et al., 2024). Our empirical analysis further shows that this type of temporal structuring achieved by the hackathon organizers produces several short- and long-term temporal benefits, including creative pressure and procedural clarity (short-term) and learning and network expansion (long-term).

5.1 Theoretical Contributions and Future Research Implications

Our findings allow us to make three contributions to the literature. First, we contribute to the hackathon organizing literature (e.g., Lifshitz-Assaf et al., 2021; Heller et al., 2023; Flus & Hurst, 2021; Cavallo & Burgers, 2025; Haefliger et al., 2025) by unbundling temporal organizing mechanisms that organizers can utilize, and we connect these mechanisms with the benefits of this temporal design, demonstrating the usefulness of such mechanisms in hackathon organizing. While previous literature has recognized the importance of temporal aspects in hackathons as a driver for innovation (Lifshitz-Assaf et al., 2021), as well as more general hackathon organizing mechanisms (Haefliger et al., 2025), this is the first study focused on how temporality can be deliberately designed as an organizing principle in hackathons. Temporal mechanisms complement the other mechanisms and organizational practices that hackathon organizing involves and provide an important dimension to the overall organizational framework of hackathons and other time-bound innovation events.

Second, our study provides a broader contribution to temporal organizing literature. While previous literature has shown the benefits of temporal pressure for creativity (Amabile et al., 2002), including hackathon settings (Lifshitz-Assaf et al., 2021; Beretta et al., 2022; Flores et al., 2018), our study demonstrates how time-bound events can be designed to utilize different temporal organizing mechanisms, including preparation, sequencing, and condensation of time. All these mechanisms have different effects on temporal perceptions of different actors and demonstrate the 'temporal toolbox' that organizing entities have at their disposal. Furthermore, more knowledge on temporal contexts in innovation contests is needed, since novelty, usefulness, and creativity are in these cases situated within a specific time frame, and generated value may be lost over time (Falk et al., 2025). We call for further research on these and other temporal aspects of creativity and innovation.

Third, we contribute to the broader organization management literature by proposing concrete mechanisms that help event organizers intertwine subjective and objective time (Bansal et al., 2025; Shipp & Jansen, 2021). Prior studies have shown that such mechanisms used for temporal structuring also have a role in shaping organizational becoming and stability in permanent, established organizations (Pentland et al., 2025). However, such mechanisms for temporal structuring and their roles have been less explored in temporary organizations such as hackathons (see e.g., Endrissat & Islam, 2022).

Future research can build on our insights to better understand the management of time in organizations (Bansal et al., 2025), temporary teams (such as hackathon teams), and in broader collectives such as meta-organizations and ecosystems. Furthermore, our finding that subjective time and periodization of time are helpful in achieving creative outcomes leaves open questions about the variety of resulting temporal complexities, which is an important topic for further research (see also Sadeghi et al., 2025).

5.2 Practical Implications

While complex cognitive processes take time, and spurring creativity without a fair amount of time is unlikely, the absence of time pressure does not lead to creativity either. A key to promoting creativity is getting solvers to buy into being on a mission, seeing their work as important and urgently needed. Likewise, it is vital to set aside specifically blocked worktime for solvers to focus on the task at hand and to be shielded from interruptions and distractions, thus offsetting the effects of time pressure (Amabile et al., 2002). Framing hackathon challenges as missions – with a clear time limitation – and relatedly adopting an 'ad-hoc problem solving' approach can further help to overcome the 'rigidity trap' typically occurring in organizational change and ideation (Ritala, 2013). Furthermore, hackathon organizers can consider adding more time and space pre- and post- events. Hackathons require considerable planning time to ensure a fast pace when event time kicks in. Likewise, ample time is needed for post-event evaluation and analysis, enabling organizational learning and follow-ups for the organizers as well as those who have sponsored the competitions.

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The Impact of Customer Knowledge and Market Orientation on Developing Services and Product Diversification

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Abstract: The study's major objective is to investigate the impact of customer knowledge and marketing orientation on product and service improvement. Furthermore, emphasizing the ability of customers to think creatively is the most significant aspect in creating organizational creativity. It also aimed to demonstrate the importance of knowledge in institutions' survival and growth, as well as to improve their effectiveness and performance in light of the enormous challenges that organizations face, by establishing a competitive advantage, using forms of coordination, design, and structure to make the organization more flexible. The descriptive-analytical approach was used to respond to the research questions and to demonstrate the validity of the hypotheses. This study's methodology is based on positivism philosophy, and it also used the quantitative research approach, which attempts to collect data about a specific occurrence or condition to examine these data in order to make recommendations and suggestions. By collecting works and theoretical books on knowledge, marketing orientation, and the development of new products and services, this study tried to assess data, and then construct a questionnaire to evaluate reality based on the previous analysis and apply it to the study sample. The study using proper statistical techniques analyze the data to make a conclusion and interpret them to reach the most important ideas that will help and enrich the research area. The hypothesis has been confirmed, with the study's findings indicating that the independent variables (customer knowledge and marketing orientation) have a statistically significant positive impact on the dependent variable (product diversification and new service improvement).

Keywords: Marketing orientation, Customer knowledge, New product, and services development, Customer requirement, satisfaction

1. Introduction

In the Business organizational environment, the era of globalization is surrounded by opportunities and risks. The major challenge that organizations face is the administrative challenge of managerial process at all levels, especially at the highest level in management and strategic leadership which requires a high degree of awareness, science, scientific knowledge, applied skill, and adopting strategies that seek to achieve scientific methods in managing organizations. Achieving success, excellence, competitive advantage, and survival in this era requires high administrative capabilities and competencies with innovative strategic thought based on a strategy capable of analyzing the environment and future expectations. According to (Cavusoglu 2014) organizations are capable of creating value by boosting the productivity of their production elements through knowledge-based economic activity.

Based on the rapid changes in the marketing environment and the intensity of competition, organizations must adopt modern marketing approaches and dimensions, which lead to achieving customer satisfaction and loyalty, and this will happen through adopting orientation trends in marketing and achieving it for this purpose. Studies have confirmed the need for organizations' departments to take into consideration customer knowledge and market orientation because it can lead to achieving competitive advantage, organizational creativity, development of new products and services, product variety, and organizational development, as organization's needs (Wei & Morgan 2004, Ahonen et al. 2011, Wiwoho, 2013, Alrubaiee 2013, Pitjatturat et al. 2021, Sofianti et al. 2009, Cui & Wu 2015, Goffin & New 2001, Sukartini et al. 2019, Najat 2017).

The development of product diversification, process, and service is a vital and important issue for the success of business organizations, also the provision and development of new services, products, and processes that are available and performed in a new way that corresponds to the change in customer needs (Menor & Roth, 2007). Organizations and its long-term growth are subject to the risk that cannot be ignored, which is represented in the possibility of customers rejecting the developed service and the inability to meet the needs of customers and reach the desired goal of customer satisfaction, and this is why market research is important in identifying current and future customer needs and develop services according to those renewed needs.

Knowledge becomes a significant tool in the process of building and developing the competitive capabilities of enterprises, also intangible assets guide organizations to creativity in an era characterized by rapid transformations in the global economy and its enormous size (Hama & Sağsan 2021). For a productive institution to move to advanced production stages and provide it with a competitive advantage over its peers, it is necessary to rely on the human element as the organizing factor of the production process and what it possesses from a cognitive and creative dimension. This is represented in organizational and administrative creativity and what the institution requires is a strategic planning or making the right decisions. The institution is related to the technical aspect and the optimal use of the element of knowledge and technology in the way that the institution needs to complete the production process (Gibbert et al 2002, Joshi & Sharma 2004).

For this reason, the real competition between organizations in attempting to own human resources has become qualified to achieve the vision and mission of the organization through the search for intellectual wealth, skills, creativity, and innovative ideas in its untapped human resources so that it can invest in it and make the best use of it. According to Hama et al. (2021) creativity is a crucial aspect of an organization in dealing with and adapting to a competitive environment.

The main objective of the study is to form a comprehensive understanding of the value of market orientation and customer knowledge in enabling the diversification of new services and products. The most important and unique feature of this study lies in the fact that it is the first one that has conducted in north of Iraq in this field of study.

Market orientation and customer knowledge are the foundation for creative ideas, the development of new services and product diversification, organizational creativity, and the focus for its implementation, according to numerous researchers who have attempted to explain the impact of these factors in the development of new services and product diversification. In a group of studies where the study was intended, it can be seen that there is a positive and significant relationship between market orientation, customer knowledge, and generating new services and product diversity.

Lukas and Ferrell, (2000), have investigated the relationship between two focal constructs in the debate: market orientation and product innovation. Moreover, Singh and Joshi (2004) have mentioned how developing customer knowledge enables new products to succeed. Furthermore, three distinct customer roles in knowledge coproduction exist, according to Blazevic and Lievens (2008), who goes into great detail on the effects of each role on specific innovation activities. According to Sofianti et al. (2009), customer knowledge is becoming a more important strategic asset for any business's future. Marketing has come to understand customer knowledge as a valuable resource that can be controlled to assist in R&D. According to Chao-Hung, W. (2015), market orientation has been identified as a key factor influencing innovation performance in service contexts. According to El-Helaly et al. (2015), organizations must successfully capture, share, acquire, and utilize customer information if they want to enhance the performance of their service recovery. According to Ocampo et al. (2018), market orientation has a favorable impact on product innovation. Moreover, the knowledge retrieved is shown as a set of rules that may be utilized to find relevant patterns for both new product creation and marketing strategies, according to Zhan ET AL. (2019), who has stated that the knowledge-based strategy is effective. In addition to this Market, orientation has a favorable and significant effect on product innovation and marketing performance, according to Sukartini et al. (2019).

2. Marketing Orientation

It is a business philosophy where the focus is on identifying customers' needs or desires and meeting their needs. Market sensing and customer linking capabilities are considered some of the most valuable features of market-oriented organizations (Day, 1994a). Where the marketing orientation concentrates on designing and offering products and services that meet customer needs in order to be profitable, the majority of organizations are moving towards a market-oriented approach because customers are becoming more knowledgeable and need more diversity and better quality of competition (Slater, 2001), organizations should

be more sensitive to the needs of its customers or else they will lose sales to their competitors, where innovations create the need rather than the customer being able to appreciate how new technology is evolving. Also, the market trend stands in contrast to marketing strategies (product orientation), in which the concentrate was on creating marketplaces for existing merchandise instead of attempting to get customers to like or understand the benefits of an organization's products or services through a marketing approach that is focused on meeting customer needs.

Market-oriented organizations concentrate squarely on the customer, also market-oriented organizations respond to marketing research and customize their products in line with what they see as market demands (Verhees & Meulenberg 2004). Market orientation is the core of organizational culture and is primarily driven by the needs of their customers marketing research results determine how much of a product is produced. Old products and the invention of new products are based on consumers' needs or desires and it is *a response to market changes and the* introduction of new products to the world to also improve an organization's performance (Becherer et al. 2001, Narver & Slater 1990, Baker & Sinkula 2009, Kohli et al. 1993). Market-oriented organizations spend a great deal of money on advertising. A market-oriented organization cultivates a rand carefully in the minds of potential customers in an attempt to influence them to buy their products instead of those of competitors, A market orientation represents an additional strategic dimension and is a fundamental approach to understanding markets (Vorhies et al. 2009).

Harmsen & Jensen (2004) clarified that it is a means through which the characteristics of markets can be identified and translated into action plans by the organization, and then implement these characteristics. Plans to achieve response and set goals.

3. Customer Knowledge

The concept of customer knowledge is a relatively recent concept, as many institutions are trying to obtain this knowledge by directing their efforts to customers and satisfying their needs and desires by providing high-quality products at reasonable prices. Acquiring knowledge from customers has become one of the most important competitive advantages that organizations seek today. Through which it seeks to achieve the standards of its services that suit the needs, desires, and preferences of its customers, customer knowledge is a type of knowledge that can be obtained from different sources, especially customer relationship management (El-Helaly, et al. 2015, Yaghoubi et al. 2016, Gibbert et al. 2002). Understanding what the customer knows has a positive impact and is reflected in the performance of the institution, the customer is the source of knowledge and one of the basic pillars of the organization, and understanding his needs, desires, and goals contributes to building strong relationships with them.

Based on this, an organization can use marketing research and customer relationship management to know their needs and desires. This is because possessing knowledge about customers in business organizations is an effective instrument in facing challenges to the external environment and competitors in the marketplace, ability to design and develop new products is also affected by levels of customers' current knowledge (Paquette. 2006).

Many researchers have classified customer knowledge into three categories that consist of knowledge from the customer which refers to assisting customers during the purchase decision, knowledge for the customer, which refers to the customer's product knowledge, and customer about knowledge this type of knowledge is gathered to help understand customer preferences and provide individualized service, and it contains information about the customer's experience.(Desouza & Awazu 2005, Williams. 2014, Wu et al. 2013, Parirokh et al. 2009, Salomann et al. 2005, Williams. 2014, Daghfous et al. 2008, Garcia-Murillo and Annabi. 2002, Williams. 2014).

Customer knowledge leads to improving products, improving customer service, enhancing customer satisfaction, increasing sales volume, determining levels of customer service improvement, discovering new customer knowledge needs, and determining the form and quality of customer-oriented knowledge.

4. The Development of new Services

The scope of service development is one of the most important marketing activities in organizations. This requires making the necessary modifications and development to be able to provide advanced services in a way that can stand up to the competition. Ojanen et al. (2008) state that a fast reaction to changing customer needs is also important in the implementation stage of the new services development process.

New services enable an organization to access market opportunities or increase business with current customers, therefore inventing new products and services is critical for organizational effectiveness. However, because product & service innovation is important, it is critical to analyze the market and adhere to a tight development and review procedure. It has also been recognized as a source of advantage for service organizations (Alrubaiee 2013).

Prior to commencing design or development, the organization should conduct research to determine customer requirements that the organization's present services seem unable to satisfy, and this research will provide a source of knowledge for developing new services, thus it should be accomplished. While the organization is planning for new service advancement, the targeted market should be properly considered, and the organization should develop new services for existing customers or new services for markets, as well as assisting market research and make temporary forecasts for potential demand and revenue for every suggestion, New service development is important for service organizations (De Brentani 1991, Kelly & Storey 2000)

When the organization determines the appropriate ideas and assesses its market potential and amount of threat, it can proceed to detailed technical and product development. As the organization creates a prototype of the new services, it can be used to evaluate the customer, so the organization has to order from a small group of customers that will provide feedback while using the product or service. (Menor & Roth 2007, Johne & Storey 1998)

5. Product Diversification

The search for completely new products is one of the basic conditions for obtaining a competitive advantage and achieving the organization's growth. The prevailing competitive environment has become more complex, in addition to that rapid technological development, which led to a reduction in the life cycle of products and the accompanying change in customer demand and fear of risks industry fluctuations and market fluctuations, or the entry of new competitors, and that the life cycle of the product may lead it to the stage of stagnation for any possible circumstance; Therefore, the organization must resort to diversifying its products or work on improving and developing its current products, regardless of the success achieved by the current product (Barbero et al. 2011, Yacob et al. 2017).

If the company wants its business to grow and prosper in the long term, they have to discover new approaches to reach new customers or consumers and increase the profits that it always wanted to achieve, one of the strategies to achieve this is diversification.

A diversification approach distributes investments over a variety of financial instruments, industries, and other categories to reduce the threat of a market decline. It is a strategy for expanding a firm's core system by offering new products and services. Diversification in business can involve expanding increased production processes or services to maximize returns by investing in several areas that will react differently to the same occurrence (Kim & Rasheed 2014).

The purpose of diversification is to produce different alternatives of products, or additional products, and to increase production lines while using other plans such as making adjustments to the nature of products or their external appearance so that they are different from those in the market, the goal is to attract a new class of customers to obtain greater profit opportunities and increase market shares, Manrai et al. (2014) stated that organizations that used product diversification strategies were more profitable and were able to increase their tangible assets.

6. Method and Data Analyzing

The authors chose the descriptive analytical approach to answer the research questions and prove the validity of the accepted hypotheses. This aims to collect facts and data about a particular phenomenon or situation, with an attempt to interpret and analyze these facts in order to reach recommendations and suggestions regarding the situation or research topic. This approach focuses on the study of the phenomenon as it exists in reality and is based on the study of the phenomenon as it exists in reality. By gathering studies and theoretical books that deal with knowledge, and then designing a questionnaire as the main survey instrument, this is the most common research tool in the administrative and social sciences, and it is used by many strategic studies centers around the world. It analyzes information to monitor the reality based on the previous analysis, the empirical section has conducted in the hypermarket of Majidi Mall in Sulaymaniyah city in the north of Iraq, because the study's population is constrained to 250 employees, researchers have published 135

questionnaires. Data was collected via Google form from these questionnaires and analyzed using the SPSS 22 software program for this study. The data for this study was obtained at random using internet forms. A questionnaire is divided into four parts (customer knowledge, market orientation, new service, and product diversification), each of which has 20 questions based on a 5-likert scale, with 5 indicating strong agreement, 4 indicating agreement, 3 indicating neutrality, 2 indicating disagreement, and 1 indicating strong disagreement = 1. This survey also contained a section for demographic factors, which included gender, marital status, age, years of experience, and academic qualification.

The purpose of this paper is to describe and verify how marketing orientation and customer knowledge develops new service development and production diversification at Majidi Mall in Kurdistan Region in the North of Iraq.

The study answered four main questions:

- What is the impact of market orientation on developing new services?
- What is the impact of market orientation on product diversification?
- What is the impact of customer knowledge on developing new services?
- What is the impact of customer knowledge on product diversification?

Hypothesis:

H1: There is a positive impact of market orientation on product diversification.

H2: There is a positive impact of market orientation on developing new services.

H3: There is a positive impact of customer knowledge on product diversification.

H4: There is a positive impact of customer knowledge on developing new services.

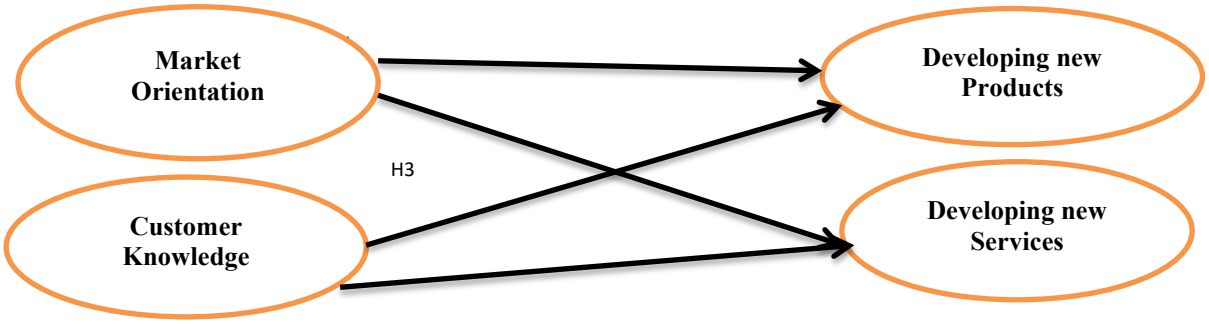


Figure 1: Research Model

7. Demographical Statistics

Table 1 lists the interviewees' gender, age, years of experience, marital status, and academic qualifications. According to the results, 34.8 % were male and 65.2 % were female. Similarly, married participants constituted 31.9 %, while single people created 68.1 %. The percentage of participants under the age of 30 was 43 %. Participants in the 30 to 39-year age group comprised 25.9% of the total. Participants aged 40 to 49 years old accounted for 23% of the total, while those aged 50 and up accounted for 8.1%. There were 32 respondents in the age group (10 to 14 years) with years of experience, whereas there were 55 participants in the age group (5 years). The percentage of employees in the (5-9 years) group reached 31 percent, while the ratio of employees in the (15 and above) group reached 17 percent. The participants' qualifications are also listed; bachelor's degree, secondary education, Master's degree, Ph.D., and Higher Diploma qualifications were (45.9%), (34.8%), (1.5%), (0.7%), and (17%), correspondingly.

Table 1: Demographical Statistics

Variable	Description	Responses	Percentage
Gender	Male	47	34.8
	Female	88	65.2
	Total	135	100
Marital status	Single	92	68.1

Variable	Description	Responses	Percentage
	Married	43	31.9
	Total	135	100
Age	Less than 30 years	58	43.0
	30-39	35	25.9
	40-49	31	23.0
	50+	11	8.1
	Total	135	100
Years of work experience	5 years	55	40.7
	5-9 years	31	23.0
	10-14 years	32	23.7
	15+	17	12.6
	Total	135	100
Academic qualification	Secondary education	47	34.8
	Bachelor	62	45.9
	Higher diploma	23	17.0
	Master	2	1.5
	PhD	1	0.7
	Total	135	100

8. Reliability Tests

SPSS was used to check Cronbach's alpha reliability; the coefficient normally ranges from 0 to 1. While the coefficient has no lower limit, the closer it is to 1.0, the greater the internal coherence of the scale's items; additionally, Cronbach's alpha values of at least 70% will provide reliable estimates.

Table 2: Cronbach's alpha coefficient for variables

Variables	NO. sample	NO. of Questions	Values of Cronbach's alpha
Market Orientation	135	5	.950
Customer Knowledge	135	5	.995
Products diversification	135	5	.993
Developing new Services	135	5	.969

9. Correlation Coefficient Test

The correlation between Market Orientation, Customer Knowledge, Product Diversification, and Developing New Services is shown in Table (3). As evidenced by the 96.6 %, there is a positive substantial relationship between Market Orientation and Product Diversification. As indicated by the 98.3 %, there is a considerable and positive relationship between Market Orientation and Developing New Services. It also reveals that there is a good relationship between Customer Knowledge and Product Diversification, as evidenced by 99.6%, and a positive relationship between Customer Knowledge and Developing New Services, as evidenced by 98.7%. As evidenced by the 96.5 %, the results reveal a considerable and positive relationship between Market Orientation and Customer Knowledge.

The significant conclusion of this analysis is that independent and dependent variables have such a significant correlation.

Table 3: Correlations

		Market Orientation	Customer Knowledge	Products Diversification	Developing new Services
Market Orientation	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	135			
Customer Knowledge	Pearson Correlation	.965**	1		
	Sig. (2-tailed)	.000			
	N	135	135		
Products Diversification	Pearson Correlation	.966**	.996**	1	
	Sig. (2-tailed)	.000	.000		
	N	135	135	135	
Developing new Services	Pearson Correlation	.983**	.987**	.988**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	135	135	135	135

**. Correlation is significant at the 0.01 level (2-tailed).

10. Model Summary

Model summary results have been obtained from computations made using SPSS 22, and the findings demonstrate that market orientation explains 96.9% of changes in Majidi Mall's product diversification and development of new services. This means that variables outside the estimated model account for 3.1 percent of changes in Majidi Mall's product diversification and development of new services; additionally, the results show that customer knowledge accounts for 99.2 % of changes in Majidi Mall's product diversification and development of new services. As a result, variables outside the estimated model account for 0.8 percent of changes in Majidi Mall's product diversification and development of new services.

Table 4: Model Summary

Model 1	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.984a	.969	.968	1.037
Model 2	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.996a	.992	.992	.619

Model 1

a. Predictors: (Constant), Products diversification, Developing new Services

b. Dependent Variable: market orientation

Model 2

a. Predictors: (Constant), Products diversification, Developing new Services

b. Dependent Variable: customer knowledge

11. Analysis of Variance (ANOVA)

The objective is to acknowledge that the model is correctly stated when the generated p-value is significant at 1 percent based on ANOVA results. Because the p-value is significant at 1%, it may be stated that the model is accurately described. According to sig, statistically, all independent variables in knowledge management have a positive impact on independent variables.

Table 5: ANOVA[b]

Model 1		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	4398.141	2	2199.071	2.047E3	.000[a]
	Residual	141.829	132	1.074		
	Total	4539.970	134			
Model 2						
1	Regression	6669.220	2	3334.610	8.714E3	.000[a]
	Residual	50.514	132	.383		
	Total	6719.733	134			

Model 1

a. Predictors: (Constant), Products diversification, developing new Services

b. Dependent Variable: Customer Knowledge

Model 2

a. Predictors: (Constant), Products diversification, developing new Services

b. Dependent Variable: Market Orientation

12. Regression Coefficient Analysis

The regression analysis findings are shown in Table (6). According to the conclusion, a 1% improvement in Market Orientation would result in an 81.8 % increase in Majidi Mall's Product Diversification, while a 1% increase in Customer Knowledge will result in a 91.9 % growth in Majidi Mall's Product Diversification. Furthermore, positive changes in Market Orientation will result in Majidi Mall's development of New Services is supported by 90.9 %, and positive changes in Customer Knowledge will result in Majidi Mall's development of New Services being reinforced by 88.6 percent, for each successive 1% improvement

Table 6: Coefficients

Model 1		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.546	.311		8.197	.000
	market orientation	.818	.084	1.260	12.597	.010
	Customer Knowledge	.919	.090	1.240	12.400	.000
	Model 2					
1	(Constant)	.550	.185		2.965	.000
	market orientation	.909	.050	.892	18.173	.000
	Customer Knowledge	.886	.054	.106	2.157	.033

Model 1

a. Dependent Variable: Products diversification

Model 2

a. Dependent Variable: Developing new Services

13. Tests of Hypotheses

The results of the hypothesis were developed through correlation coefficient analysis, which is the result of this survey, which was attained through the analysis of data gathered from Majidi Mall employees, and is based on the previously described literature research. The findings of the study showed that all hypotheses were accepted. However, it can be acknowledged that advances in market orientation and customer knowledge have a positive significant impact on product diversification and new service development.

14. Conclusion

The organization's preservation of its customers has become equivalent to the customer's decision to continue with the level of value that is offered to them. The customer is located in an open environment that is easy for him to view offers presented and compared between them and thus choose the best. This means that the organization faces two imperatives: the first is to create a competitive advantage through diversification of products and development in services and the second is to maintain this advantage or an innovation that could limit this superiority. This study consists of a theoretical and empirical section for accomplishing the objectives of the study and identifying and demonstrating the theoretical components. This study depended on sources that were applied to the research, including books, articles, journals, newspapers, magazines, thesis and dissertations, organization reports, as well as the international information network (Internet websites), also to obtain primary data of the study, the questionnaire was adopted as the main tool in data collection, as its formulation took into account its inclusion on the approved research variables, and was formulated to serve the research objectives and hypotheses based on the theoretical side, moreover, also (SPSS) was used in the data analysis process, Statistical Package for the Social Sciences program. The study's results demonstrate that market orientation and consumer knowledge have a positive and statistically significant effect on product diversification and the development of new services.

15. Implication

The conclusion of this study suggests that management at the organization should exploit their knowledge of customers and market orientation to the institution's advantage and should also empower the organization with the required knowledge to complete the work as effectively as feasible. A high degree of performance from the personnel will improve the organization's capacity for producing new products and services. Increased customer satisfaction results from fast and effective problem-solving within a business, which is influenced by customer knowledge and market orientation.

The market orientation and customer knowledge came to raise the value of the customer and create and maintain the competitive advantage, diversifying the offers, taking into account their response to the customer's cost ability, taking into account all the variables of the competitive environment, and also leaving no room for surprise and for the organization to remain in a permanent superiority. It provides the organization with continuous monitoring of its competitive environment and helps it raise the value of the customer, which increases loyalty to the company. Market orientation and consumer knowledge is a continuation of the development of marketing, which is an affirmation of the flexibility of this thought, to fill the deficit known by previous trends that were characterized by marketing short-sightedness. This requires the organization's possession of a strong marketing information system, the market orientation with its multiple elements makes the organization; An extensive amount of information that needs to be updated, modified and analyzed.

One of the study's most important recommendations is to increase attention to market orientation and customer knowledge because it is an organization's most important strategic resource and primary component of excellence. In organizations, knowledge has to become the real wealth of organizations, as it plays a key role in supporting organizations in competition with different companies. Relationships between corporate employees with stakeholders, customers, and external resources will increase the ratio of knowledge exchange. The analysis of the various forces that affect the efficiency of the organization is proving that the main force that has the greatest impact on The human aspect, which reflected in individuals and groups dealing with the organization and making decisions that will permit it to launch and succeed, it is responsible

for the formation of the organization's movement among these different forces. To face intense competition and maintain a competitive advantage, it must incorporate the development of new products and services into its strategies.

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Trust and Knowledge Sharing in Temporary Project Teams: A Literature Review

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Abstract: Knowledge has become a pivotal organisational asset, with its value realised primarily through effective sharing. This is especially critical in project-based organisations (PBOs), where temporary teams operate in dynamic environments. Trust is a key enabler influencing knowledge sharing within these teams. This paper reviews literature on the relationship between trust and knowledge sharing in project teams, focusing on how trust facilitates or impedes knowledge flow. It examines mechanisms for trust development in temporary, team-based organisational structures and explores the concept of swift trust as a model for rapid trust formation. The review identifies gaps in understanding how traditional trust models apply to temporary teams and highlights unique challenges in PBOs, where trust must often be established quickly among members without prior relationships. Findings suggest that while trust remains essential for effective knowledge sharing, its development in temporary teams relies on different mechanisms than in long-term teams. The paper concludes by emphasizing the need for early trust-building strategies in temporary teams and calls for further research on trust dynamics in these contexts.

Keywords: Knowledge sharing, Trust, Swift trust, Tacit and explicit knowledge

1. Introduction

In today's dynamic business environment organisations are confronted by challenges arising from economic uncertainty, technological innovation, and growing environmental responsibilities. This volatile context necessitates organisational agility and adaptability to ensure both survival and long term success. Drucker (1993) identified knowledge as the most important productive asset, a view widely supported as a key driver of competitive advantage (Azeem *et al*., 2021). However, this potential is only realised when knowledge is embedded in a supportive and enabling environment (Davenport and Prusak, 2005). While knowledge originates at the individual level (Grant, 1996), its value grows when shared collectively, enhancing team capability and organisational learning.

Knowledge sharing has therefore become central for both practitioners and scholars (Nonaka, 1994; Anwar *et al*., 2019). Within organisations, it is especially prioritised at the team level, where collaboration, performance, and overall success are directly influenced by how effectively knowledge is shared. This sharing of knowledge promotes better team outcomes (Lee *et al*., 2015), supports innovation (Rahmi and Indarti, 2019), and stimulates creativity among employees (Zeb *et al*., 2019). It also contributes to organisational learning and strengthens commitment (Curado and Vieira, 2019), facilitates change initiatives (Park and Kim, 2015), and enhances organisational effectiveness by leveraging shared expertise (Mueller, 2014).

The emphasis on knowledge sharing is particularly significant in project-based organisations (PBOs), such as those in engineering, procurement, and construction (EPC) (Hobday, 2000). In these settings, tasks often require multidisciplinary collaboration, making knowledge sharing vital for successful project delivery. Furthermore, projects in PBOs are inherently varied (Project Management Body of Knowledge, 2021), each one presents opportunities for learning through shared experiences. However, despite its value consistent knowledge sharing remains a challenge (Mueller, 2014) with barriers that can hinder innovation, and overall organisational viability (Rutten *et al*., 2016).

Among the various factors influencing knowledge sharing, trust stands out as a critical enabler (Kipkosgei *et al*., 2020; Rutten *et al*., 2016). Researchers have increasingly explored the interplay between trust and knowledge sharing (Anwar *et al*., 2019), often highlighting its central role in facilitating open communication and collaboration within teams (Rutten *et al*., 2016), which ultimately enhances organisational outcomes (Mueller, 2014).

Recent empirical research details the pivotal role of prior ties and familiarity in facilitating early trust formation within temporary project teams, particularly in complex and interdisciplinary settings such as construction (Buvik and Rolfsen, 2015; Buvik, 2019). The temporary nature of project-based teams often preclude the luxury of building trust through extended interactions, challenging traditional trust models that assume gradual trust develops over time. This gap highlights the need for alternative mechanisms, such as swift trust, to explain trust

dynamics in temporary teams (Meyerson *et al*., 1996), yet the conditions under which swift trust transitions into more resilient trust remain insufficiently understood (McLaren and Loosemore, 2019).

Having established the importance and complexity of knowledge sharing in project teams, this review employs a structured methodology to gather and synthesise existing research, as detailed below.

2. Methods

This literature review was conducted using a rigorous approach to identify, select, and synthesise relevant studies on knowledge sharing and trust within project-based organisational contexts.

A comprehensive search was performed across multiple academic databases including IEEE Xplore, Emerald Insights, Scopus, Web of Science, and Google Scholar. Keywords such as "knowledge sharing," "knowledge transfer", "trust," "project teams," "project-based organisations," and "virtual teams" were combined using Boolean operators to capture a broad yet focused set of publications.

Inclusion criteria were applied to select peer-reviewed journal articles, conference papers, and authoritative reports published primarily between 2011 and 2025 to ensure relevance. Studies were included if they addressed factors influencing knowledge sharing, trust, within teams and project-based settings. Both empirical and theoretical works were considered to provide a comprehensive understanding. Titles and abstracts were screened for relevance, followed by full-text reviews. Key data extracted included research objectives, theoretical frameworks, methodologies, and findings related to enablers and inhibitors of knowledge sharing and trust development. Thematic synthesis was employed to organise findings into coherent themes, such as trust as a critical enabler, and challenges in temporary teams.

This review concentrates on the role of trust in shaping knowledge sharing practices among project teams in PBOs. It begins with a conceptual overview of knowledge sharing, then examines the nature of knowledge itself. The review then considers both the enablers and inhibitors of knowledge sharing, before focusing in detail on trust as a central factor influencing the sharing of knowledge in project teams.

3. Conceptualising Knowledge Sharing

The literature presents various interpretations of knowledge sharing. Generally, it is seen as a behaviour initiated by individuals who voluntarily share insights and expertise (Swart *et al*., 2014). Knowledge sharing involves making one's knowledge accessible to others often through the sharing of skills, experiences, and insights (Caruso, 2017), and through effective communication (Xue *et al*., 2011). This exchange not only enhances the receiver's understanding (Davenport and Prusak, 2005) but also supports the development of individual and collective capabilities.

Swart *et al*. (2014) define knowledge sharing in teams as exchanging task relevant ideas that reshape existing knowledge, enhancing decision making through diverse perspectives. According to Lee *et al*. (2015, p. 3), "members of a team share knowledge with one another when they have access to other team members through which they can garner and integrate knowledge and can anticipate value through sharing". Nonaka (1994) also noted the crucial role of team interaction in effective knowledge sharing. Ultimately, these exchanges foster a learning culture and support stronger organisational commitment (Curado and Vieira, 2019).

4. Understanding the Nature of Knowledge in Knowledge Sharing

To understand knowledge sharing fully, it is important to first understand what knowledge entails. Knowledge is often classified into two main categories: explicit and tacit (Polanyi, 1966). Explicit knowledge is codified and easily documented, taking the form of manuals, procedures, blueprints, and other tangible resources (Maravilhas and Martins, 2019). It is easily articulated and widely shared (Grant, 1996). Tacit knowledge, on the other hand, is embedded in personal experience and is harder to communicate (Nonaka, 1994). It consists of insights, routines, beliefs, and intuitions (Maravilhas and Martins, 2019), and is shaped by values, emotions, and lived experience (Nonaka, 1994). Unlike explicit knowledge, tacit knowledge is subjective, fluid, and deeply tied to context. Its complexity often prevents individuals from expressing it easily, because it is difficult to articulate (Argyris and Schön, 1996). Additionally, tacit knowledge evolves over time and adapts through continuous interaction with the environment, making it dynamic and experiential in nature (Davenport and Prusak, 2005). For this reason, effective knowledge sharing strategies must account for both the explicit and tacit dimensions of knowledge. Understanding these two dimensions is essential for identifying the factors that enable and inhibit knowledge sharing, particularly within project-based teams, where both explicit and tacit knowledge sharing is essential.

5. Enablers and Inhibitors of Knowledge Sharing

Sharing knowledge is a fragile and complex process, which is dependent on an understanding of the enablers as well as the potential inhibitors which influence the practice.

5.1 Enablers of Knowledge Sharing

Knowledge sharing enablers are factors at the individual, team, and/or organisational level which improve the knowledge holder's willingness to share knowledge. Such factors, if implemented correctly, will significantly contribute to the knowledge sharing process. Table 1 below summarises the enablers of knowledge sharing identified within the literature.

Table 1: Knowledge sharing enablers

Enablers of Knowledge Sharing	Description	Author/Year
Trust	Builds psychological safety and openness to share knowledge	Meyerson *et al*. (1996), Rosendaal and Biilsma-Frankema (2013), Rutten *et al*. (2016), Olaisen and Revang (2017), Ouakouak and Ouedraogo, (2018), Zeb *et al*. (2019)
Team leader attributes	Leadership that encourages open communication	Xue *et al.* (2011), Zeb *et al*. (2019)
Relationships	Strong bond among team members	Olaisen and Revang (2017), Wei, Y., Miraglia, S. (2017)
Cognitive diversity	Different thinking styles enhances the variety of perspective shared	Rahmi and Indarti (2019)
Knowledge heterogeneity	Differences in background knowledge .	Pinjani and Palvia (2013), Wu *et al*. (2015)
Team identification	Strong identification with a team	Rosendaal and Biilsma-Frankema (2013)

Among the numerous enablers, trust consistently emerges as the most influential factor in facilitating knowledge sharing. Not only is it significant in its own right, but trust also underpins several other concepts that contribute to effective knowledge sharing (Ouakouak and Ouedraogo, 2018; Anwar *et al*., 2019). Empirical studies have demonstrated that higher levels of trust among colleagues correlate with a greater willingness to share knowledge (Rutten *et al*., 2016) and can even accelerate the pace at which knowledge is exchanged (Zeb *et al*., 2019). Trust is particularly vital when individuals are concerned about how their shared knowledge might be used. Rosendaal and Biilsma-Frankema (2013) argue that knowledge sharing is more likely to occur when the provider trusts that recipients will not exploit the knowledge for personal gain. This is especially pertinent in distributed or remote teams, where virtual interactions amplify the importance of trust in shaping collaborative behaviours (Olaisen and Revang, 2017).

The collective findings suggest that trust plays a central role in cultivating environments where knowledge is freely exchanged. However, despite the significance of trust as a facilitator, knowledge sharing is often impeded by a range of organisational and individual inhibitors. These inhibitors must also be considered to develop a more comprehensive understanding of the dynamics that shape knowledge sharing.

5.2 Inhibitors of Knowledge Sharing

Knowledge sharing inhibitors are factors which restrict or prevent the knowledge holder's willingness to share knowledge and, therefore, may prevent the organisation from reaching its full potential. Table 2 below summarises the main inhibitors of knowledge sharing.

Table 2: Knowledge sharing inhibitors

Inhibitors of Knowledge Sharing	Description	Author/Year
Hoarding knowledge:	Fear of losing value or power	Muqadas *et al*. (2016), Jugdev and Wishart (2014)

Inhibitors of Knowledge Sharing	Description	Author/Year
Poor leadership	Fails to support knowledge sharing	Boies *et al.* (2015)
Lack of trust/distrust	Inhibits willingness to share.	Rutten *et al*. (2016)
Time constraints	Sharing seen as time consuming	Cleveland and Eilis (2015),
Organisational culture	May discourage sharing	Wei and Miraglia (2017)
Poor communication skills	Prevents effective sharing	Cleveland and Eilis (2015)

Key inhibitors include knowledge hoarding, poor leadership, and lack of trust. Hoarding often stems from fear of losing one's unique value and power (Muqadas *et al*., 2016). Bureaucratic leadership styles further discourage sharing, particularly when leaders fail to promote openness and collaboration. Among these factors trust is the most crucial. Low levels of trust reduce willingness to share and often lead to knowledge hiding (Rutten *et al*., 2016). When team members fear exploitation or misuse of shared information, they become reluctant to contribute, impeding team performance. Trust not only enables sharing but also mitigates the risk of knowledge being withheld (Anwar *et al*., 2019).

Given the importance of trust, in knowledge sharing, it warrants a deeper exploration. The next section trust will examined how trust is conceptualised, the enablers and inhibitors of trust, and its specific influence in knowledge sharing in teams.

6. The Conceptualisation of Trust

Trust has been widely studied across disciplines, industries, and sectors, with consensus that it is multifaceted (Mayer *et al*.,1995), involving a dyadic relationship and evolving over time through an individual's repeated positive experience with another. Mayer *et al*. (1995) characterised trust as a risk-taking action reflecting "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (p. 712). The authors also proposed that trustworthiness is assessed through three dimensions: integrity, ability, and benevolence. Integrity refers to a set of principles the trustee adheres to, and the trustor finds acceptable. Ability refers to the skill set and competence one displays. Benevolence implies a connection between team members with the understanding that each member wants to do good (Mayer, *et al.*, 1995).

Similarly, Lewicki and Bunker (1996) proposed a three stage sequential model of trust: calculus-based trust, knowledge-based trust, and identification-based trust. Calculus-based trust is based on the integrity of the team member. Knowledge-based trust is based on familiarity through interactions of team members, which develops over time. This is followed by identification-based trust, which takes place when team members acknowledge that one member can act on behalf of another. These stages align closely with Mayer *et al.'s* (1995) trust dimensions. Specifically, Integrity and ability compares to the earlier stages of calculus and knowledge-based trust, which typically develops early in a working relationship. Benevolence-based trust aligns with identification-based trust, which tends to emerge later as deeper relationships form (Buvik and Rolfsen, 2015). Therefore, it can be ascertained that trust develops over time based on an individual's repeated positive behaviour through professional working relationships (Buvik and Rolfsen, 2015).

Meyerson *et al*. (1996) asserted that a unique form of trust – that is not behaviour and time dependent – exists within a temporary team environment, where team members still experience the advantage of trust through the development of swift trust. Meyerson and colleagues argued that swift trust has two requirements in order for it to occur: (a) team composition, which consists of limited working history, prospects of working together again, team size, and diverse talent; and (b) team tasking, which consists of complex tasks, that are non-routine, and time bound. Swift trust is an individual's initial trust perception (Robert *et al.*, 2009) which is developed through a category-based process built on a team members' characteristics, such as title, expertise, and specialised roles, where individuals subconsciously place team members into a category and assume trust based on that category (Meyerson *et al*., 1996). Category-based processing develops out of a long-term association predominantly from past experience (Robert *et al*., 2009).

Barrett (2025) conducted a systematic review which synthesizes current knowledge on swift trust in temporary teams, emphasising that while swift trust facilitates rapid collaboration, its formation and sustainability are influenced by team composition, task complexity, and communication patterns. McLaren and Loosemore's (2019) research found that reputation and clear roles foster swift trust in temporary project teams. Swift trust has been recognised as essential in virtual teams, where trust musted be assumed immediately to meet objectives (Crisp and Jarvenpaa, 2013). In such settings doubts are set aside for the sake of collaboration (Germain, 2011). Robert *et al*. (2009) provided empirical evidence showing that swift trust can develop into knowledge-based (ability, benevolence, and integrity) trust. Similarly, Zakaria and Yusof (2020) findings suggest that swift trust can develop and deteriorate quickly and, depending on the right conditions, maybe replaced by a resilient longer lasting trust.

6.1 Enablers and Inhibitors of Trust in a Team

Studies suggest there are a number of enablers of trust. Table 3 below summarises the enablers of trust within a team identified from the literature.

Table 3: Enablers of trust in teams

Enablers of Trust	Description	Author/Year
Shared vision	Comon beliefs and values shared among team members	Rios-Ballesteros and Fuerst, (2022).
Communication	Effective sharing of information within teams	Germain (2011)
Intellectual ability and agreeableness	Team members cognitive abilities and competence.	Naber *et al*. (2018)
Prior positive relationships	Previous good working experience among team members	Buvik and Rolfsen (2015)
Co-operative behaviour	Engaging collaboratively to achieve common goals	Naber *et al*. (2018)
Leadership	Influence of leaders in fostering trust	Phung *et al*. (2019), Islam, *et al.* (2021), Legood *et al*. (2020).

Trust in teams is fostered by shared vision, effective communication, intellectual ability, prior positive relationships, cooperative behaviour, and supportive leadership (Rios-Ballesteros and Fuerst, 2022; Germain, 2011; Naber *et al.,* 2018; Buvik and Rolfsen, 2015; Legood *et al*., 2020). These factors collectively enhance trust development by promoting alignment, familiarity, and collaboration.

6.2 Inhibitors of Trust in a Team

Similarly, studies suggest there are a number of inhibitors of trust. Table 4 below summarises the inhibitors of trust within a team identified from the literature.

Table 4: Inhibitors of trust in teams

Inhibitors of Trust	Description	Author/Year
Language barrier	Lack of common language impeding communication	Tenzer *et al.* (2014)
Control systems	Organisational controls limiting trust developing	Jørgensen and Åsgård (2019)
Deep level diversity	Differences in attitudes and values	Pinjani and Palvia (2013)
Intellectual ability, co-operative behaviour	Lower cognitive ability reducing trust	Naber *et al*. (2018)
Knowledge sharing	Lack of sharing knowledge	Rutten *et al.* (2016)

Trust is inhibited by language barriers, controlling organisational mechanisms, low intellectual ability, deep-level diversity, and poor knowledge sharing (Tenzer *et al*., 2014; Jørgensen and Åsgård, 2019; Pinjani and Palvia, 2013; Rutten *et al*., 2016). Such inhibitors disrupt communication and reduce interpersonal trust, undermining team cohesion.

6.3 The Role of Trust in Knowledge Sharing in Teams

Trust influences knowledge sharing within teams (Rutten *et al*., 2016) and contributes improved team and task performance (Boies *et al*., 2015), team and organisational commitment (Curado and Vieira, 2019). Trust engenders team identification, and collective thinking (Rosendaal and Biilsma-Frankema, 2013). While trust is widely recognised as important to the functioning of teams, it is especially necessary for enabling knowledge sharing. Trust improves team cohesion and relationships (Zand, 1971), this enhances team members' willingness to help each other; which enhances knowledge sharing (Xue et al., 2011, Rutten et al. 2016). Individuals are more likely to share knowledge with those they trust. While trust has been research in teams, few have focused on temporary project teams, such as PBOs, where this literature review interests lie.

7. Project-Based Organisations

Project-based organisations (PBOs) rely on temporary teams, requiring high levels of interdependence among members (Buvik and Rolfsen, 2015). This structure creates both a need and a vulnerability as team members must share knowledge to perform effectively, yet the temporary nature of these teams can make it difficult to build the trust that facilitates such sharing.

Unlike traditional organisations, PBOs are structured around individual projects as the primary unit of work, with the organisational structure adapting to each project's specific needs (Hobday, 2000). This often involves bringing in specialised external contractors who may be unfamiliar to the core team. These temporary contributors provide essential expertise but may leave at project completion, taking with them valuable knowledge that could benefit future initiatives. The changing nature of such teams hinder the development of strong interpersonal relationships, which are typically needed for trust to emerge (Mueller, 2014).

Traditional theories propose that trust is built gradually through repeated positive interactions (Mayer *et al*., 1995; Lewicki and Bunker, 1996) and cannot be imposed. In temporary teams, however, these conditions are rarely met, suggesting that initial trust levels may be low and, consequently, that knowledge sharing may be limited (Rutten *et al*., 2016). While PBOs are often successful at delivering individual projects, they are frequently criticised for lacking the formal or informal mechanisms to capture and share knowledge between projects (Hobday, 2000; Davidavičienė, 2020). This raises concerns about long-term organisational learning and performance.

Research challenges the assumption that trust must always develop slowly. In temporary project environments, teams often demonstrate swift trust, where trust is formed rapidly based on perceived roles, competence, or credentials rather than past experience (Meyerson *et al*., 1996; McLaren and Loosemore, 2019). Swift trust appears particularly relevant in fast-paced project settings, where members with diverse skills and backgrounds must collaborate quickly to meet deadlines. This concept offers a potential alternative model of trust that may better suit the realities of PBOs.

8. Contribution to Academic Debate

This literature review contributes to the academic debate by synthesising the intersection of trust and knowledge sharing specifically within temporary project teams in project-based organisations (PBOs), highlighting that traditional trust models may not fully apply in these transient, multidisciplinary settings. It emphasizes the critical role of swift trust in enabling rapid trust formation while identifying gaps in understanding how swift trust evolves and transitions into more enduring forms. Furthermore, it bridges theory and practice by outlining how trust-building strategies tailored to temporary teams where early trust development and perceived competence are vital due to limited prior relationships. Finally, the review sets a clear agenda for future research, calling for studies on trust dynamics, empirical validation of swift trust across diverse contexts, and development of integrative models linking trust, knowledge sharing, and project outcomes, thereby advancing both theoretical understanding and practical management of knowledge in dynamic organisational environments.

9. Conclusion

This paper presents a comprehensive literature review on knowledge sharing within teams, with a specific focus on the role of trust as a critical influencing factor. Despite the wealth of research on knowledge sharing, there is a noticeable gap in the exploration of knowledge sharing dynamics within project teams of a temporary nature. Furthermore, while there is extensive literature on trust development among team members, there is a scarcity of research specifically addressing trust development in temporary project teams. The literature review

emphasises the significance of trust development in temporary teams, particularly in project-based teams where knowledge sharing is paramount. Notably, there is a need for more research on swift trust, suggesting trust can be rapidly established in temporary teams. Investigating swift trust can offer valuable insights for practitioners, raising awareness of trust development and its significance in fostering knowledge sharing. This, in turn, contributes to advancing the theoretical understanding of knowledge sharing practices.

Ethical declaration: Ethical Clearance was not needed for the research referred to in this paper.

AI declaration: AI tools where not used in the development of this paper.

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Navigating the Unknown: Knowledge Management in Machine Learning-Driven Product Development

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Abstract: The Digital Fish Simulation Project is a machine learning-driven innovation initiative aimed at optimizing fish production processes by developing simulation-based tools for digital modeling of fish behavior. Set within the context of the seafood industry's increasing demand for sustainability, precision, and efficiency, the project operates in a domain characterized by limited prior expertise and significant biological variability. As such, knowledge creation must be dynamic, interdisciplinary, and continuously evolving. This article explores the project from a knowledge management perspective, applying Nonaka and Takeuchi's SECI model of organizational knowledge creation and the Manulab–Industry Competence Building Process as theoretical frameworks. The study focuses on how structured knowledge management practices, embedded from the earliest stages, enable successful navigation of uncertainty and foster innovation in machine learning-based product development. Workshops were employed as the primary research method, functioning not only as operational project checkpoints but also as structured environments for facilitating interdisciplinary collaboration, surfacing tacit knowledge, externalizing insights, and iteratively refining concepts and prototypes. Through this action research methodology, the study captures the dynamic interplay between knowledge creation activities and project advancement. Preliminary findings indicate that, unlike traditional automation projects where knowledge transfer follows linear trajectories, machine learning-driven innovation demands multiple, parallel SECI cycles running simultaneously across different knowledge domains. Sustained involvement of industry partners from the earliest stages, coupled with interdisciplinary teamwork among engineers, biologists, simulation specialists, and students, has proven critical for effective knowledge creation. Trial-and-error learning, real-time adaptation, and continuous feedback loops emerged as key mechanisms for accelerating organizational learning. The article concludes with recommendations for future research, emphasizing the need to explore structured models for parallel SECI cycle management, interdisciplinary knowledge transfer optimization, and the institutionalization of trial-and-error learning processes. The findings contribute to a deeper understanding of how knowledge management practices must evolve to support sustainable, human-centric innovation in emerging machine learning-driven industrial environments.

Keywords: Simulation-based product development, Knowledge management, Seafood industry innovation, Machine learning, Industry 4.0, Industry-academia collaboration

1. Introduction

This article presents an analysis of the preliminary results and current status of a research project that leverages simulation as a tool for knowledge creation in machine learning-driven product development within the seafood industry. The project's core objective is to develop a simulation environment that supports innovation and customization of fish production lines. This includes the integration of fish processing machinery and transport systems, digital soft-body models of fish, AI-based generation of synthetic datasets for different fish species and varieties, as well as advanced machine learning and related algorithms. The simulation environment is intended to support the design, testing, and innovation of fish production lines. Its anticipated benefits include accelerated innovation, reduced time to commissioning, and faster achievement of full industrial performance. While the technical aim of the project focuses on the development of digital fish models and the optimization of production lines through simulation, this article specifically explores how structured knowledge management (KM) processes can support innovation in environments characterized by high uncertainty and limited prior expertise.

The project operates in a context where traditional, tacit knowledge about automation in fish processing is largely lacking. Therefore, knowledge creation must be dynamic and collaborative, involving interdisciplinary efforts across academia, industry partners, and students. Drawing on Nonaka and Takeuchi's model of organizational knowledge creation, and further developed through the Manulab–Industry Competence Building Process, this research investigates how knowledge can be generated, validated, and integrated into machine learning-based product development (Nonaka and Takeuchi 1995; Hansen *et al.* 2023). A wide range of knowledge domains and competencies are involved in the project, including: 1) biologists' understanding of fish

anatomy and responses to various conditions; 2) physicists' ability to convert biological insights into measurable physical data, including the design of measurement systems; 3) data experts' capabilities in developing scanning technologies and data handling methods; 4) simulation experts' knowledge of platforms and simulation environment design; 5) industrial practitioners' practical insights into real-world fish production lines. Expertise in areas such as automated measurement technologies, advanced data tools for scanning, machine learning, simulation, and appropriate lab procedures is crucial for project success. *Based on these knowledge challenges, this article examines how well the Manulab–Industry Competence Building model supports machine learning-driven product development. The research outlines and reflects on key learnings from this case study.*

This article is structured as follows: the Background section presents the challenges of knowledge creation in fish processing innovation. The Method section explains the research approach based on structured workshops used as a research method. The Theoretical Framework outlines key concepts from knowledge management theory and introduces the Manulab–Industry Competence Building Process. The Case Description provides insights from the ongoing Digital Fish Simulation Project, focusing on early-stage knowledge creation and interdisciplinary collaboration. The Discussion section analyses the preliminary findings in relation to knowledge management strategies for machine learning-driven projects. The Conclusion summarizes the main contributions and proposes directions for future research. The article ends with an Ethics Declaration and an AI Declaration, following the ECKM submission requirements.

2. Background

The development of fish production lines has historically been based on practical experience and tacit knowledge accumulated through hands-on trial and error. Equipment has often been designed, tested, and verified using available dead fish in workshop settings, providing limited insights into how systems would perform under real operational conditions. Once installed aboard vessels, these production lines typically undergo years of incremental adjustments before achieving acceptable efficiency levels of 85–90%. This long commissioning phase results in substantial costs, operational disruptions, and increased financial risks for both vessel owners and equipment suppliers.

Traditional development models, while valuable in low-uncertainty environments, struggle when applied to contexts marked by biological variability, changing regulations, and rapid innovation cycles. The seafood industry increasingly faces demands for higher production efficiency, greater sustainability, and faster time-to-market — challenges that require new approaches to knowledge creation and application.

In response to these needs, the current research project adopts a simulation-driven methodology designed not just to optimize technical performance but to build organizational knowledge systematically. By embedding knowledge management principles into every phase of development, the project moves beyond isolated technical improvements toward holistic innovation processes. The aim is to create a simulation-based platform that reduces reliance on physical prototyping, accelerates learning cycles, and integrates biological complexity into production design. These goals align with a broader transformation seen across manufacturing industries in the wake of Industry 4.0. The advent of intelligent, connected technologies has reshaped knowledge management, shifting it from static, repository-based systems toward dynamic, adaptive infrastructures. Historically, KM focused on the manual documentation of explicit knowledge, with limited responsiveness to rapidly evolving environments (Zhang *et al.* 2025). Today, with the integration of artificial intelligence, cyber-physical systems, and advanced data analytics, modern KM platforms support real-time decision-making and continuous learning by incorporating both tacit and explicit knowledge (Del Vecchio *et al.* 2018).

Central to this evolution is the role of data as a strategic asset. Data-driven KM systems now leverage machine learning, big data analytics, and natural language processing to extract insights from heterogeneous sources such as sensor data, operational logs, and expert input. This enables organizations to detect anomalies, predict trends, and enhance responsiveness across complex systems (Zhang *et al.* 2025). In this way, KM becomes a critical enabler of innovation, resilience, and continuous improvement—capabilities that are especially relevant in smart manufacturing and biologically complex sectors like seafood processing (Machado, Winroth and Ribeiro da Silva 2020; Romero *et al.* 2016).

At this early stage, significant progress has been made in assembling preliminary digital fish models and testing various simulation environments. Researchers and industry partners at the Norwegian University of Science and Technology (NTNU), Campus Ålesund, have collaborated to produce soft, flexible digital fish models within discrete-event simulation frameworks (Banks *et al.* 2010) and game engine environments. Initial results demonstrate the feasibility of replicating realistic fish behaviour in a digital setting. However, empirical

limitations—particularly concerning fish stiffness, friction coefficients, and dynamic interaction properties—highlight the pressing need for robust biological data collection (Kleppe *et al.* 2024; Giske *et al.* 2023).

These findings reveal a key insight: effective development in machine learning-driven product innovation depends on structured, interdisciplinary knowledge creation. Engineers, marine biologists, simulation developers, and industrial practitioners must work together continuously, sharing and iterating knowledge in real time rather than relying on handovers between isolated domains.

Beyond technical outcomes, the project's approach also supports broader sustainability goals by minimizing reliance on dead fish for prototyping, reducing waste, and enabling more sustainable, resource-efficient production workflows (Giske *et al.* 2023). By integrating Nonaka and Takeuchi's knowledge creation model into its methodology and adapting it to the realities of machine learning-based innovation, the project lays the groundwork for a new way of developing industrial systems—one that emphasizes agility, collaboration, and continuous learning.

3. Method

This study adopts an applied research approach, using structured workshops as the primary research method to investigate how knowledge management practices—specifically, the SECI model and the Manulab–Industry Competence Building Process—can be operationalized to manage a machine learning-driven innovation project (Ørngreen and Levinsen 2017). The research is conducted by a core team of four researchers: three are affiliated with the Norwegian University of Science and Technology (NTNU), and one works as a Research and Development (R&D) manager in industry while holding a part-time position at NTNU. Together, the team is engaged in both the management of the Digital Fish Simulation Project and the study of how knowledge is created, shared, and institutionalized throughout its phases.

Workshops have been organized at critical project milestones, serving as structured reflection points where knowledge creation activities are observed, documented, and analyzed. These workshops are not only part of the project's operational activities but are explicitly used as data collection events for the research.

The workshops are designed to: enable direct socialization between researchers, students, and industry professionals, surfacing tacit knowledge; facilitate externalization of insights through joint discussion, documentation, and shared problem-solving; track how concepts are created, justified, and embodied in prototypes; analyze how interdisciplinary collaboration shapes knowledge emergence and management; support empirical investigation of how SECI cycles operate in a machine learning-driven project context.

Participants in the workshops include representatives from multiple knowledge domains: simulation technology, mechanical engineering, automation, marine biology, and industrial fish processing. Each workshop focused on discussions related to key work packages:

- **WP1: Data collection** – Investigating how empirical biological data is collected and transformed into structured knowledge assets.
- **WP2: Model development of digital fish** – Exploring the translation of physical measurements into dynamic simulation models.
- **WP3: Simulation environment development** – Analyzing the validation processes for integrating real-world interactions into virtual environments.
- **WP4: Industrial case studies** – Reflecting on the preparation and application of knowledge in industrial pilot settings.
- **WP5: Project management and communication** – Studying coordination, knowledge dissemination, and strategic alignment activities.

Data collected during workshops include meeting notes, prototype evaluations, observational reports, and reflections shared during discussions. This material is systematically analyzed to understand how knowledge management practices influence project development, collaboration dynamics, and the progression from uncertainty to structured innovation.

Through this workshop-based research methodology, the study captures both the intentional and emergent aspects of knowledge creation within a real-world, interdisciplinary, machine learning-driven product development initiative.

4. Theoretical Framework: Knowledge Creation in Machine Learning Contexts

Innovation projects driven by machine learning, especially in emerging industrial domains, present unique challenges for knowledge creation. Unlike traditional product development projects that build upon established expertise and follow relatively linear knowledge transfer processes, machine learning initiatives often start from a position of limited or nonexistent prior knowledge. In these cases, effective innovation requires structured approaches to managing uncertainty, building new knowledge collaboratively, and accelerating organizational learning across multiple domains.

A useful lens for understanding knowledge creation in such environments is Nonaka and Takeuchi's (1995) SECI model. This model conceptualizes knowledge creation as a dynamic and iterative process, involving four modes of knowledge conversion: Socialization (tacit-to-tacit knowledge transfer), Externalization (tacit-to-explicit), Combination (explicit-to-explicit), and Internalization (explicit-to-tacit). Through successive SECI cycles, organizations generate new knowledge by continuously spiraling between tacit and explicit forms.

In traditional industrial projects, SECI cycles often unfold sequentially, with phases of concept development, validation, and industrialization following an ordered progression. However, in machine learning-driven projects, the need for rapid iteration, cross-disciplinary integration, and real-time adaptation leads to multiple SECI cycles operating simultaneously across different domains. Knowledge does not move smoothly from one phase to another; instead, it evolves dynamically, shaped by continuous feedback loops among academic researchers, engineers, industry practitioners, and end-users.

Recognizing these demands, the Manulab–Industry Competence Building Process was developed as an adaptation and operationalization of Nonaka and Takeuchi's theory for Industry 4.0 and 5.0 contexts (Hansen *et al.* 2023). This model expands the SECI framework by structuring knowledge creation into six interconnected phases, specifically designed to foster dynamic, cross-organizational collaboration in environments characterized by high uncertainty:

- **Gemba Walks:** Creating opportunities for sharing tacit knowledge through direct observation and dialogue between researchers, engineers, and industrial practitioners at the actual work sites.
- **Creating Concepts:** Developing new ideas collaboratively by synthesizing diverse tacit knowledge and making it explicit.
- **Justifying Concepts:** Testing and refining new concepts against empirical data, industrial requirements, and strategic goals.
- **Building Prototypes:** Iteratively translating validated concepts into physical or digital prototypes that can be tested and further improved.
- **Industrial Installation:** Implementing validated solutions within operational industrial environments, integrating feedback from real-world application.
- **Operating and Upgrading:** Continuously learning from operations, iterating improvements, and embedding new knowledge into organizational practices.

In contrast to traditional automation projects, where industry partners often become actively involved only during the validation or implementation stages, the Manulab model emphasizes continuous engagement of all partners—academia, industry, and system integrators—across all phases. This enables knowledge to be created, tested, and refined collaboratively in real time, aligning closely with the needs of machine learning-driven innovation where uncertainty and complexity demand flexibility and speed.

In the context of the Digital Fish Simulation Project, this theoretical framework provides essential guidance. The project does not simply apply simulation tools to existing problems; it operates in a largely unknown domain where fundamental knowledge about biological properties, material interactions, and system behavior must be constructed as part of the innovation process itself. By embedding structured knowledge management practices into project management workflows, the team ensures that learning is continuous, interdisciplinary, and cumulative—critical factors for success in machine learning-based product development.

Thus, the SECI model and the Manulab–Industry Competence Building Process together offer a coherent theoretical foundation for understanding how knowledge is created and managed in this project. They illuminate why sustained interdisciplinary collaboration, parallel SECI cycles, and adaptive iteration are not just advantageous but essential for navigating the challenges of machine learning-driven innovation.

5. Case Description: The Digital Fish Simulation Project

The Digital Fish Simulation Project represents a dynamic effort to create new knowledge in machine learning-driven product development, applying simulation and physical measurement to one of the most variable domains—biological seafood processing. The project is planned to run for three years, from November 2024 to June 2027. At the time of writing, the project is in its first six months of development, currently focused on iterative prototyping, knowledge building, and setting the foundation for later industrialization.

5.1 Gemba Walks: Understanding the Unknown

At the outset, researchers, students, and industry partners engaged in Gemba walks across fish processing plants, onboard trawlers, and directly in the field. These sessions were crucial for immersing the academic team in the realities of industrial fish processing and biological variability. One particularly important activity was organizing field trips where students actively participated in fishing wild cod, collecting fresh samples needed for early-stage physical measurements (Figure 1). Through these hands-on experiences, the project team could observe the biological diversity of fish populations, understand handling challenges, and refine their approaches to data collection. These practical engagements helped surface critical tacit knowledge from both the industrial and biological perspectives, framing the project's initial direction.



Figure 1: Students collecting wild cod for research

5.2 Creating Concepts: Testing Ideas Across Disciplines

With no established roadmap to follow, the team quickly moved into a creative, exploratory phase. The primary challenge was identifying what physical data would be necessary to build realistic digital fish populations for simulation in Isaac Sim—and how to collect it reliably under industrial conditions (NVIDIA 2025). In the very first weeks of the project, students, researchers, and industry partners made an initial visit to a land-based fish processing facility, where farmed cod was used to test early prototypes (Figure 2).



Figure 2: First friction jig test with farmed cod at processing facility

This provided accessible fish specimens to begin testing concepts in a real but controlled environment. One of the first friction jigs—manually operated—was tested here, sparking the project's iterative prototyping process. In parallel, preparations began for measuring stiffness under laboratory conditions. A cross-disciplinary team—including researchers from NTNU, research institution Moreforskning, and industry—gathered at the biological lab to plan and develop the first stiffness jigs (Figure 3). This session involved testing bending setups and evaluating fish-handling techniques, marking a key step in turning early concepts into practical experimental systems.



Figure 3: Interdisciplinary team preparing stiffness measurements in biological laboratory

5.3 Justifying Concepts: Learning Through Trial and Error

As early prototypes emerged, rapid testing cycles became central to project progress. Each iteration of the friction jig and measurement systems was evaluated in real-world or near-real-world conditions, with immediate feedback guiding refinements.

In one key session, students tested an improved version of the friction jig using wild cod freshly delivered by a local fisherman (Figure 4). This setting allowed the team to validate whether the modifications—such as improved surface materials, better angle adjustment, and more stable measurement procedures—produced reliable and realistic results closer to industrial needs.

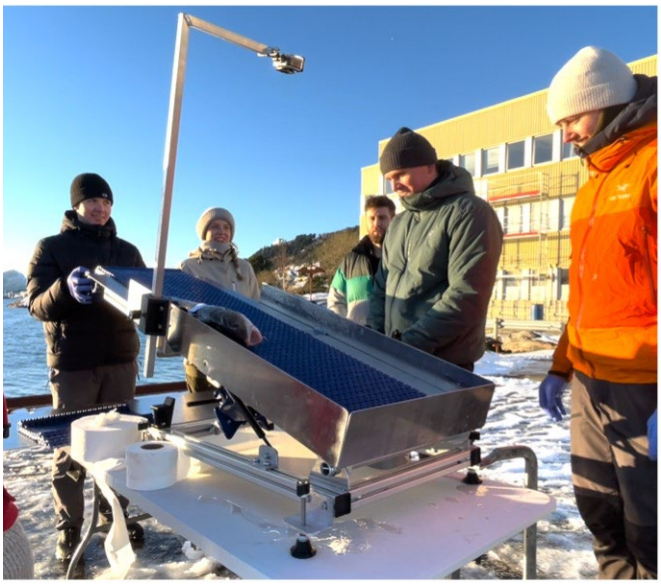


Figure 4: Students testing improved friction jig with wild cod

6. Building Prototypes: Toward Functional Measurement Systems

Through ongoing collaboration and successive iterations, the project has progressed toward fully functional prototype systems for 3D scanning, friction measurement, and stiffness evaluation. As insights accumulated through testing and feedback, physical setups became increasingly refined, and the connection between digital simulation and biological measurement became more tangible.

One key session took place in the biological laboratory, where students and researchers jointly tested both the improved friction jig and the photogrammetry-based 3D scanning setup (Figure 5). The simultaneous testing of multiple systems allowed for comparison, coordination, and shared problem-solving — aligning digital model requirements with physical data collection methods.



Figure 5: Testing friction jig and 3D scanning setup in biological laboratory

This phase of the project marked a shift from isolated experiments to coordinated prototype testing. By bringing together students from engineering, automation, and marine biology with academic researchers and external

partners, the lab became a shared space for real-time learning and mutual adjustment — a central arena for combining, internalizing, and refining knowledge across disciplines.

6.1 Preparing for Industrialization: The Next Steps

While full-scale industrialization has not yet begun, the shape of the final measurement solutions is becoming increasingly clear. Several versions of friction and stiffness jigs, along with scanning setups, have been tested and refined based on biological input, simulation requirements, and practical constraints.

In a recent workshop held at the Manulab facility, students, researchers, and industry representatives from both biological and engineering backgrounds gathered to evaluate the prototype systems (Figure 6). This collaborative evaluation session focused on identifying improvements needed for scaling, improving measurement consistency, and ensuring alignment between physical data collection and simulation performance. These evaluation activities represent a critical transition between iterative prototyping and future industrial deployment. They also reinforce the role of shared physical and organizational spaces—such as Manulab—as enablers of structured interdisciplinary knowledge creation. The knowledge generated during this phase will guide the next steps in preparing field-ready systems for data collection onboard fishing vessels.



Figure 6: Prototype evaluation at Manulab with interdisciplinary team

7. Discussion

The early stages of the Digital Fish Simulation Project offer valuable insights into how knowledge management practices can be adapted to support machine learning-driven innovation under conditions of uncertainty. Several key lessons emerge from the project's experience so far, illustrating the relevance and utility of the theoretical frameworks outlined earlier.

8. Parallel SECI Cycles in Practice

One of the most striking features of the project is the way knowledge creation has unfolded through multiple, parallel SECI cycles rather than following a traditional, linear progression. Socialization, externalization, combination, and internalization processes are not confined to distinct stages but occur simultaneously across different domains: biological data collection, simulation modeling, prototype development, and industrial evaluation. The iterative development of the friction and stiffness measurement jigs involved simultaneous sharing of tacit knowledge, externalization into design choices, combination of empirical findings with simulation, modelling, and internalization of learning into improved prototype designs.

9. Sustained Interdisciplinary Collaboration

The project emphasizes the importance of continuous collaboration across knowledge domains. In contrast to traditional projects, where industry partners primarily contribute during validation, this project sees industry engineers, researchers, and simulation experts jointly engaging from the earliest stages of concept development through to prototype testing. This intensive engagement accelerates knowledge emergence and ensures practical relevance of new knowledge, reflecting the evolving demands of machine learning-driven innovation.

10. Knowledge Creation Through Trial and Error

The trial-and-error approach has proven to be a powerful driver of knowledge creation. Instead of being seen as setbacks, failures in prototype development have been embraced as essential inputs into the ongoing SECI cycles. Each iteration enhances understanding, refines methods, and strengthens the collaborative learning process. This learning-by-doing resonates with Nonaka and Takeuchi's vision of dynamic, spiraling knowledge creation and operationalizes the Manulab–Industry Competence Building Process.

11. Building a Foundation for Industrialization

While still in the early stages, the project's prototype systems represent valuable knowledge artifacts, crystallizing interdisciplinary collaboration into tangible innovations. By embedding structured knowledge management practices into everyday project activities, the project team ensures that early investments in knowledge creation will support later phases of scaling and industrial deployment.

12. Conclusion and Recommendations for Further Work

The early phases of the Digital Fish Simulation Project demonstrate how structured knowledge management practices, when carefully embedded within project workflows, can support innovation in machine learning-driven product development even under conditions of high uncertainty. By operationalizing Nonaka and Takeuchi's SECI model through the Manulab–Industry Competence Building Process, the project has fostered dynamic, interdisciplinary collaboration, enabled continuous knowledge creation, and accelerated the development of prototypes suitable for future industrial application. Several key lessons have emerged:

- **Multiple SECI cycles must run in parallel** to accommodate the need for rapid, cross-domain knowledge integration.
- **Sustained interdisciplinary collaboration** is critical; knowledge workers from academia and industry must be actively engaged at every stage.
- **Trial-and-error learning** must be embraced as an essential engine of innovation, not as a deviation from planned processes.
- **Early and continuous industry involvement** transforms projects from linear, handover-driven processes into collaborative ecosystems of knowledge creation.

By embedding these principles into its operations, the Digital Fish Simulation Project has built a solid foundation for further development. Although the project is still in its early stages, the evolving prototypes for 3D scanning, friction measurement, and stiffness evaluation already represent valuable knowledge assets that will inform future scaling and deployment efforts. Based on the experiences gained so far, several directions for future research in knowledge management within machine learning-driven projects are recommended:

- **Structuring Parallel SECI Cycles in Machine Learning Projects**. Further research should investigate how concurrent SECI cycles can be structured, coordinated, and supported systematically.
- **Managing Trial-and-Error Learning as a Formal Knowledge Process**. Methods for systematically capturing, evaluating, and institutionalizing learning from iterative prototyping should be explored.
- **Enhancing Interdisciplinary Knowledge Transfer**. Frameworks for measuring and optimizing knowledge flows between diverse disciplinary domains should be developed.
- **Evaluating industry–academia knowledge co-creation mechanisms**. Research should examine how early and continuous co-creation partnerships can be sustained across full project lifecycles.
- **Designing knowledge management tools for simulation-driven innovation**. Practical tools such as reflection workshops, knowledge repositories, and collaborative platforms could support dynamic knowledge flows.
- **Understanding organizational learning across project phases**. Longitudinal studies could track how early-stage knowledge is adapted or institutionalized through scaling and industrialization phases.

By pursuing these directions, both the project team and the broader research community can contribute to a deeper understanding of how knowledge management strategies must evolve to support machine learning-based innovation.

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AI declaration: AI tools, including language models such as OpenAI's ChatGPT, were used as writing assistants to help formulate, structure, and improve the clarity of the text. All project ideas, empirical data, methodological choices, and theoretical framing originate from the researchers. The authors retain full responsibility for the originality, interpretation, and conclusions of the article.

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Knowledge-Based HRM: A Systematic Literature Review and Research Agenda

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Abstract: This study aims to conduct a systematic literature review on Knowledge-Based HRM (KBHRM) by exploring the development of research, implementation, key variables related to antecedents, mediation, moderation, and outcomes, as well as providing directions for future research. The review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The data analyzed are sourced from Scopus and Google Scholar databases. The findings indicate that empirical research on KBHRM began to develop in 2009, focusing on strategic human resource management. However, subsequent developments have been more influenced by studies in knowledge management. The most common KBHRM implementations include knowledge-based recruitment and selection, training and development, knowledge-based compensation, and performance appraisal. Further analysis reveals that none of the articles reviewed specifically addressed the determinants of KBHRM. However, there is evidence that KBHRM implementation positively impacts both individual and organizational levels. Regarding methodology, most existing studies use surveys as the primary approach, with a scarcity of alternative methods. Additionally, we identify that most KBHRM-related research adopts a single-level approach at the organizational level, while research at the individual level or using perceived approaches is still rare. There is also debate regarding conceptualizing KBHRM as a unidimensional or multidimensional construct. In the final section, this study provides directions for future research, including recommendations related to antecedents, research methods, levels of analysis, and new approaches to develop the KBHRM concept further.

Keywords: Knowledge-based, HRM, Review, KBHRM

1. Introduction

The industrial world must be prepared to face the era of a knowledge-based economy (Kim and Ko, 2014). The consequence of this change is the increased use of information and communication technology and uncertainty (Bhardwaj, 2019). Organizations that fail to anticipate these changes will lose their competitive edge to more competitive newcomer companies (Idrees et al., 2022). One key to addressing this issue is effective knowledge management, which allows knowledge to drive innovation (Gupta, 2022).

One perspective that emphasizes the importance of knowledge in organizations is the knowledge-based view (KBV). KBV highlights the significance of knowledge as an important organizational resource that must be managed properly. The company's expertise and information will provide long-term and sustainable competitive advantages (Grant, 1996).

Given the central role of knowledge in supporting organizational competitiveness, efforts are needed to manage knowledge effectively. One such effort is through knowledge-based HRM (KBHRM). This concept emphasizes that organizations need to modify traditional HRM practices to enhance the creation and sharing of knowledge (Al-Tal and Emeagwali, 2019). This is because conventional HRM practices are considered to have not comprehensively incorporated knowledge elements into their various activities (Sáenz, Aramburu, and Kianto, 2017). KBHRM stresses the importance of changing the paradigm in managing human resources from being primarily focused on personnel administration; employee needs fulfillment, and compliance with regulations to HRM practices oriented towards utilizing knowledge as a strategic asset to create added value for the organization (Hussinki, Kianto, and Adibe, 2018).

In the KBHRM concept, HRM activities are already integrated with knowledge creation, sharing, and utilization (Kianto, Sáenz, and Aramburu, 2017). Companies can reward (financial/non-financial) employees willing and able to engage in knowledge-sharing (Singh et al., 2021). Additionally, companies can modify performance evaluations based on employees' contributions to knowledge-sharing activities.

Research findings show a positive influence of KBHRM on knowledge-sharing activities and innovation performance (Kianto, Sáenz, and Aramburu, 2017; Ouerdian et al., 2019). These findings confirm the important role of KBHRM in organizations. However, since KBHRM is a relatively new concept (Ahmad et al., 2020; Kianto

et al., 2017), there are still limited references available for study, making further research necessary to strengthen the theoretical foundation and broaden the conceptual understanding of this topic. Based on this explanation, the researcher has formulated the following research question:

RQ1: How has KBHRM research developed?

RQ2: How are the key variables related to the antecedents, mediation, moderation, and outcomes of KBHRM mapped?

RQ3: What is the direction for future research on KBHRM?

The researcher developed a systematic literature review on KBHRM to answer these research questions, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. The results of this study are expected to serve as a reference for researchers who will further explore the topic of KBHRM.

2. Method

2.1 Research Approach

This study uses a systematic literature review (SLR) approach. The literature review process follows the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The PRISMA approach ensures that all aspects of this research are reported accurately and transparently, helping the author better explain what has been done, what has been found, and what will be done (Sarkis-Onofre et al., 2021). Referring to the PRISMA model, several review stages are carried out, namely: (1) data collection, (2) inclusion criteria, (3) data extraction, and (4) sample analysis.

2.2 Data Collection

The research databases for this study are sourced from Scopus and Google Scholar. Scopus is the most comprehensive database of high-reputation journals (Mongeon and Paul-Hus, 2016), and Google Scholar is considered easier to use, offers a higher quality system, and provides greater user satisfaction, with the capacity to index more publications and academic citations (Harzing and Alakangas, 2016). In the initial search process, the researcher used the following search terms and keywords separately, combined using the "OR" operator: “knowledge-based HRM,” “knowledge-based HR,” “knowledge-based human resource management,” “knowledge-based HR Practices,” “KBHRM.”

2.3 Description of Inclusion Criteria

In the systematic literature review process, the researcher searched for articles from January 1, 2000, to December 31, 2024. The decision to search for articles in the year 2000 is based on the development of the KBHRM topic, which is derived from the research by Lepak and Snell (2002) on the configuration of HRM practices emphasizing the importance of knowledge-based work. The criteria used to select articles include: (1) the article is written in English, (2) the article has clear relevance to the KBHRM topic, and (3) the article has a clear research methodology.

2.4 Data Extraction Procedure

In the data extraction process, the researcher screened the articles to eliminate those that were not relevant, so only the articles that met the criteria for analysis were retained at the discussion stage. In the initial stage, 2,510 articles were identified, consisting of 32 articles from Scopus and 2,478 from Google Scholar. In the next stage, the researcher reduced the number of articles by 32 due to duplication between the two databases. In the third stage, the titles and abstracts were checked, where it was found that 2,364 articles did not have a strong enough relevance to the research topic, so those articles were deleted, leaving only 151 articles for further analysis. In the fourth stage, the researcher read all 151 articles, and after a thorough evaluation, 43 articles were selected that met the criteria for in-depth analysis. Articles not included in the study did not adequately explain the KBHRM concept or provide sufficient clarity regarding the research methodology.

2.5 Description of Sample Analysis

The researcher rechecked the articles to ensure that the articles to be discussed were of high quality and that they had explained the KBHRM concept relevantly, had a clear research methodology, and offered meaningful research contributions. These articles were reviewed based on the following factors: research

questions/objectives, the theoretical framework adopted, KBHRM implementation, the sample used, research design and methodology, and key findings.

3. Result

3.1 Theoretical Development of KBHRM

The first empirical research on KBHRM was published in 2009 by Lopez-Cabrales et al. These researchers explained the influence of KBHRM in creating valuable knowledge. Additionally, KBHRM was found to significantly impact innovation activities. This study emphasized that HRM practices significantly influence innovation activities when considering knowledge aspects.

Although empirical research on KBHRM was first recorded in 2009, integrating HRM practices with knowledge began to be advocated in the early 2000s. Lepak and Snell (2002) proposed a configuration of HRM practices that could encourage knowledge-based work. Knowledge-based work is characterized by high demands on individuals to possess adequate knowledge to achieve innovation. This thinking was supported by Minbaeva et al. (2009), who emphasized that HRM practices should be revised from an administrative orientation to a more strategic HRM approach to foster innovation. They promoted the integration of HRM practices with knowledge. One expected outcome of this integration was HRM practices capable of promoting organizational knowledge behavior.

Lopez-Cabrales et al. published the empirical results of KBHRM in 2009. This study used the research instrument developed by Lepak and Snell (2002). It provided initial empirical evidence of the development of the integration between HRM and knowledge. However, the findings of Lopez-Cabrales et al. (2009) did not clearly define KBHRM nor explain the dimensions of KBHRM practices. The development of KBHRM research from the early 2000s to 2009 was rooted in HRM practices integrated with knowledge.

In subsequent developments, KBHRM research evolved from the research topic of knowledge management (KM). Andreeva and Kianto (2012) explained that there are two approaches to understanding KM: (1) the knowledge process, which includes knowledge creation, sharing, acquisition, transfer, and application, and (2) knowledge practices, which involve a set of infrastructure, capabilities, or management activities that support and enhance the knowledge process. In this study, Andreeva and Kianto (2012) introduced the terminology "HRM practices for KM," or HRM practices that support knowledge management. Their research findings demonstrated that HRM practices supporting knowledge management positively and significantly impact competitiveness and financial performance. In this study, Andreeva and Kianto (2012) used only one KBHRM dimension: knowledge-based compensation.

In later developments, Inkinen et al. (2015) developed 10 KM practices that can drive innovation, including job supervision, knowledge protection, strategic knowledge and competency management (strategic KM), learning mechanisms, information technology (IT) practices, work organization, and four HRM practices: recruitment, training and development, performance evaluation, and compensation practices. An important contribution of this research was the development of four dimensions of HRM practices that can drive knowledge management within organizations, where previous studies had not divided these dimensions. The findings of Inkinen et al. (2015) showed that knowledge-based compensation has the most dominant influence in driving innovation compared to the other three practices.

Two years after the publication of the research by Inkinen et al. (2015), Kianto et al. (2017) published an article on KBHRM that defined KBHRM and explained its dimensions. Kianto et al. (2017) defined KBHRM as HRM practices modified to encourage organizational knowledge behavior. They described four dimensions of KBHRM: recruitment and selection, training and development, performance evaluation, and knowledge-based compensation. These dimensions adopt four HRM practices for knowledge described by Inkinen et al. (2015). The research findings showed that KBHRM has a significant impact on innovation performance. To date, the findings of Kianto et al. (2017) remain a primary reference in KBHRM research.

3.2 Key Variables of KBHRM Using the AMO Framework (Antecedents, Mediation, Moderation, and Outcomes)

3.2.1 Mediation and moderation

The literature review results indicate that no studies explain the antecedents of KBHRM. Still, several variables link KBHRM practices and outcomes at the individual and organizational levels. Sarfraz et al. (2023) demonstrated that absorptive capacity mediates the impact of KBHRM on the business innovation process.

Other studies showed that the three dimensions of intellectual capital, including human capital, relational capital, and structural capital, act as links between KBHRM practices and innovation performance (Sáenz, Aramburu, and Kianto, 2017; Al-Tal and Emeagwali, 2019; Gupta, 2022). Three dimensions of dynamic capabilities, including entrepreneurial orientation, marketing capability, and technological capability, have also been shown to significantly mediate the impact of KBHRM on innovative service offerings (Ahmad, Imm, Yuhanis Abdul Aziz et al., 2020). Other variables used as mediators in KBHRM research include learning climate (Ouerdian et al., 2019), logistics capabilities (Evangelista et al., 2023), social capital (Singh et al., 2021), and knowledge sharing (Le and Ha, 2023). Regarding moderating variables, we identified that knowledge-oriented organizational culture moderates the four KBHRM practices regarding the organization's absorptive capacity (Sarfraz et al., 2023).

3.3 Outcomes of KBHRM Practices

KBHRM is an HRM practice modified to encourage knowledge behavior within organizations. The research findings of Ouerdian et al. (2019) confirm the positive impact of KBHRM in promoting knowledge-sharing behaviors among workers in knowledge-intensive firms in Tunisia. KBHRM was also found to play a vital role in company innovation. At the individual level, an increase in employees' innovative behavior can be explained through HRM policies focused on knowledge (Noopur and Dhar, 2020; Singh et al., 2021). At the organizational level, KBHRM was found to improve the provision of more innovative services (Ahmad, Imm, Yuhanis Abudl Aziz et al., 2020) and product improvements (Sarfraz et al., 2023). KBHRM has been shown to enhance innovation performance (Kianto, Sáenz, and Aramburu, 2017; Al-Tal and Emeagwali, 2019; Le and Son, 2024). KBHRM encourages companies to be more open with their business partners in building innovation projects (Shahin, Chong, and Ojo, 2023). Finally, KBHRM can improve company performance in both financial and non-financial aspects. KBHRM helped SMEs in Malaysia achieve better international performance (Ahmad et al., 2022). Based on the explanation of the implementation, mediation, moderation, and outcomes of KBHRM, we have formulated the conceptual framework of KBHRM in Figure 1.

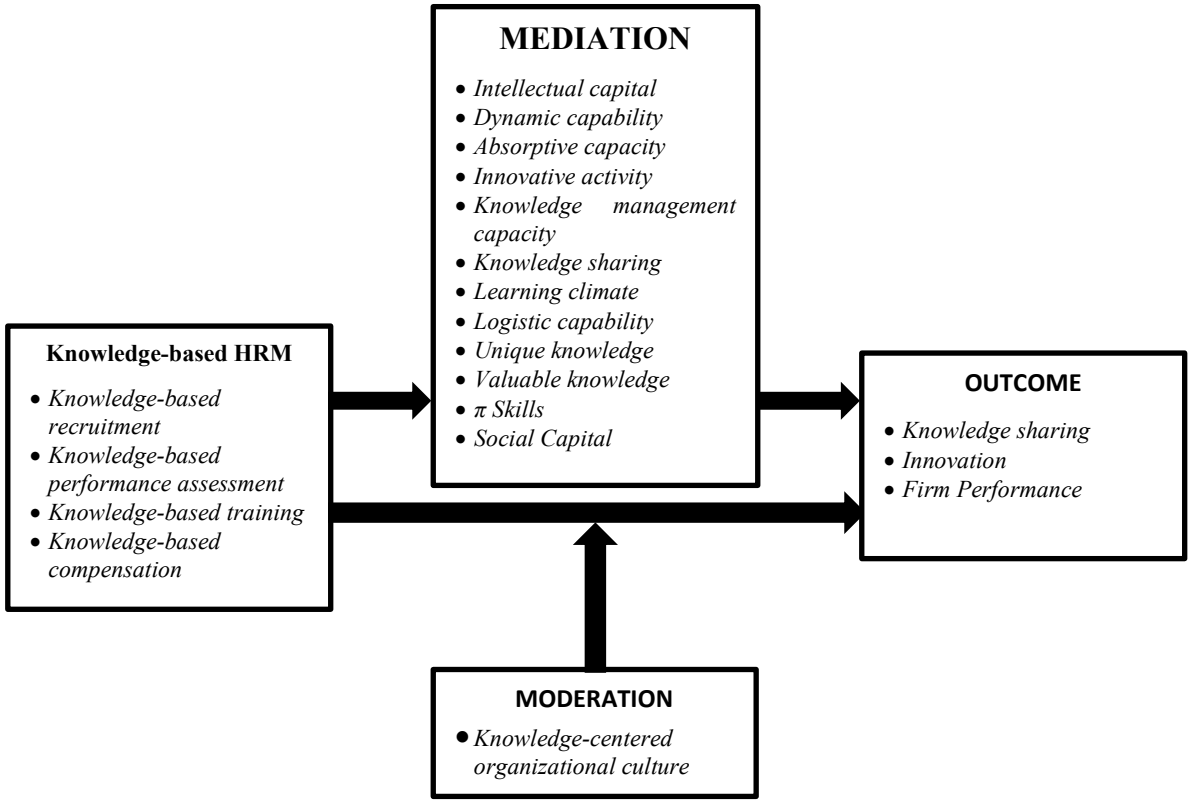


Figure 1: Conceptual framework on the dimensions, mediation, moderation, and outcomes of KBHRM practices

3.4 Theoretical Implications

The literature review on KBHRM provides information that can be used to develop future studies. First, based on the review of articles on KBHRM, there is no research discussing the antecedents of KBHRM. The research

results on KBHRM only explain the mediators, moderators, and outcomes of KBHRM at both the individual and organizational levels. Future research is expected to create a conceptual framework regarding the factors that influence the implementation of KBHRM and conduct empirical testing of that conceptual framework. Several variables, such as leadership style, organizational culture, and company orientation, can be considered as antecedents.

Second, the literature review results show that KBHRM is still limited to four dimensions: recruitment and selection, training and development, compensation, and knowledge-based performance appraisal. Future research is expected to develop other dimensions related to HRM activities that previous studies have not explored. Dimensions that could be developed as new components in KBHRM include knowledge-based career management or expanding the dimension of knowledge-based teamwork, which has been researched but not widely tested.

A further note regarding research methods: All the articles we reviewed used a quantitative approach with survey instruments. Future research could adopt a qualitative approach. Additionally, there has been no research using a longitudinal approach. Finally, previous studies focused on the micro level, such as innovation behavior, and the macro level, such as innovation and company performance. Future research is expected to conduct meso or group-level studies, such as the impact of KBHRM practices on team creativity. This issue becomes important as more work is done on a team or group basis.

3.5 Managerial Implications

The results of this study provide recommendations for management. First, management can consider implementing KBHRM by applying a reward system for employees who engage in knowledge-sharing processes within the organization. These rewards could be financial or recognition-based, such as praise. Management could also include knowledge-sharing activities as a performance appraisal indicator. Second, since the implementation of KBHRM is related to high levels of knowledge or expertise, the recruitment process should be designed to filter quality talent capable of adapting to this system.

3.6 Limitations

This study has several limitations. First, we only used data sources from Google Scholar and Scopus, excluding Web of Science due to access limitations to that database. However, most articles in Scopus are also generally available on the Web of Science. Second, we not only analyzed journal articles but also included conference proceedings. This was done due to the limited number of studies addressing the topic of KBHRM. However, the proceedings used in this research are those indexed in Scopus. Another limitation is that we only analyzed articles written in English, although high-quality articles may have been published in languages other than English.

4. Conclusion

Empirical research on KBHRM was first published by Lopez-Cabrales et al. (2009). This research evolved based on the stream of strategic HRM thought, although, in recent developments, KBHRM has been more dominated by the stream of knowledge management thinking. There are four dominant dimensions in KBHRM practices: knowledge-based recruitment and selection, knowledge-based training and development, knowledge-based compensation, and knowledge-based performance appraisal. The research findings also identify various mediating and moderating variables and the impact of KBHRM on knowledge sharing, innovation, and company performance.

Ethics Declaration: This study did not require ethical approval as it is based solely on a systematic review of existing literature and did not involve any human participants, personal data, or experimental procedures

Declaration of AI Use: This paper makes limited use of generative AI tools (e.g., ChatGPT by OpenAI) to support language refinement and clarity during the writing process. All intellectual content, conceptual development, data analysis, and argumentation were solely developed by the authors. The authors take full responsibility for the content and interpretation of the paper.

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How can Interorganizational Dialogue Generate New Knowledge for Problem Solving?

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Abstract: The study aims to clarify how interorganisational dialogue can promote the generation of new knowledge. Additionally, it aims to propose the role of an organisational manager who need to generate new business knowledge through the dialogue. Nowadays, it is important for people, organisations, and countries in different positions to understand each other and collaboratively create new solutions. However, the success rate of such multidisciplinary collaborations is not necessarily high. One of the primary reasons for this is that differences in disciplinary backgrounds and professional positions often lead to misunderstandings or a lack of mutual comprehension regarding perspectives and ideas. Analysing these challenges and identifying the key factors that facilitate productive dialogue -- thereby increasing the likelihood of generating new knowledge -- has become essential in contemporary business environments. While much of the literature on knowledge creation focuses on the mechanisms by which knowledge is generated, relatively little attention has been paid to the diverse backgrounds of individuals involved in such creation processes and how these individuals engage with differences in perspectives and assumptions to co-create new knowledge. Similarly, although existing studies on knowledge creation and dialogue frequently highlight the potential of interdisciplinary dialogue to generate novel insights, they tend to lack detailed discussions on the specific steps, conditions, and considerations required to facilitate such processes effectively. This study seeks to shed light on the process of knowledge creation through interorganisational, interdisciplinary dialogue at the individual level, with an emphasis on cognitive aspects. Specifically, it explores what kind of preparatory understanding or mindset participants should cultivate prior to engaging in dialogue, how they should perceive and work with different perspectives and thought frameworks of other disciplinary experts, and how these interactions can lead to the generation of new knowledge. Furthermore, this study discusses the role of organisational managers in enabling and supporting productive interorganisational dialogue among specialists from different fields.

Keywords: Interorganizational dialogue, Knowledge creation, Exploration, Multi-disciplinary discussion,Cross functional team

1. Introduction

Knowledge is the most important resource to generate a competitive advantage. Knowledge workers are high-level workers who apply theoretical and analytical knowledge to develop products and services (Drucker, 1999). Nowadays, it is important for people, organisations, and countries in different positions to understand each other and create new solutions. As Chesbrough (2003) claims, in open innovation, competitive companies adopt external knowledge and combine it with their internal knowledge to create new business knowledge.

Companies have changed their management, moving from vertically divided organisations to cross-functional teams. However, 75% of cross-functional teams are unsuccessful, primarily due to difficulties in coordination and collaboration arising from insufficient shared understanding among team members with diverse backgrounds (Dussart, et al., 2021). It is highly challenging for specialists from different disciplines to collaborate effectively and create new knowledge.

The study aims to clarify how interorganisational dialogue can promote the generation of new knowledge. To overcome interorganisational barriers, companies have adopted a dialogue style of discussion to understand each other and create new business knowledge. For interorganisational dialogue to be productive, it is important to define the role of the organisational manager who must generate new business knowledge through this dialogue.

Previous discussions regarding knowledge creation and discussion assume that all participants have the same knowledge base; they do not consider differences between business and engineering, traditional and high-tech ventures, or developed and emerging countries (Nonaka, 1994; Tsoukas, 2009). Furthermore, they do not consider how to overcome the differences in background and context of the knowledge of each participant and how participants understand external knowledge from one another through dialogue. They focus exclusively on knowledge generation without discussing these gaps. This study aims to articulate the sequential steps through which knowledge is created via dialogue among interdisciplinary experts. It outlines what participants recognise and learn at each stage of the dialogue process and describes the role that organisational managers should play in facilitating effective knowledge creation among participants.

2. Literature Review

2.1 Dialogue and Knowledge

Dewey (1938) argued against the definition of knowledge as justified true belief, asserting instead that knowledge is acquired through the dynamic process of inquiry and serves as a practical tool for problem solving, gained through experience and action. Thus, for individuals from diverse fields to generate new knowledge, they must engage in a dynamic process of inquiry into one another's existing knowledge while continuously updating and refining it. Dialogue enabling exposure to others' experiences and values can facilitate the creation of new knowledge.

Dialogue consists of turn-taking and exchange of verbal messages to attain a collective goal (Gergen et al., 2004; Isaacs, 1999; Luckmann, 1990; Walton, 2006). During the dialogue process, participants alternate between being the speaker and the listener (Van Eemeren and Grootendorst, 2004; Walton, 2006). This study discusses deeper background factors that enable interlocutors to send messages. Previous discussions on dialogue assume that interlocutors have different opinions. There are three phases of dialogue: mutual understanding (Buber, 1958), offset difference of opinions, and creating new knowledge. Buber (1958) focuses on mutual understanding and acceptance and claims that through dialogue, people can recognise and accept their differences. Recent literature argues that dialogue is not merely a process for bridging differences in opinions stemming from participants' varying backgrounds and values; rather, it involves embracing these differences to collaboratively generate new understandings and perspectives (Bohm, 1996; Isaacs, 1999; Schein, 1993). Isaacs (1999) argues that dialogue facilitates mutual understanding and collaboration among individuals with different forms of expertise and backgrounds, thereby enabling the emergence of new ideas and innovation. He emphasises the importance of the *quality of the conversational space* and the *transformation of relationships*, suggesting that knowledge naturally emerges within dialogic relationships, where participants listen deeply to one another and express their thoughts authentically. However, the recent literature does not propose a clearly defined process model for knowledge creation.

2.2 Knowledge Creation

Knowledge has been defined in many ways, notably as justified true belief (JTB) and as the capacity to act. This paper adopts both definitions, focusing on knowledge that helps generate solutions or shared understanding in contexts where participants have different goals. In such settings, practitioners must navigate gaps in interpretation rooted in tacit knowledge. While this knowledge is often unspoken or implicit (Taylor, 1991; Ryle, 1949), understanding its background is critical. As Nonaka (1994) argues, new knowledge can emerge when individuals from diverse perspectives exchange tacit insights. This is particularly relevant in multidisciplinary collaboration, where shared knowledge creation relies not only on facts, but on dialogue and mutual understanding.

Previous literature on multidisciplinary knowledge generation often focuses on "knowledge integration" (Hong et al., 2012; Hutto et al., 2013; Lewis et al., 2005; Rai and Kang, 2009). These studies do not focus on creating new knowledge and mainly discuss how to assimilate and utilise external knowledge. The argument for knowledge integration emphasises building a shared vision but does not address how to build this shared vision among people with different backgrounds or why this shared vision is necessary. Srikanth et al. (2016) point out the risk for diverse teams to run into coordination problems due to a lack of common ground. As participants' interests can differ depending on their areas of specialisation, participants must first clarify these differences before integrating their knowledge. They claim that individuals must be able to see the larger picture beyond their areas of specialisation to share a common vision (Dussart et al., 2021; Prieto-Pastor et al., 2018). Past discussions claim that properly understanding the cognitive boundaries between one's own expertise and that of others—that is, the differences in knowledge and perspectives—makes it possible to select appropriate boundary-spanning mechanisms at various stages of a project (Carlile, 2004; Dussart et al. (2021). The authors refer to such mechanisms as "boundary objects," which have been previously defined as "concrete or abstract bridges that allow groups with different perspectives and goals to contribute to a more comprehensive objective" (Adenfelt & Maaninen-Olsson, 2007). However, they also point out that, in some cases, knowledge boundaries may collapse or even be deliberately ignored. In these studies, boundary objects such as whiteboards, mockups, and prototypes are tangible and visible, making them easier to share among experts from different disciplines. In contrast, new business knowledge or conceptual ideas, which lack physical form, are more difficult to share across disciplinary boundaries. In such cases, it becomes increasingly important to clarify the role of dialogue in the process of knowledge creation.

This gap is also visible in engineering research. Janjua et al. (2013) discusses integrating incomplete and conflicting information from various internal and external sources within enterprises by combining semantic web technologies and argumentative reasoning to enhance the accuracy of decision support systems. However, this study does not address how individuals from different specialties understand and utilise this integrated information. Furthermore, it does not explore how individuals from different fields engage in creating new knowledge in response to changes in competitive environments, such as shifts in market rules. Rai et al (2009) addresses knowledge integration between the digital and the physical domain. However, if both prototypes are developed by individuals from the same field—for example, experts in mechanical design—the underlying knowledge bases are likely to be similar. As a result, significant differences in perspectives, such as those typically observed in interdisciplinary dialogue, are less likely to arise.

3. A New Model Proposal for Interorganisational Knowledge Creation Through Dialogue

This section aims to propose a new model for the process of interorganisational knowledge creation utilising a dialogue discussion style. The previous section shows that past discussions on knowledge creation do not dig deeper into multidisciplinary dialogue where each participant has a different background. It also shows that previous literature on interdisciplinary discussion using engineering technologies does not consider that tacit knowledge dimension can differ widely depending on interlocuters' fields.

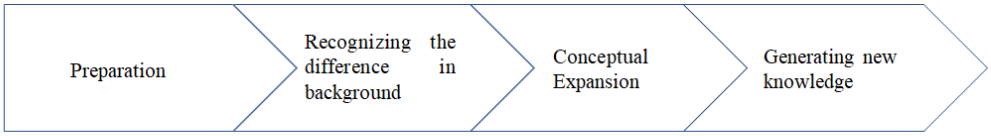
This study proposes a model showing how people can create new knowledge by collaborating with experts from different fields through dialogue that considers each person's tacit knowledge (Figure 1). The model also aims to propose the role of an organisational manager to promote the creation of new knowledge. To generate new knowledge through interdisciplinary dialogue, different factors must be considered at each stage of the process. The following sections will discuss each stage in detail.

3.1 Preparation Stage

In the initial stage, each organisation needs to prepare an environment for its members to develop literacy to understand and utilise external new knowledge. As Goldman (1986) argues that the acquisition of knowledge depends on cognitive abilities and the proper mechanisms of reasoning, an organisational manager must develop absorptive capacity, which is the organisational capacity to absorb and implement new external knowledge to be competitive (Cohen & Levinthal, 1990; Zara & George, 2003; Todorova & Durisin, 2007). In particular, a manager must prepare an effective environment for people to develop the cognitive ability to learn external knowledge (Dussart et al., 2021).

The first factor in building this literacy is recognising the value of external knowledge and shared vision. Previous literature stresses the importance of recognising the value of external knowledge in the process of understanding new knowledge (Cohen & Levinthal, 1990). It also emphasises the importance of shared vision in collaboration among diversified experts (Dussart et al., 2021; Prieto-Pastor et al., 2018). They must see a larger picture than their areas of specialisation. Thus, an organisational manager must show the visionary goal that can be reached by multidisciplinary dialogue.

Second, participants in a dialogue need to recognise the difference between exploitation and exploration. Gupta et al. (2006) clarify this difference: exploitation refers solely to the use of their conventional knowledge, and exploration refers to the pursuit and acquisition of new knowledge (Gupta et al., 2006). Referring to previous discussions (Benner & Tushman, 2002; Vermeulen & Barkema, 2001), Gupta et al. (2006) argue that exploitative innovations involve improvements in existing components, knowledge, and technology, whereas exploratory innovation involves searching for new knowledge and shifting to a different technological trajectory. They claim that while it is hard for individuals to balance exploration and exploitation, organisations can achieve this balance by allocating responsibilities separately (Gupta et al., 2006). Multidisciplinary discussions mainly aim to generate exploratory innovation (O'Reilly & Tushman,2021). An organisational manager must illustrate the goal to be reached by exploratory dialogue among diversified experts and balance exploitation and exploration within their organisation and management practices.



Interlocuters	Acquire literacy: Recognize the value of external knowledge and the difference between exploitation and exploration	Recognize that their respective knowledge frameworks are socially constructed by social contexts and backgrounds.	Recognize the limitations of their own specialized knowledge within the context of the broader goal Expand their own disciplinary frameworks in order to engage meaningfully with knowledge from other fields	Construct a new conceptual frame for knowledge creation by engaging in dialogue and incorporating perspectives influenced by interlocutors from different disciplinary backgrounds.
Organizational manager	Prepare the environment for acquiring the two factor of literacy to learn external knowledge	Avoid interpreting external knowledge solely through the conventional values and practices. Emphasize that dialogue is essential for comprehending differences in values, intentions, and customary practices	Encourage to expand interlocutors' own perspectives and facilitate effective collaboration through the utilization of such external knowledge	Facilitate dialogue in which participants co-construct new perspectives influenced by interdisciplinary exchange.

Figure 1 Interorganizational knowledge creation through multidisciplinary dialogue

3.2 Recognizing Differences in Background

At this stage, managers must avoid interpreting external knowledge through established norms alone and instead foster awareness of its socially constructed nature, shaped by shared histories and contextual contingencies. When individuals initially encounter external knowledge, they interpret it through their pre-existing cognitive frameworks (Tsoukas, 2009). Such understanding is shaped by *path dependence*, whereby prior learning and organisational routines guide assimilation (Cohen & Levinthal, 1990). This tendency is reinforced by self-sustaining mechanisms, such as past decisions and habits, which constrain the capacity to adopt alternative interpretations (Hanger-Copp et al., 2022). Tsoukas (2009) argues that metaphors facilitate initial comprehension by mapping unfamiliar knowledge onto familiar conceptual structures.

However, the assimilation of external knowledge requires more than cognitive alignment. According to Ryle (1949), knowledge includes not only "knowing that" (justified true belief) but also "knowing how"—a *capacity to act* embedded in practice. Human understanding, therefore, emerges not solely from mental representations but also from situated action within social contexts. Wittgenstein (1979) refers to this implicit awareness as the "inherited background," a tacit cultural and practical framework that informs how individuals participate in specific communities or professional domains.

For an organisation to successfully incorporate knowledge from different sources, it must not only discard its previous environment, habits, and established practices but also actively engage in learning and adapting to new contexts, routines, and operational conditions.

Tsoukas (2009) points out the importance of the background to conduct a certain social practice. He claims that the knowledge employed in a social practice cannot be adequately grasped through mere knowledge of explicit meanings. Rather, the socially situated meanings and nuances of knowledge are gradually acquired experientially through active participation and deep engagement with the actions, customs, perspectives, and values embedded within the particular environmental and contextual settings of the practice. Thus, to achieve mutual understanding of each other's knowledge through dialogue, it is essential for both parties to recognise that their respective knowledge frameworks are socially constructed, fundamentally shaped by their distinct social contexts and backgrounds. Participants in a dialogue must engage with an awareness that knowledge is shaped by different social contexts and backgrounds, as dialogue must explore the process of thought behind each interlocuter's basic assumptions, such as those regarding their interests and values (Bohm, 1996; Shadnam, 2021).

In this light, external knowledge cannot be understood through routines and instruction manuals (Grant, 1996). Organisational managers must thus cultivate environments in which members are encouraged to interpret external knowledge with sensitivity to context and to recognise the limitations of their own interpretive frameworks.

3.3 Conceptual Expansion

In the next stage, self-instantiation occurs; this is the awareness of the limitations inherent in one's own perspective (Dussart et al., 2021; Tsoukas, 2009). Organisational managers must emphasise to interlocutors that dialogue should not aim at fully understanding external expertise, including all background contexts, values, and terminologies, but rather should focus on expanding their perspectives and facilitating effective collaboration through the utilisation of external knowledge. People have their own "subjective worlds" constructed by their experiences, backgrounds, values, and cultures, and their opinions and ways of understanding can inevitably differ (Habermas, 1984).

In productive dialogue, each interlocutor potentially makes the other realise the limitations of his/her "focal awareness" and starts searching for broader awareness (Acti, et al., 2024; Tsoukas, 2009). Thus, dialogue must consider how a listener can understand a speaker's statement differently from how the speaker expects and how a listener can disagree with a speaker and aim to solve this problem for effective collaboration. In productive interorganizational dialogue, interlocutors must openly express their respective claims on an equal footing and rationally create new knowledge by embracing and coexisting with these differences based upon mutual understanding (Dussart et. al., 2021; Habermas, 1984; Majchrzak et al., 2012).).

Cogt and Zander (1992) emphasise the importance of an organisation's *combinative capability* -- its ability to integrate newly acquired external knowledge with existing internal knowledge. This capability enables organisations to generate new insights and foster innovation. However, as Gupta et al. (2006) point out, organisational members tend to rely heavily on familiar, existing knowledge, which can hinder the effective utilisation of external inputs. Therefore, managers play a crucial role in shaping an environment that balances both approaches, encouraging the assimilation and application of new knowledge alongside conventional practices.

To deepen this discussion, Goldman (1967) offers a valuable epistemological lens. Challenging the traditional notion of knowledge as *justified true belief*, Goldman (1967) argues that knowledge depends not on personal justification but on the existence of a proper causal connection between belief and truth. Applying this perspective to the organisational context, if members do not recognize causal relationships, and if there is no system in place for generating, retaining, and transmitting knowledge, then what is assumed to be "knowledge" may not truly exist within the organisation. This highlights the critical need to not only create knowledge but also ensure its structural integration and accessibility within organisational processes.

A more advanced form of knowledge boundary object is manifested in the practice of *knowledge traversal*, which entails metacognitive engagement, in-depth epistemic dialogue, and reflective processes. This process facilitates the identification of knowledge asymmetries among team members and supports the establishment of a shared epistemic foundation (Keestra, 2017; Majchrzak et al., 2012; Srikanth et al., 2016). In a related theoretical contribution, Tsoukas (2009) characterises this dynamic as *conceptual expansion*, wherein individuals interpret externally sourced knowledge not by fully internalising the epistemological perspective of others but rather by extending their own conceptual schemas rooted in disciplinary experience. Such a process underscores that effective interdisciplinary collaboration does not necessitate comprehensive mutual understanding but instead depends on individuals' capacity to selectively integrate relevant knowledge through the transformation of their existing cognitive frameworks.

This problem cannot be addressed solely through information technology (IT) solutions. Previous literature on knowledge integration with IT solutions focuses on the integration of heterogeneous information systems and data across organisations and does not assume any difference in interpretation caused by diverse backgrounds (Janjua et al., 2013). Building on social network theory and the Technology Acceptance Model (TAM), another study on IT solutions explores the process of tacit knowledge integration, discussing how interpersonal relationships and interactions within social networks influence the integration of tacit knowledge at the individual level (Hong et al., 2012). However, it does not address how individuals from different backgrounds interpret external knowledge in ways that differ from those of its original holders, nor how such interpretations influence the process of knowledge integration.

3.4 Generating New Knowledge

At this stage, knowledge creation involves more than the accumulation of explicit information. Drawing on Nonaka's (1994) SECI model, knowledge is generated through the externalisation of tacit knowledge, which is then aggregated and restructured into new explicit knowledge. This process spirals from the individual to group and organisational levels, enhancing collective learning and competitiveness. However, Nonaka's model assumes a relatively homogeneous organisational context and does not explicitly address the challenges posed by differences in values, cultures, and disciplinary backgrounds among participants.

To create knowledge that transcends individual cognitive boundaries, dialogue becomes indispensable. Tsoukas (2009) argues that through dialogic engagement, individuals engage in collective sensemaking, enabling the emergence of perspectives that would not arise in isolation. This is particularly relevant for radical or exploratory innovation, which, unlike incremental improvements, entails fundamental shifts in conceptual frameworks (Henderson & Clark, 1990; Tushman & Anderson, 1986). Such innovation often requires organisations to navigate divergent viewpoints and construct shared meaning through sustained interaction.

Organisational managers must therefore actively facilitate environments that support deep dialogue, encouraging the articulation of tacit insights and the co-construction of novel understanding across disciplinary and cultural boundaries.

Drawing on a case study involving eight software architects, Tsoukas (2009) illustrates how *conceptual reframing*—the process of viewing an object, action, or situation from a different perspective—can lead to new shared understandings. In another example, he demonstrates how analogical reasoning enables team members to articulate previously tacit similarities by mapping the relational structure of one domain onto another. These processes—conceptual reframing and analogy—can be further enriched through interdisciplinary dialogue. It can thus be argued that the use of metaphors and alternative framings, influenced by perspectives from different fields, facilitates the emergence of novel understandings and the generation of new knowledge. To promote this process, organisations may consider introducing a facilitator to help participants create new perspectives influenced by ideas from other disciplines. A facilitator can assist members who lack experience with conceptual reframing and collaborating with experts in different fields.

4. Discussion and Conclusion

This study aims to propose a new model for interorganisational knowledge creation through multidisciplinary dialogue. While prior literature has examined factors essential for knowledge creation and the common tendencies in understanding new knowledge, comprehensive studies that adopt an organizational managerial perspective to systematically explore the processes and stage-specific considerations necessary for generating new knowledge after acquiring external insights remain scarce. A comprehensive examination of the process by which new knowledge is created through dialogue that integrates expertise from different domains can help organisations reduce the number of unconsidered factors when partially adopting such practices. By identifying and addressing these overlooked elements, this approach is expected to enhance the success rate of interdisciplinary alliances and cross-functional teams.

The first stage involves a preparatory phase, in which a clear goal—namely, the innovative creation of new knowledge—is defined. In this phase, participants must also develop an understanding of *why* interdisciplinary dialogue is necessary to achieve that goal. Building on this foundation, managers should facilitate an awareness that each participant's knowledge has been shaped by their respective social and disciplinary context. This helps participants appreciate the epistemic diversity within the team.

Next, it is crucial for individuals to recognise the limitations of their own specialised knowledge within the context of the broader goal, while also understanding how their expertise contributes to the collective objective. Rather than fully adopting the perspective of another discipline, individuals must learn to expand their own disciplinary frameworks to engage meaningfully with knowledge from other fields. At the same time, they must acknowledge differences in perspectives and approaches across disciplines and develop the ability to collaborate constructively toward shared knowledge creation.

Finally, in the process of generating new knowledge, it becomes increasingly important that participants engage in dialogue in a way that allows for mutual influence, enabling them to adopt alternative viewpoints and reframe their thinking through sustained interaction with experts from other fields.

This study has primarily focused on the cognitive aspects of new knowledge creation through interorganisational dialogue across disciplinary boundaries. Another study on interorganizational dialogue also

emphasises that such activities require the establishment of appropriate evaluation systems and the reduction of bureaucratic barriers (Newman, 2024). In addition, social capital—such as trust and social ties—constitutes a critical factor in enabling effective multidisciplinary dialogue (Dussart, 2021; Robert, et al., 2008). These organisational and structural issues warrant further investigation beyond the scope of this study.

Ethics declaration: Ethical approval was not required for this study, as it involved no human participants or sensitive data and utilized only publicly accessible sources and academic publications.

AI Declaration: The authors used OpenAI's ChatGPT (GPT-4) to assist in improving the clarity and fluency of English expressions in the manuscript. The AI-generated suggestions were critically reviewed, edited, proofread, and incorporated into the manuscript as deemed appropriate by the author. The author remains fully responsible for the content and accuracy of the paper.

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Business Analytics Governance, External Uncertainty, and Firm Performance

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Abstract: Constantly evolving business environment and technological innovations, such as business analytics and artificial intelligence, press firms to rethink their information technology governance approaches in order to secure business value extracted from these technologies. Business analytics governance comprises several key mechanisms, among which is business analytics organizing, which guides the firm's business analytics activities, related decision-making authority, and location of business analytics function within the organization. The pros and cons of different approaches to business analytics organizing have been discussed in the existing business analytics literature, but there is only scant empirical evidence on how they help firms extract business value of their business analytics capability investments. Further, current literature posits that the level of uncertainty of the external business environment has a strong influence over which information technology governance approach a firm adopts, but the links between the external uncertainty, business analytics organizing, and firm performance are unestablished. Our study seeks to contribute to the contemporary business analytics literature by developing and testing a research model that comprises a firm's business analytics capability, firm's operational performance, and the moderating impact of business analytics organizing and uncertainty of the firm's external environment. In more detail, we propose that business analytics capability is positively associated with the firm's operational performance, and that business analytics organizing, ranging from centralized to decentralized, moderates this relationship. That is, centralized business analytics organizing characterized by concentrated expertise and standardization of analytics services helps firms achieve operational efficiency gains, while more de-centralized organizing approach burdened with a lack of control and possible agency issues weakens the association. Further, we also propose that the uncertainty of the external environment further moderates the other moderation effect, i.e., the centralized business analytics organizing approach works better in low uncertainty environments, while a decentralized organizing approach characterized by wider spread business analytics expertise and agile decision-making outperforms the centralized organizing approach in more uncertain circumstances. Our paired-response survey data collected from Finnish firms provide support for our hypotheses.

Keywords: Business analytics capability, Business analytics governance, Business analytics organizing, External uncertainty, Operational performance, Survey

1. Introduction

Firms seek to reap business benefits from their investments in information technology (IT) and information systems (IS) by building and strengthening their IS capabilities, such as business analytics capability (BAC), which is defined as the effective mobilization, deployment, and use of business analytics (BA) resources and the alignment of BA planning with the firm's strategy for improved firm performance (e.g., Gupta and George, 2016; Kristoffersen et al, 2021). To leverage BAC in business value creation necessitates firms to identify and deploy supporting organizational mechanisms for BAC, such as strategic IT flexibility (Mishra et al, 2019) and a suitable fit between the organization and its BA systems (Rialti et al, 2019), and BA governance (Fadler and Legner, 2021).

BA governance sets guidelines on how BA is used in firms, having implications for the business value a firm can reap from its BA investments (Baijens et al, 2022; Grossman and Siegel, 2014). BA governance literature is grounded in more established literature on IT governance (Weill and Ross, 2005), which has primarily focused on IT artifacts in general (De Haes and Van Grembergen, 2009) or the specific contents of these artifacts, such as data and information (Tallon et al., 2013). BA governance, however, differs from earlier IT governance concepts by placing greater emphasis on the transformation of IT artifact content (Baijens et al, 2022), for instance, to enable the use of data in a firm's business processes. Therefore, to efficiently transform a firm's data assets into, e.g., enhanced decision-making and business value, a firm needs to establish a BA governance, including its structural, process, and relational mechanisms (Baijens et al, 2022; De Haes and Van Grembergen, 2009; Tallon et al, 2013; Wu et al, 2015). Among the key structural mechanisms, a firm must choose and deploy a BA organizing model that defines the decision-making authority and the location of the analytics function in a firm (Grossman and Siegel, 2014). BA organizing can vary from centralized, hybrid, to de-

centralized approaches, with each of them involving potential advantages and disadvantages (e.g., Baijens et al, 2022; Fadler and Legner, 2021). However, BA governance literature is nascent in terms of empirical evidence on the impact of different ways of BA organizing on BA business value, with most of the works just lamenting the lack of contributions (Gröger, 2018; Grover et al, 2018) or offering conceptual foundations (Baijens et al, 2022). Further, IT governance literature suggests that the uncertainty of the external environment influences a firm's preferred IT governance model (Xue et al, 2011). However, there is a lack of understanding of how such externally driven decisions translate as IT business value, and even less empirical evidence on the optimal way of organizing BA in different degrees of external uncertainty. Therefore, the objective of this study is to improve the understanding of the relationship between BAC and firm's operational performance by examining the moderating roles of BA organizing and the uncertainty of the external environment. To meet this objective, we seek to answer the following research questions:

RQ1:Does BAC support a firm's operational performance?:

RQ2: Does BA organizing affect BAC's association with the firm's operational performance?

RQ3: Does the degree of uncertainty of the external environment impact the business value of different BA organizing models?

We propose that BAC is positively associated with a firm's operative performance, as it provides, e.g., data-driven insights for quicker and better-informed decisions (Lepenioti et al, 2020). Also, we propose that the BA organizing moderates the relationship between BAC and operational performance. That is, the more centralized the BA organizing model is, the more effectively it supports its operational performance through the economics of scale, stability, and standardized BA activities (Schüritz et al, 2017). On the contrary, a decentralized BA organizing model suffers from agency issues, such as a lack of control (Baijens et al, 2022), weakening the positive association between BAC and operative performance. We also propose that the external uncertainty, including dynamism, heterogeneity, and hostility (Newkirk and Lederer, 2006) further curvilinearly moderates the moderating effect of BA organizing, so that a centralized and stable organizing model provides operational business value mainly in stable conditions (i.e., low uncertainty environments), while highly uncertain conditions require more agile decentralized BA organizing model, where BA experts work in the business units. Our pair-matched data collected from BA experts and business unit directors/managers of 89 Finnish companies provide support for these propositions.

2. Research Model and Hypotheses

2.1 Business Analytics Capability and Firm's Operational Performance

Drawing from the resource-based view of the firm (RBV), BAC is often portrayed as a higher-order construct comprising of firm-specific combinations of various BA-related resources. These BA resources, including tangible (data, technology, time, funding, staffing), human (technical and managerial skills), and intangible (data-driven culture), are therefore in the focal point of BAC business value creation (e.g., Wamba et al, 2017; Mikalef et al, 2020a). Previous literature has provided evidence on the positive association between BAC and various tenets of firm performance (e.g., Wamba et al, 2017; Khan et al, 2024; Kristoffersen et al, 2021), including operational performance (Gupta and George, 2016) and sustainable performance (Tetteh et al, 2024). Therefore, we propose the following hypothesis:

H1: Business analytics capability is positively associated with the firm's operational performance

2.2 Business Analytics Governance and Firm's Operational Performance

IT governance facilitates the alignment of the firm's business objectives and the use of its IT resources by establishing governance mechanisms that enable business and IT stakeholders to fulfill their responsibilities, which ensures and sustains business value through the effective use of IT (De Haes et al, 2020). However, rapidly developing digital technologies, such as BA and artificial intelligence (AI) have challenged firms and scholars to revisit the structural, process, and relational mechanisms of IT governance (Enholm et al, 2021; Papagiannidis et al, 2023), as these new technologies are more concerned with the transformation and utilization of the contents of IT artifacts, such as data and information (Bajens et al, 2022). One of the most impactful structural mechanisms is the firm's BA organizing model, which defines the decision-making authority over analytics resources and the location of the analytics function in a firm (Table 1, see Grossman and Siegel, 2014). In a centralized organizing model, all data analytics activities, such as decision-making and problem prioritization, are concentrated within a single unit (Grossman and Siegel, 2014). In contrast, a decentralized organizing model distributes these activities across multiple units, while a hybrid structure

combines elements of both, with some activities coordinated from a central unit while others are distributed across various units (Baijens et al, 2022).

For supporting the firm's operational performance, the centralized BA organizing is the most viable option, as it improves the firm's ability to leverage its BA to deal with its operational-level (e.g., daily and routine-like) tasks more efficiently through coordination and consolidation of activities, and by minimizing duplication (Baijens et al, 2022; Schüritz et al, 2017). Conversely, more decentralized BA organizing models might hinder the positive association between BAC and operational performance, as reuse of analytics resources is restricted to local levels and cannot be leveraged organization-wide (Grossman and Siegel, 2014; cf. Holmström and Milgrom, 1990). Therefore, we propose the following hypothesis:

H2: BA organization decentralization negatively moderates the relationship between BAC and the firm's operational performance

2.3 Business Analytics Governance and Environmental Uncertainty

A firm's IT governance structure reflects not only its strategic business needs but also the degree of A firm's IT governance structure reflects not only its strategic business needs but also the degree of uncertainty of a firm's external environment (Xue et al, 2011). The advantages of a centralized structure are more evident in firms operating in stable environments characterized by low dynamism, homogeneity, and reduced hostility. In such conditions, the centralized IT unit can effectively understand the needs of various business units and optimize resource allocation at an organizational level (Xue et al, 2011). Additionally, procuring IT infrastructure at the firm level offers greater bargaining power with IT vendors compared to procurement at the business unit level (Turban et al, 2006). Consequently, the economies of scale achieved through centralization contribute to improved operational performance in stable environments.

However, when uncertainty increases from low to higher levels, the benefits of decentralization become more evident. This is because the dynamism of the environment, the unique needs regarding new business opportunities, or suddenly arising threats are likely to be more effectively responded by individual business units through, e.g., direct communication with end users (Schüritz et al, 2017). Changes in the external environment may cause conflicts between business units managers' preferences and the firm's long-term goals, causing agency issue (Shpilberg et al, 2007), but the effective utilization of new business opportunities and neutralizing threats is more desirable in such situation than the stability provided by the centralized structure (Schüritz et al, 2017). Based on these, we propose the following hypotheses:

H3: Uncertainty of the external environment positively moderates the moderating effect of business analytics organizing in the relationship between BAC and the firm's operational performance

Table 1: Constructs and definitions

Construct	Definition	Sources
Business analytics capability	The ability of a firm to effectively mobilize, deploy, and utilize BA resources and align BA planning with its strategy to improve its performance.	Gupta and George, 2016; Kristoffersen et al, 2021; Wamba et al, 2017
Business analytics organizing	BA organizing defines the decision-making authority over analytics resources and the location of analytics function in a firm.	Grossman and Siegel, 2014
Uncertainty of the external environment (UNC)	UNC is characterized by the degrees of dynamism, heterogeneity, and hostility, impacting how firm can accurately and reliably predict the market dynamics.	Mikalef et al, 2020b; Newkirk and Lederer, 2006
Operational performance	The degree to which a firm has superior performance relative to its competition in areas of productivity, profit rate, return on investment, and sales revenue.	Gupta and George, 2016

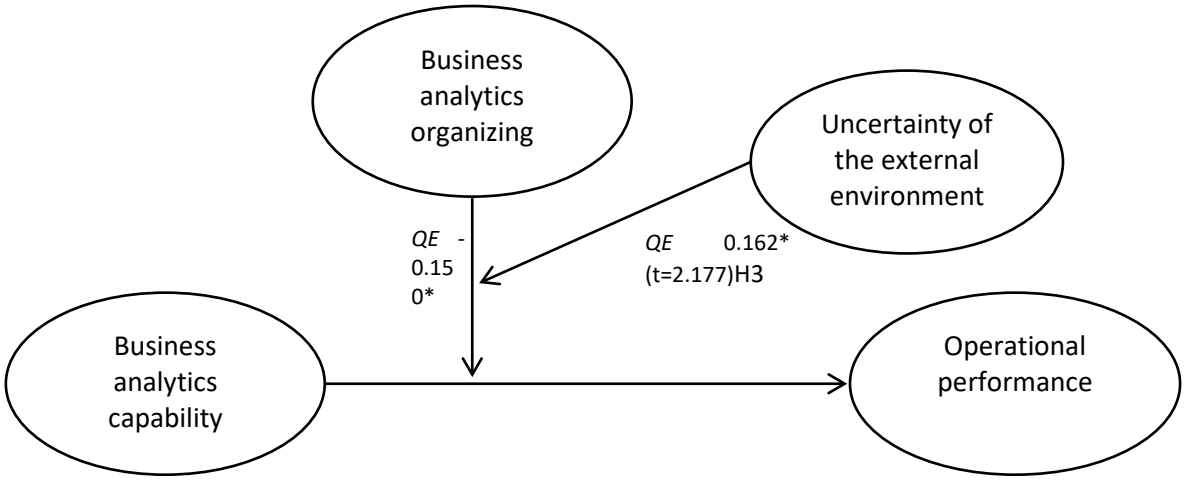


Figure 1: Research model

3. Empirical Study

3.1 Survey, Administration, and Data

The constructs and survey items selected for this study are consistent with the previously published and empirically validated latent variables (Table 2). The only exceptions are "Business managers' analytics skills", "Data-driven decision-making", and "BA governance", that were added as new constructs to better reflect the evolving nature of the firm's BAC. All constructs and respective survey items were operationalized on a 7-point Likert scale, which is a standard practice in large-scale empirical research where no standard or objective measures exist.

To test the research model, we collected data from medium to large-size Finnish firms (more than 100 employees) familiar with BA use. Data was collected in October-December 2023, resulting in 236 individual responses. After establishing a paired response dataset by combining the firm-level responses from 1) BA experts and 2) business managers, we attained the final dataset consisting of 89 valid responses (i.e., 178 individual responses from 89 firms), with responses were received nearly from all industries. Measured by the number of employees, the middle-sized firms with 100–249 employees (47.2%) and large firms with 250 or more employees (52.8%) were nearly equally represented. By the firm turnover (measured in 2022), firms with 20+ million-euro annual turnover constituted most of the sample (66.3%).

3.2 Measurements

To avoid common method bias and collect reliable data for the key constructs of this study, two different surveys were developed for two different respondent profiles. The survey for the respondent profile 1 comprised BAC and BA organizing measurements and it was targeted at senior managers in the BA unit or IT department, while the survey for the respondent profile 2 consisted of business environment and firm performance measurements and it was targeted at senior business directors and managers.

The survey scales for BAC (Gupta and George, 2016; Kristoffersen et al, 2021; Mikalef et al, 2017; Wamba et al, 2017), uncertainty of the external environment (Mikalef et al, 2020a; Newkirk and Lederer, 2006), and operational performance (Gupta and George, 2026) were mostly adopted from the existing literature. In addition, we developed two new scales for business manager's analytics skills and for BA resources taking inspiration from seminal BAC studies (e.g., Gupta and George, 2016; Kristoffersen et al, 2021). First, on the basis on analytics personnel's managerial skills measurement scale (Gupta and George, 2016), we developed a scale for business manager's analytics skills, adding a sub-dimension that incorporates the business managers' important role in leveraging BA in firms (e.g., Orjatsalo et al, 2025). Second, the data-driven culture measurement scale (Gupta and George, 2016; Kristoffersen et al, 2021) was split into data-driven decision-making and data-driven culture, as they measure fundamentally different sub-dimensions of BAC, i.e., to what degree firms make decisions based on data (e.g., Brynjolfsson and McElheran, 2016), and the organizational culture and attitudes related to the use of data in various firm's value creation activities (Gupta and George, 2016).

Further, based on earlier BA governance literature (Grossman and Siegel, 2014), we operationalized BA organizing centralization/decentralisation on a 4-point scale, ranging from (1) centralized to (4) decentralized BA organizing, with two items for different hybrid BA organizing approaches in the middle.

Control variables (continuous) of this study include firm age measured as the number of years since the establishment of the firm and firm size measured as the number of employees.

Table 2: Latent constructs and sub-dimensions

Third-order	Type	Second-order	Type	First-order	Type
Business analytics capability	Formative	Tangible resources	Formative	Data (DATA)	Reflective
				Technology (TECH)	Reflective
				Basic resources (BASIC)	Reflective
		Human skills	Formative	Technical skills (BAAS)	Reflective
				Analytics personnel's managerial skills (BAMS)	Reflective
				Business managers' analytics skills (MBAS)	Reflective
		Intangible resources	Formative	Data-driven decision-making (DDD)	Reflective
				Data-driven culture (DDC)	Reflective
		Uncertainty of the external environment (UNC)	Formative	Dynamism (DYN)	Reflective
				Heterogeneity (HET)	Reflective
				Hostility (HOS)	Reflective
				Operational performance	Reflective

4. Analysis

Data was analyzed with SmartPLS 4 (Ringle et al., 2024) to assess the measurement and structural models of the study. PLS-SEM is a commonly employed quantitative research method across various realms, including IT governance and BA (e.g., Riemer et al., 2020; Mikalef et al., 2020a), especially when studies predict constructs for structural models and estimate various relationships among them (Henseler et al., 2017). Moreover, PLS-SEM is preferred over covariance-based SEM in studies that use simultaneously formative and reflective constructs in higher-order model specification, and those that aim at theorizing instead of testing a validated theory (Akter et al, 2017).

4.1 Measurement Model

First, we established the validity and reliability of the used reflective and formative constructs as measures of BAC. For reflective constructs, we started by examining the outer loadings, leading to us confirming that most of the values exceeded the recommended threshold of 0.7 (Hair et al, 2017). The outer loadings for BAMS2 (0.63), BAMS4 (0.68), DDD2 (0.69), DDD4 (0.67), and DDC4 (0.69), were slightly below the recommended threshold of 0.7, but these items were decided to be retained due to their theoretically strong contribution to their respective first-order constructs. Regarding dynamism, heterogeneity, and hostility (the sub-dimensions of the uncertainty of the external environment), we found low outer loadings for DYN1, DYN2, and HOS 1-5, leading us to retain only dynamism and heterogeneity for further analysis. Further, all items measuring operational performance exhibited strong outer loadings (0.76-0.88) on its related construct.

Second, we assessed the reliability, convergent validity, and discriminant validity of the first-order reflective constructs (Table 3). Composite Reliability (CR) values were examined, with all exceeding the 0.70 threshold (Hair et al, 2024). Average Variance Extracted (AVE) values for the reflective constructs were above 0.5, establishing their convergent validity (Hair et al, 2021). Three tests were employed to assess the discriminant validity: 1) ensuring that the square root of each construct's AVE exceeded its highest correlation with any other construct (Fornell and Larcker, 1981), 2) confirming that each indicator's outer loading was higher than its cross-loadings with other reflective constructs (Farrell, 2010), and 3) using the heterotrait-monotrait ratio (HTMT) as recommended by MacKenzie et al (2011). The outcomes of these tests indicate that our first-order reflective constructs are robust indicators of their respective higher-order constructs.

Table 3: Assessment of reliability, convergent and discriminant validity of reflective constructs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) BAAS	0.830										
(2) BAMS	0.644	0.733									
(3) BASIC	0.496	0.574	0.891								
(4) BMAS	0.513	0.675	0.440	0.772							
(5) DATA	0.473	0.577	0.402	0.516	0.756						
(6) DDC	0.633	0.626	0.464	0.623	0.589	0.756					
(7) DDD	0.443	0.472	0.326	0.617	0.419	0.633	0.708				
(8) DYN	-0.170	-0.072	0.126	-0.220	-0.093	-0.146	-0.197	0.848			
(9) HET	0.054	-0.082	-0.105	0.030	-0.007	-0.025	-0.107	-0.156	0.802		
(10) OP	0.206	0.096	0.171	0.068	0.146	0.223	0.120	-0.232	0.232	0.815	
(11) TECH	0.585	0.435	0.434	0.301	0.289	0.573	0.283	0.009	0.069	0.260	0.777
CR	0.87	0.89	0.92	0.90	0.80	0.84	0.80	0.84	0.84	0.89	0.90
AVE	0.69	0.54	0.79	0.60	0.57	0.57	0.50	0.72	0.64	0.67	0.60

Third, we began evaluating the formative constructs by examining their indicator weights, confirming that all weights were positive and statistically significant. We then calculated Edwards' (2001) adequacy coefficient (R^2_a) to assess the validity of the sub-dimensions of the formative constructs, finding that all R^2_a values exceeded them minimum threshold of 0.50 (MacKenzie et al, 2011), which indicates that most of the variance in the indicators is shared with their respective formative constructs (Edwards, 2001). We then assessed the degree of multicollinearity among the formative construct indicators by assessing the Variance Inflation Factor (VIF) values, which are acceptable at levels below 5 (Hair et al, 2017). The VIF values for all of our formative constructs were under 3.3, indicating low multicollinearity (Cenfetelli and Bassellier, 2009).

Table 4: Formative higher-order construct validation

Construct	Measures	Weight	Significance	VIF	R^2_a
Tangible resources	Data	0.46	$p < 0.001$	1.216	0.58
	Technology	0.43	$p < 0.001$	1.256	
	Basic	0.43	$p < 0.001$	1.373	
Human skills	Technical skills	0.40	$p < 0.001$	1.741	0.74
	Analytics personnel's managerial skills	0.39	$p < 0.001$	2.356	
	Business managers' analytics skills	0.37	$p < 0.001$	1.873	
Intangible resources	Data-driven decision-making	0.44	$p < 0.001$	1.669	0.80
	Data-driven culture	0.66	$p < 0.001$	1.669	
BAC	Tangible	0.39	$p < 0.001$	2.623	0.82
	Human	0.35	$p < 0.001$	3.230	
	Intangible	0.37	$p < 0.001$	2.503	
UNC	Dynamism	0.66	$p < 0.001$	1.025	0.58
	Heterogeneity	0.66	$p < 0.001$	1.025	

Considering results attained for construct validity, reliability, and discriminant validity, all formative and reflective indicators of this study showed strong psychometric qualities.

4.2 Structural Model

A bootstrap analysis with 10,000 resamples was conducted to assess the structural model, including the explained variance of endogenous variables (R^2), the standardized path coefficients (β), effect size of the predictor variables (f^2), and the significance estimates (t-statistics). Two of our three hypotheses were empirically supported, with the structural model explaining 26.0% of variance in operational performance (R^2 =

0.260), and representing moderate predictive power (Hair et al, 2021). Regarding f^2, referring to an exogenous construct's contribution to an endogenous latent variable, all direct values were above the threshold of 0.15, portraying moderate effect sizes. The impact of all control variables was nonsignificant.

The direct effect of BAC on operational performance was positive and statistically significant (β = 0.256, T = 2.955, p < 0.01). This indicates that higher BAC is associated with better operational performance, suggesting that enhancing a firm's BAC directly improves its operational performance. Therefore, our first hypothesis is supported (Table 5). The moderation effect of BAC*BA organizing was negative and highly significant (β = -0.282, T = 3.223, p < 0.001), confirming our second hypothesis and hinting that the centralized BA organizing model is more likely to support operational performance than the hybrid or decentralized approaches. The three-way interaction term BAC*BA organizing*UNC was statistically non-significant (β = 0.163, T = 1.219, p = 0.111). This implies that uncertainty of the external environment does not significantly alter the moderating effect of BA organizing on the BAC-operational performance relationship in a linear sense.

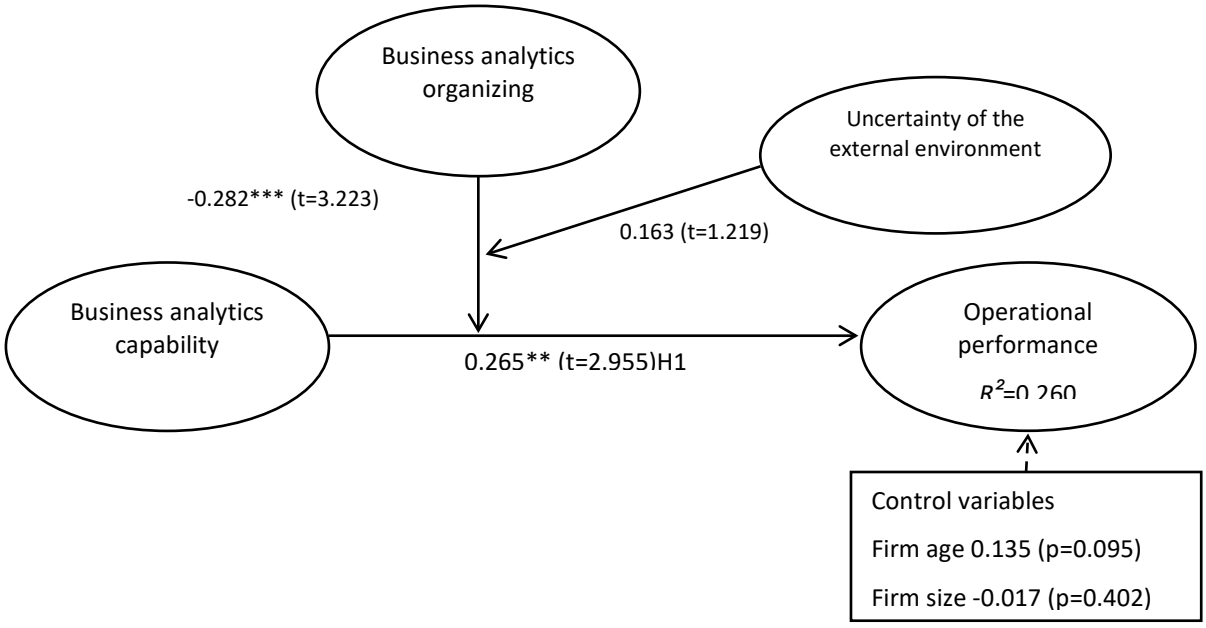


Figure 2: Results and estimated relationships of the structural model

Table 5: Summary of hypotheses and results of linear and nonlinear effects

Structural path	Effect	t-value[a]	Bias corrected 95% confidence interval	Conclusion
BAC -> Operational performance	0.265	2.955**	[0.110-0.403]	H1 supported
BAC*BA organizing -> Operational performance	-0.282	3.223***	[-0.433- -0.148]	H2 supported (partial moderation)
BAC*BA organizing*UNC -> Operational performance	0.163	1.219	[-0.097-0.341]	H3 rejected
Quadratic effect (BAC*BA organizing) -> Operational performance	-0.150	2.310**	[-0.247- -0.036]	Post-hoc test (partial nonlinear moderation)
Quadratic effect (BAC*BA organizing*UNC) -> Operational performance	0.162	2.177*	[0.017-0.272]	Post-hoc test (full nonlinear moderation)

[a] * significant at p < 0.05; ** significant at p < 0.01; *** significant at p < 0.001 (one-tailed test).

4.2.1 Post-hoc test for nonlinear effects

To extract more nuanced information about the role of our two moderating variables, we conducted a post-hoc test for their nonlinear, quadratic effects. The quadratic term for BAC*BA organizing was negative and statistically significant (β = -0.150, T = 2.310, p < 0.05), indicating a nonlinear moderating effect and suggesting that the impact of BA organizing on the BAC-operational performance relationship changes at different degrees of centralization/decentralization. Specifically, the negative coefficient hints that when BA organizing

is highly decentralized, the weakening effect on the BAC-operational performance relationship becomes more pronounced. This additional finding further bolsters the hypothesized moderating role of BA organizing. The quadratic three-way interaction term for BAC*BA organizing*UNC was also positive and statistically significant ($\beta = 0.162$, $T = 2.177$, $p < 0.05$), suggesting that at higher levels of external uncertainty, the moderating effect of BA organizing on the BAC-operational performance relationship becomes less negative or even positive, hinting at the suitability of more decentralized BA organizing approaches in higher levels of environmental uncertainty.

5. Discussion

This study aimed at improving the understanding of the intra- and extra-organizational conditions under which firms may reap business value on their BAC investments. Specifically, we were interested in exploring the effects that BA organizing and the uncertainty of the firm's external environment may have on the association between BAC and the firm's operational performance. Based on our empirical survey data collected from Finnish firms, we found that both BA organizing and external uncertainty have significant roles in BAC business value creation, but their interplay might be more complex than expected, including both linear and nonlinear effects.

First, in line with past BAC literature (e.g., Khan et al, 2024; Wamba et al, 2017), our findings suggest that variance in a firm's BAC is directly related to variance in firm performance. More specifically, as we hypothesized based on earlier literature (Gupta & George, 2016), in the higher the level of a firm's BAC, the better its operational performance. A firm that has invested heavily in BAC is likely to improve its operational performance by, for instance, enabling quicker and better decision-making (Lepenioti et al, 2020). For instance, a retail company using BA to manage inventory can reduce stockouts and overstock situations, leading to improved productivity, sales and profit rate.

Second, the extant literature on BA governance has been mostly conceptual by nature (Baijens et al, 2022)

and/or bemoaned the lack of empirical evidence regarding the business value implications of different BA governance approaches (Gröger, 2018; Grover et al, 2018). The findings of this study contribute to BA governance by addressing and empirically confirming the impact of the degree of BA organizing centralization/decentralization in terms of reaping operational performance gains from the firm's BAC. In more detail, the attained negative moderation coefficient suggests that a centralized BA organizing approach, characterized by standardization of services, consolidation of activities, and duplication minimization (Schüritz et al, 2017) has a positive impact on the relationship between BAC and operational performance, while this positive impact decreases when BA organizing becomes more decentralized. Further, our post-hoc test for the nonlinear effect bolstered this finding, indicating that the more decentralized the firm's BA organizing approach is, the stronger the weakening effect becomes. This could mean that beyond a certain point, decentralized BA organizing might add complexity without corresponding benefits, potentially leading to, e.g., local, business unit-level optimization that does not serve the entire firm (Grossman and Siegel, 2014). Addressing such problem, past literature has suggested that the lack of control and potential agency issues may be the main disadvantages of the decentralized approach (Holmström and Milgrom, 1990; Xue et al, 2011). However, more research should be done specifically in the BA and BAC context to better understand the optimal fit between the degree of BA organizing de-centralization and different facets of firm performance.

Third, the existing literature has addressed the role of environmental uncertainty in effective IT governance (Turban et al, 2006; Xue et al, 2011) but has not provided sound empirical evidence on its business value implications. The results of our study showed non-significant linear moderation effect, but the post-hoc test for nonlinear moderation affirmed that the negative impact of a decentralized BA governance on the BAC-operative performance relationship might be mitigated or even reversed in highly uncertain conditions. For instance, during a period of rapid market changes, a decentralized BA organizing model might provide the necessary agility and framework to adapt quickly, navigate the uncertainty more effectively, thus enhancing the positive impact of BAC on operational performance. Or, as stated in earlier research, a centralized structure may simply lack insight into urgent data analytics needs across firm (Schüritz et al, 2017). We emphasize that even though the nonlinear impact was not hypothesized in this study, the finding is valuable starting point to better understand the interplay between these intra- and extra-organizational factors in BAC value creation.

6. Conclusion

In this study, we explored the moderating effects of BA organizing and the uncertainty of the firm's external environment on the association between BAC and operational performance. Our findings provide novel insights on BAC business value creation mechanisms, emphasizing the importance of addressing both internal and external factors and underlining the criticality to match the impact of the uncertainty of the external environment with a suitable BA organizing approach. Our study found that a centralized structure supports firm's efforts to leverage its BAC for operational performance gains in low to moderately uncertain conditions, while a decentralized approach seems to suit highly uncertain environments. That said, more research should be done to address this phenomenon to confirm these findings.

Ethics Declaration: Ethics approval was not required.

AI Declaration: AI tools were not used in the creation of this paper.

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Modern Technologies in Knowledge Management in HR Processes in Organizations

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Abstract: The paper examines the role of modern technologies in knowledge management within HR processes, emphasizing their importance for building a competitive advantage in the era of digital transformation. It has been demonstrated that organizations are increasingly utilizing advanced IT tools to support key HR functions, such as recruitment, onboarding, competency development, performance evaluation, and talent management. Based on qualitative research involving HR department employees, the most commonly used technologies were identified, including Artificial Intelligence, Applicant Tracking Systems (ATS), Human Resource Management Systems (HRM), HR process automation (workflow automation), Learning Management Systems (LMS), and Robotic Process Automation (RPA). These technologies enable the automation of repetitive tasks, the analysis of HR data, and the personalization of training programs while also supporting the development of an organizational culture based on knowledge sharing. Although the study was of a pilot nature, the obtained results provide a basis for further quantitative analysis. The next stage will involve a survey aimed at assessing the extent to which modern IT technologies are used in knowledge management within HR, as well as identifying their strengths and weaknesses and the benefits and barriers associated with their implementation.

Keywords: Knowledge management, HR functions, Information technology, Artificial intelligence, Big Data analytics, Robotic process automation

1. Introduction

Modern organizations operate in a dynamically changing environment, which forces them to constantly adapt, innovate, and effectively manage intangible resources, especially knowledge. In this context, knowledge management (KM) is becoming one of the key elements in building competitive advantage for companies. It plays a crucial role in human resource management (HR), where the employees' knowledge, competence, experience, and ability to learn organizationally are the foundation for the effectiveness of personnel processes.

The personnel function was one of the first areas of business activity for which information technologies began to be implemented. These technologies were and still are primarily used to automate personnel administration processes – to carry out the so-called transactional function. The development of technologies that increasingly enable the virtualization of the personnel function has also made it possible to implement HR processes in the transformational domain, covering key HR areas such as employee competencies, development, employee evaluations, career paths, and talent management (Urlich et al., 2001).

Modern technologies enable the data integration from multiple sources, automation of recruitment and training processes, predictive analysis of HR data, and creation of intelligent systems supporting HR decisions. Their deployment influences both operational efficiency and the organization's potential to develop a culture centered on learning and innovation. HR digitization is playing an increasingly important role in organizations (Prasad et al., 2024). According to a study by Deloitte and Randstad (2017), the digitization of HR processes ranked seventh in the ranking of the most essential tasks of HR departments.

The purpose of this article is to identify the role of modern technologies in knowledge management in HR processes in organizations. In particular, the focus is on defining technologies supporting HR processes, assessing their impact on knowledge management, and indicating the challenges and barriers associated with their implementation. Based on this objective, the following research questions have been formulated:

RQ1. What are the most relevant modern technologies applied to knowledge management in HR processes?

RQ2. How do these technologies contribute to the efficiency and effectiveness of HR knowledge management?

RQ3. What are the benefits and limitations of implementing modern technologies in HR knowledge management?

The article presents key findings from qualitative research—interviews conducted with HR department employees aimed at defining a set of the most important technologies used in knowledge management within HR processes in modern organizations, as well as assessing their potential.

2. Background

To present the theoretical foundations and define the research gap, a systematic literature review was conducted. Three main thematic blocks and their combinations were analyzed in scientific publications (in their titles, abstracts, and keywords) indexed in the Scopus database—see Table 1:

- Main thematic blocks (blue cells),
- Combinations of main thematic blocks (green cells).

Table 1: Summary of the number of indications for selected keywords in the Scopus database

Keywords	Number of publication	Number of publications in the subject categories of "*Business, Management and Accounting*"
Knowledge Management	65954	5236
Human Resource Management	13322	1971
Information Technology	88355	8089
Knowledge Management and Human Resource Management	1931	322 (40)*
Knowledge Management and Information Technology	3001	479 (52)*
Human Resource Management and Information Technology	573	120 (14)*
Knowledge Management and Human Resource Management and Information Technology	149	39 (5)*

* Number of open access publications in English

Source: own elaboration base on Scopus database

The conducted quantitative analysis reveals that the body of domain-specific literature contains relatively few publications that offer a comprehensive examination of the use of advanced information technologies in knowledge management within the organization's HR functions.

2.1 Knowledge Management in HR Processes

Knowledge management is the systematic process of acquiring, organizing, sharing, and utilizing knowledge within an organization to achieve strategic goals. In the literature, knowledge is perceived as a key intangible resource; when effectively leveraged, it can serve as a source of competitive advantage (Sánchez et al., 2025). In the context of organizational management, knowledge management acts as a glue between strategy, organizational culture, and business processes (Shen et al., 2024). It is present at the operational level (e.g., employee training) and the strategic level (e.g., building a learning organization), (Contreras et al., 2024). In HR departments, knowledge management not only supports the development of employee competencies but also enables critical knowledge to be consolidated and shared within organizational structures.

Key HR processes related to knowledge are:

- Recruitment,
- Onboarding,
- Competency development,
- Succession,
- Retention.

The process of hiring a new employee involves the collection and analysis of knowledge about the labor market, candidates' competencies, and the organization's needs. This knowledge enables the effective alignment of the candidate's profile with the organizational culture and the specific requirements of the position (Apascaritei, Elvira, 2022).

The onboarding of a new employee is a moment of intensive knowledge transfer—both formal (e.g., procedures, regulations) and informal (e.g., customs, norms). A well-designed onboarding process enables the employee to reach full effectiveness more quickly (LaMont, Lucey, 2022).

Knowledge management is an integral part of training policy. Organizations identify competency gaps, plan development activities (such as training, coaching, and mentoring), and then monitor their outcomes. Knowledge regarding the effectiveness of various learning methods is also collected and analyzed (Piwowar-Sulej et al., 2022).

The succession process requires the identification of critical knowledge—essential for the functioning of the organization—and its transfer across employee generations. Knowledge accumulated by experienced employees must be systematically passed on to their successors (Salvadorinho et al., 2024).

Talent retention is closely linked to preserving knowledge within the organization. The departure of an employee often simultaneously means the loss of the knowledge they have accumulated. Therefore, retention mechanisms (e.g., career paths, engagement strategies, organizational culture) are crucial in minimizing the risk of knowledge loss (Al Nsour, Abu Tayeh, 2018).

In knowledge management, two main types of knowledge are distinguished: explicit and tacit knowledge. Explicit knowledge refers to knowledge that can be documented, cataloged, and transferred through materials such as documents, procedures, and databases. In the HR context, this may include onboarding manuals, competency frameworks, workplace regulations, or performance evaluation systems. Tacit knowledge, on the other hand, is difficult to formalize and is embedded in personal experience, intuition, and individual competencies. Examples in HR include the ability to conduct challenging recruitment interviews, intuition in assessing employee potential, or knowledge about team dynamics. Knowledge management in HR should aim to extract tacit knowledge—for example, through mentoring, job shadowing, or collaborative projects—and to effectively capture and distribute explicit knowledge, ensuring it is accessible across the organization (Shen et al., 2024).

2.2 Modern Technologies Supporting Knowledge Management in HR

In the age of digital transformation, modern technologies play a key role in knowledge management within HR departments (Contreras et al., 2024). They not only enable the efficient collection, processing, and distribution of knowledge but also support the development of competencies, analysis of HR data, and automation of many processes related to human capital (Indradevi et al., 2024).

Information and communication technologies (ICT) form the foundation of digital transformation in HR (Manekar, 2024). They encompass a wide range of tools, such as computer systems, databases, web applications, communication networks, and online collaboration platforms. In the context of knowledge management, ICT enable:

- the storage and sharing of knowledge (intranet, knowledge bases),
- internal communication (chats, videoconferences, social platforms),
- support for remote and hybrid work,
- automation of HR processes through integration with other systems.

Information systems dedicated to knowledge management are referred to as Knowledge Management Systems (KMS). These are specialized tools that support processes related to the creation, storage, sharing, and utilization of knowledge within an organization. In HR, their functions include, among others (Apascaritei, Elvira, 2022):

- building knowledge bases (FAQs, procedures, instructions),
- cataloging employee competencies,
- supporting collaboration and knowledge sharing (forums, wikis, social platforms),
- integration with performance, training, and talent development systems,
- analyzing competency gaps and forecasting training needs.

Key technologies supporting knowledge management in HR include:

- Big Data technology and data analysis methods (Zhang et al., 2021),
- artificial intelligence, chatbots, and virtual assistants (Bastida et al., 2025),
- Robotic Process Automation (RPA) (Ulatowska et al., 2023).

Big Data is a term that emerged due to the exponential increase in the volume of data generated and processed in information systems. ‘Big Data’ refers to data that exceeds the capabilities of traditional relational databases and data warehouses. Due to the size and high rate of change, they require alternative methods of collection and processing.

In analyzing HR data, particularly useful methods include network structure analysis and content analysis. Network structure analysis (Social Network Analysis and Web Structure Mining) involves identifying connections between nodes in a network, distinguishing user groups, determining key nodes in the network, and analyzing the flow of information between these nodes. The primary goal of network structure analysis is to identify patterns in the processes being carried out and to determine employees who:

- condition the correctness of process execution and the achievement of set goals – they represent central nodes in the network,
- condition effective connections with other elements of the network – nodes that serve as integrators between dependent nodes,
- are poorly integrated or not integrated at all with other actors in the process – they represent isolated nodes in the network,
- form informal groups that influence the behaviors of other employees within the organization.

Network structure analysis enables the selection of individuals for task teams, the creation of effective communication channels, the identification of leaders and experts, the identification of relationship categories, and the determination and monitoring of information exchanged between team members.

Content analysis (content mining), on the other hand, involves extracting information from documents and websites. A specific case in the context of HR is the automatic analysis of CV content, speech recognition, content and statement evaluation, image and video analysis, enabling the hiring of the best candidate for a vacant position.

In HR processes, analyses such as employee loyalty analysis, new employee attraction studies, employee opinion surveys, burnout analysis, and the study of employee turnover causes and probabilities are also conducted. These analyses are made possible by access to new data and the development of new techniques for knowledge extrapolation from data (Buyck et al., 2016; Saradhi, Palshikar, 2011).

Artificial intelligence is revolutionizing the modern world. AI-based solutions, such as:

- chatbots and voicebots engaging in conversations with customers,
- virtual teachers personalizing learning paths,
- recommendation systems,
- search engines,
- object recognition programs, are present in virtually all areas of human life, not only in professional but also in personal spheres.

Organizations recognize numerous advantages in the application of artificial intelligence solutions, which are distinguished by their operational speed, continuity, and the reduction of the risk of errors. Furthermore, robotic systems are capable of functioning around the clock, 24 hours a day, 7 days a week. They do not experience illness, take leave, or suffer from challenging working conditions. Additionally, they do not express dissatisfaction nor present any demands. In this regard, it can be argued that they represent 'ideal' employees.

Artificial intelligence can be leveraged in human resource management across a diverse range of areas, including mitigating gender discrimination in recruitment processes, predicting employee turnover or profitability based on factors such as phone conversations, social media data, and internal databases. The development of HR applications capable of defining competency requirements for specific roles and identifying key traits to seek in candidate profiles represents a forthcoming advancement in the field (PwC, 2017). It is increasingly evident that administrative tasks of a routine nature will be automated, and many job roles will likely be enhanced through AI integration. The term AI, traditionally referring to artificial intelligence, has, in recent years, come to be interpreted as 'augmented intelligence.' This perspective underscores the augmentation and optimization of human labor, with the aim of enhancing and more effectively utilizing human potential (Singh, 2020). Such advancements may offer solutions to a longstanding challenge faced by employers – the identification, retention, and development of the most suitable employees, a challenge that is expected to intensify in the future.

Chatbots and virtual assistants are solutions based on artificial intelligence technologies, particularly Natural Language Processing (NLP), which enable automated and interactive communication with users. In the HR environment, their use is growing rapidly as they facilitate efficient knowledge management and the automation of processes related to employee support. HR chatbots serve as the first point of contact for employees with the HR department and perform various functions, including:

- providing answers to frequently asked questions (FAQ) – the chatbot can respond to inquiries regarding, for example, leave policies, internal procedures, benefits, or payroll schedules,
- supporting the onboarding process – new employees can ask questions about their first days at work, safety regulations, organizational structure, etc., which reduces the burden on the HR department and accelerates the onboarding process,
- reminders and notifications – the chatbot can automatically remind employees to complete performance evaluations, training sessions, or medical examinations,
- collecting feedback – the chatbot can conduct short satisfaction surveys or engagement assessments in a quick and unobtrusive manner,
- supporting recruitment processes – recruitment chatbots can conduct preliminary interviews with candidates, analyze resumes, and even schedule interview appointments, thus saving recruiters' time.

Virtual assistants, on the other hand, are more advanced versions of chatbots, often integrated with HRM and KMS systems, offering enhanced functionality:

- personalization of communication – they provide information tailored to individual employees, such as reminding them of their career development path or suggesting courses based on performance evaluations,
- access to organizational knowledge – by integrating with knowledge bases, the virtual assistant can 'extract' information from documents, procedures, and regulations, facilitating access to knowledge embedded in systems,
- decision support – they assist leaders and managers in analyzing HR data, for example, suggesting potential candidates for promotion or recommending retention strategies based on historical data.

Chatbots and virtual assistants are becoming an integral part of modern HR departments, supporting knowledge management and enhancing operational efficiency. Their effective implementation allows for the transformation of traditional HR into a model that is more data-driven, automated, and employee-experience focused.

Robotic Process Automation (RPA) is a business process automation technology that utilizes software, so-called software robots, to perform repetitive, rule-based tasks previously carried out manually by employees. RPA mimics user actions in the interfaces of information systems, such as data entry, copying information between applications, generating reports, or answering emails. It enables the transfer of routine, monotonous, rule-based tasks, previously executed solely by humans, to robots (Fersth et al., 2019; Sobczak, 2022). Software robots serve as digital collaborators and digital assistants to computer operators. Contemporary software robots represent an easy-to-use, digital workforce.

RPA can also be successfully applied to HR-related tasks that involve multiple systems. For example, the fact of hiring, transferring, or dismissing an employee can trigger processes in systems related to benefits management, payroll, and pensions. The RPA application can be programmed to automatically initiate these processes.

RPA often constitutes the first step toward intelligent automation, which integrates RPA with artificial intelligence technologies, machine learning, and natural language processing.

3. Research Results

3.1 Research Methodology

The research findings presented in this article constitute part of a broader study, the primary objective of which is to determine the role and potential of modern technologies in knowledge management within HR processes. The research design comprised two main components: interviews (qualitative research) and a survey (quantitative research). The interviews conducted with HR department employees aimed to identify the most significant technologies used in knowledge management in HR processes within contemporary organizations and to assess their potential. They also served as the basis for developing the survey questionnaire, an essential tool for conducting the main study. The goal of the survey was to examine the extent to which automation, robotization, artificial intelligence, and digitalization are applied in managing human resource processes in modern organizations; to assess the level of familiarity with modern information technologies used in knowledge management in HR processes among employees from various organizational departments—not limited to HR; and to evaluate their effectiveness, particularly by identifying their strengths and weaknesses. This article presents the key findings from the qualitative research phase.

The first stage of the study was planned to be conducted over a period of three months. The research commenced on January 7, 2025. The research sample was non-representative, and a purposive sampling method was employed. The following selection criteria were established: (1) respondents were required to be employees of HR departments; (2) only one respondent per organization was permitted; (3) the organization's headquarters had to be located in an economically developed region—specifically, the most economically developed provinces in Poland, namely the Mazowieckie and Śląskie Voivodeships. Respondents were reached through various channels. During the designated period, a total of 25 interviews were successfully conducted.

The qualitative research was carried out using a questionnaire-based interview method. The questionnaire included nine core questions (presented in the following section of this article) and five demographic questions.

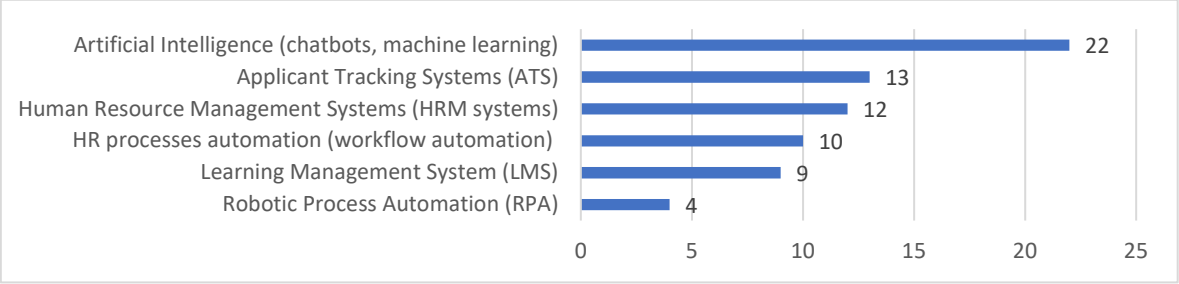
The demographic questions asked respondents about: (1) gender, (2) age, (3) type of position held within the HR department, (4) size of the organization, and (5) the organization's sector of activity. The study included 15 female and 10 male participants. Fifteen respondents were aged between 20 and 25 years, seven were between 31 and 49 years old, and three were aged between 26 and 30 years. Six respondents held managerial positions, while the remaining participants were non-managerial white-collar employees. The majority of respondents—thirteen individuals—represented large organizations. The remaining respondents were employed in medium-sized organizations (seven respondents), small organizations (one respondent), and microenterprises. The participants worked across a variety of sectors, including public administration, education, finance and banking, trade and e-commerce, information technology, employee outsourcing, industrial manufacturing, healthcare, and diverse service industries.

3.2 Results

During the interviews, respondents were asked the following questions:

- What modern technologies do you know that are useful in employee management?
- What modern technologies useful in employee management are currently implemented in the organization you work for?
- In your view, do these technologies contribute to improved knowledge management in HR?
- What benefits can result from their implementation?
- What are the main barriers to using modern technologies in HR?
- Which HR areas in your company are supported by modern technologies?
- In your view, should the organization you work for invest more in modern HR technologies?
- In your view, what additional technological functionalities would be most useful in HR?
- What are your greatest concerns related to the implementation of modern technologies in HR?

Respondents' answers were categorized, which allowed for the identification of a group of modern technologies perceived as useful in employee management by HR practitioners. These technologies included: Artificial Intelligence (chatbots, machine learning), Applicant Tracking Systems (ATS), Human Resource Management Systems (HRM systems), HR processes automation (workflow automation), Learning Management System (LMS) and Process Automation (RPA) – Figure 1. One respondent indicated a lack of knowledge regarding HR-dedicated solutions that could be classified as modern technologies.



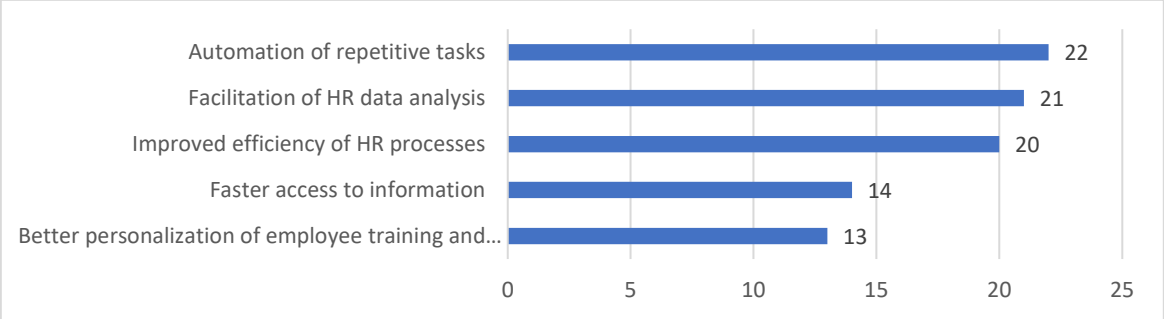
Source: Own study

Figure 1: Categorized responses of respondents to the question: What modern technologies do you know that are useful in employee management? N=25

All of the identified technologies are in use across surveyed organizations; however, not all of the studied companies implement them. Ten out of the 25 surveyed organizations do not utilize such solutions. This may be partially explained by the presence of small and micro-enterprises within the sample group; nevertheless, no

statistically significant relationship was found between the implementation of modern information technologies and organizational size within this sample. The extent of technology adoption also varied among organizations. The most frequently applied solutions included HR processes automation (workflow automation), reported by nine respondents, and Human Resource Management Systems (HRM systems), indicated by eight respondents. Less commonly used were Learning Management System (LMS) – cited by four respondents – as well as Robotic Process Automation (RPA), Artificial Intelligence (chatbots, machine learning), and Applicant Tracking Systems (ATS), each mentioned by three respondents.

The respondents generally agree that modern technologies enhance knowledge management within the HR domain—21 participants indicated "definitely yes" (9) or "rather yes" (12). The main benefits identified as resulting from the implementation of such technologies include: automation of repetitive tasks, facilitation of HR data analysis, improved efficiency of HR processes, faster access to information and better personalization of employee training and development – Figure 2.

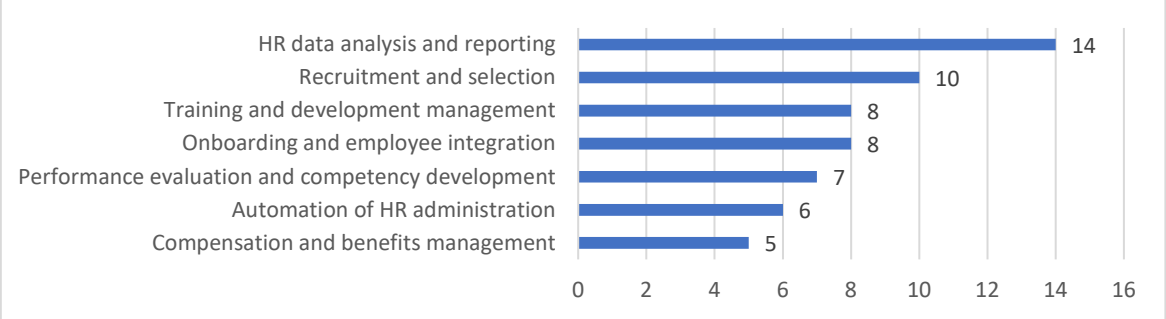


Source: Own study

Figure 2: Categorized responses of respondents to the question: What benefits can result from modern technologies implementation? N=25

The technological functionalities considered most beneficial for HR, as identified by respondents, include: monitoring employees' knowledge levels; personalized career development plans; individualized training aligned with personal needs and development trajectories; the use of AI to measure employee engagement; prediction of burnout risk; automation of recruitment processes, including the generation of reports based on candidates' CVs and publicly available online information, CV verification, recruitment chatbots, automation and optimization of routine and repetitive tasks such as email communication and thank-you messages after recruitment; enhancement of onboarding processes through personalized messages for specific employees; automation of performance evaluations; workforce scheduling; and broader automation of standard HR procedures. These functionalities are closely aligned with the previously indicated benefits.

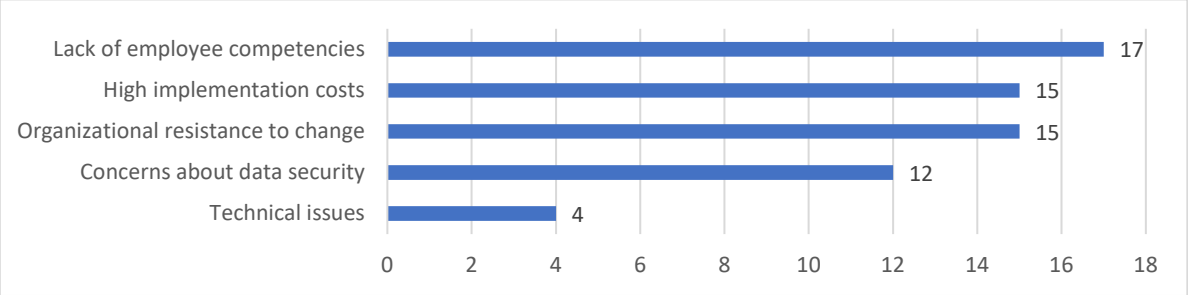
In the surveyed organizations, these technologies are applied across various HR domains. The areas identified in the study (within 15 organizations) include: HR data analysis and reporting, recruitment and selection, onboarding and employee integration, training and development management, performance evaluation and competency development, automation of HR administration and compensation and benefits management – Figure 3.



Source: Own study

Figure 3: Categorized responses of respondents to the question: Which HR areas in your company are supported by modern technologies? N=15

Fifteen out of 25 respondents believe that their organization should invest more heavily in modern HR technologies. Two respondents indicated that they do not see such a need, while the remaining respondents did not express a clear opinion on the matter. The main barriers to the adoption of these technologies, as identified by the respondents, include: lack of employee competencies, high implementation costs, organizational resistance to change, concerns about data security and technical issues – Figure 4. None of the respondents considered the lack of appropriate software tools on the market to be a barrier.



Source: Own study

Figure 4: Categorized responses of respondents to the question: What are the main barriers to using modern technologies in HR? N=25

Respondents were also asked to identify the greatest risks associated with the implementation of modern technologies in HR. The respondents highlighted the following threats: data security issues, such as data breaches or loss; a high risk of dehumanization; treating employees through the lens of metrics; lack of direct contact; employment limitations—the replacement of humans by machines, which could lead to increased unemployment and the disappearance of certain professions; software errors; high implementation costs; and resistance to new solutions from the older workforce. These concerns are strongly correlated with the identified barriers to implementation.

4. Conclusions and Discussion

The article addresses the role of modern technologies in knowledge management within HR processes, emphasizing their significance in building a competitive advantage for organizations in the digital era. The background illustrates how modern technologies are transforming the way knowledge is managed in HR—from manual procedures to integrated, digital environments that support employee development and operational efficiency. The effective implementation of ICT tools, Knowledge Management Systems (KMS), and Artificial Intelligence (AI) not only enhances the performance of HR departments but also fosters an organizational culture centered on continuous learning and knowledge sharing. The key HR processes related to knowledge include recruitment, onboarding, competency development, succession, and employee retention.

The foundation of digital transformation in HR is built upon information technologies that support the collection, processing, and utilization of knowledge within the personnel domain. The conducted qualitative research based on interviews with HR department employees enabled the identification of key technologies applied in organizational practice within Polish enterprises. The following technologies were identified: Artificial Intelligence (including chatbots and machine learning), Applicant Tracking Systems (ATS), Human Resource Management Systems (HRM), HR processes automation (workflow automation), Learning Management System (LMS), and Robotic Process Automation (RPA). The identified technologies align with those recognized as modern and relevant in the academic literature on the subject.

The article also outlines the functionality and utility of modern technologies in the HR domain, as well as identifies the potential benefits and challenges associated with their implementation in organizational practice. The key benefits identified through the study include: the automation of repetitive tasks, facilitation of HR data analysis, improvement of HR processes efficiency, faster access to information, and enhanced personalization of employee training and development. The research findings confirm the growing importance of technology in the digital transformation of HR functions. The highlighted functionalities align with those recognized in the relevant academic literature.

The study is not of a representative nature. However, as noted, it constitutes the first stage of a broader research project aimed at identifying the role and potential of modern technologies in knowledge management within HR processes in contemporary organizations. The results presented herein served as the basis for developing a

research questionnaire to be used in the main quantitative survey. The objective of the main study is to examine the extent to which automation, robotization, artificial intelligence, and digitalization are applied in managing HR processes in modern organizations; to assess the level of familiarity with modern information technologies used in knowledge management within HR among employees; and to evaluate their effectiveness, with particular attention to identifying their strengths and weaknesses.

Ethics and AI declaration: The paper does not infringe the copyright of third parties. No relevant AI tools are used to develop this paper.

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Knowledge Sharing in Communities of Interest for Better Self-Confidence

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Abstract: Sharing knowledge in a community of interest creates additional value to the members of the community. The way to avoid hardly bearable problems and live a better life is to search for and belong to communities of interest. The previous research analyzes the environmental factors for playing a crucial role in shaping knowledge sharing behaviors within virtual communities (Cai and Shi, 2020). The success of open knowledge sharing community requires individuals to involve in and make continuous commitment to a community the one must be accepted by all the members of the community as equally and involved (Wu *et al.*, 2019). Multiple studies highlight the importance of trust in fostering knowledge sharing. For instance, (Lin and Huang, 2013) (Cien *et al.*, 2005) identified affective-based trust as a positive influence on knowledge sharing behavior, while (Lin, Hung and Chen, 2009) found that trust significantly influences knowledge sharing self-efficacy. The norm of reciprocity is frequently examined as an environmental factor for knowledge sharing (Cheung, Lee and Lee, 2013). Reciprocity is mentioned in the selected motherhood community members' answers. Communities share common goals and create a safe climate where individuals exchange ideas, experiences, and expertise. Such interactions contribute to both individual and group development by accelerating learning, refining skills, and fostering creative solutions to everyday challenges and are the subject to explore. The aim of the research is to identify the factors that contributes to knowledge sharing in communities of Interest for better self-confidence. The research method is case study of community of interest of mothers by conducting qualitative survey. The qualitative methodology was selected on purpose to gain personal reflections on knowledge sharing in communities of interest.

Keywords: Knowledge sharing, Communities of interest, Case of motherhood, Self-confidence

1. Introduction

According to social interactions many studies examine knowledge sharing in various fields: influencing factors of knowledge sharing willingness among virtual community members (Castaneda and Cuellar, 2020), trust plays a crucial role in fostering knowledge sharing (Cien *et al.*, 2005) and etc.

Although outcome expectations, both personal and community-related, play a significant role in self-confidence mechanisms: regarding personal outcome expectations it was found that personal outcome expectation significantly affects knowledge sharing (Zhou, 2008); while community-related outcome expectations were identified as a significant antecedent of knowledge sharing behavior (Kyung-Soo and Yong-Hwan, 2008) and interaction with self-efficacy observed that self-belief (conceptualized as individual and environmental factors) influences motivation, which in turn affects knowledge outcomes (C., Hui-Tzu and S., 2017). In the context of expectations should be considered emerging technologies that evolve a vision for advancing future internet governance within common understanding of blended reality, a convergence of physical and virtual worlds (*Shared Commitments in a Blended Reality: Advancing Governance in the Future Internet 2024*). The Fifth industrial revolution (5IR) within technology based rapidly evolving changes creates new challenges and demands to fulfill for individuals (Noble *et al.*, 2022). Studies using social cognitive theory, theory of planned behavior, and social exchange theory consistently show that community climate, trust, and reciprocity foster a supportive atmosphere for sharing although self-efficacy, outcome expectations, and attitudes drive individuals' willingness to contribute (Cai and Shi, 2020) which may be found as crucial. *The aim of the research* is to identify the factors that contributes to knowledge sharing in communities of Interest for better self-confidence. *The tasks of the research* are to analyze the theoretical framework of the activity system and other theories adapted to knowledge sharing, to analyze knowledge sharing process in communities of interest, to examine self-confidence concept according to knowledge sharing and to conduct the case study of community of interest of mothers in virtual environment. *The research method* includes scientific literature analysis and case study of community of interest of mothers by conducting qualitative survey. The qualitative methodology was selected on purpose to gain personal reflections on knowledge sharing in communities of interest.

The research might be a link for further investigation conducting broader surveys including more cases of communities of interest and other countries.

2. Literature Review

In the process of knowledge sharing the term of knowledge might have various definitions such as: knowledge as a resource, for example, framing sharing as the transfer or dissemination of valuable assets, while others specify it as a dynamic, interactive process involving mutual influence and exchange. Researchers using resource-based views (Chowdhury, 2005) as well as those applying process-oriented approaches (Desouza, Nissen and Sørensen, 2008) illustrate these two primary epistemological perspectives (Willem and Scarbrough, 2002). Key dimensions of these definitions include the level of analysis of individual factors (such as attitudes and willingness to share) versus organizational factors (including structure, culture, and interdepartmental boundaries). Also, there's importance of the nature of knowledge, which is distinguishing between explicit, codified knowledge and tacit, experience-based insights and before mentioned 5IR factors refer to contextual elements such as organizational design, social capital how sharing is conceptualized. Individual factors influencing knowledge sharing appear as attitudes, social influence, personal control (Chiri and Klobas, 2010) as well as willingness to share, perceived receipt of knowledge (Evans, Wensley and Frissen, 2015).

2.1 Review of Theories

Theoretical foundations and contextual considerations when studying knowledge sharing suggest that a unified theory of knowledge sharing may be a challenge to develop, given the varied contexts and perspectives involved.

Explicit Knowledge focus on knowledge exchange and explicitly distinguish between explicit and tacit knowledge sharing (Yao *et al.*, 2020). Particularly self-efficacy identified in self-confidence mechanisms as an important factor in understanding knowledge sharing behavior in virtual communities. These mechanisms are often conceptualized within the broader framework of social cognitive theory but are also examined through other theoretical frameworks (Figure 1).

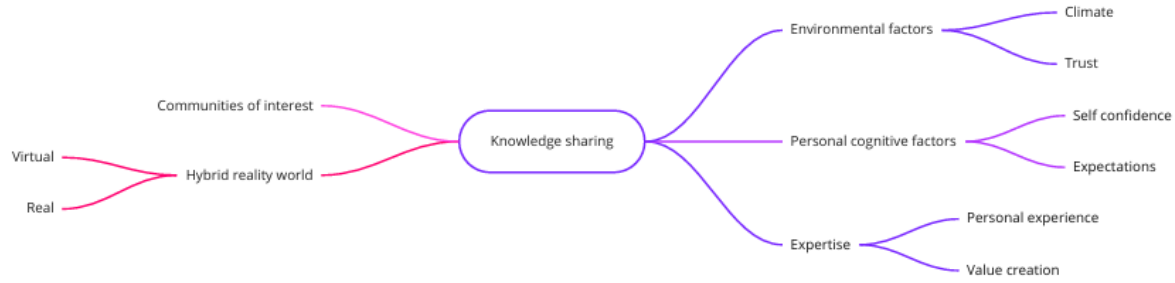


Figure 1: Developed by the author

The concept of shared activity system by (Engeström, 2015) as the triangular model of the interactive elements of activity system (Burner and Svendsen, 2020) is presented in Figure 2. The model consists of the subject (the actor in the system which in particular case is the member of the community), the object (the activity in the case is knowledge sharing), tools or mediating artefacts (includes instruments by which the action is able to proceed), rules (sets of conditions that help to determine how and why individuals may act), division of labor that effects relevant problem solving skills, appropriate acceptance of daily issues, trust in others and rising self-confidence (which provides for the distribution of actions and operations among a community) and community. The importance of the relationship between the subject and object being part of an activity is the mediation by a tool. While sharing valuable knowledge transforms the object into an outcome and the transformation requires various tools such as social media platforms. The relationship between the subject and the community is mediated by rules (Burner and Svendsen, 2020). Rules in this study consist of community agreement on knowledge sharing practices, respect for the members and active participation in community life.

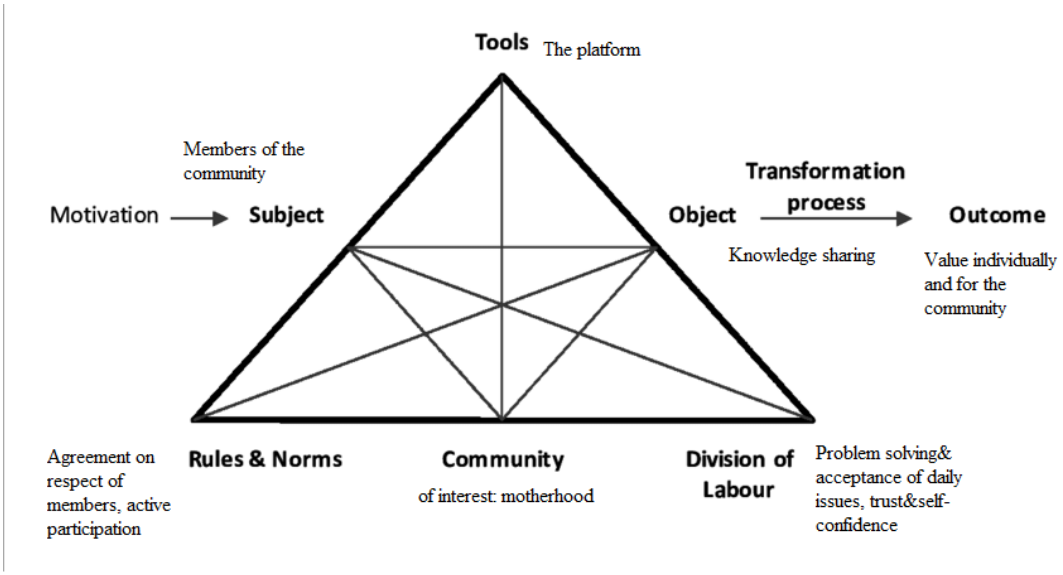


Figure 2: Adapted by the author according to (Karanasios *et al.*, 2013)

2.2 Knowledge Sharing

Knowledge sharing as a form of activity refers to the task of helping others with knowledge (Cummings, 2004), and collaborating with others to solve problems, develop new ideas (Gaál *et al.*, 2015). Self-efficacy, defined as an individual's belief in their ability to perform a specific task, is consistently identified as a key predictor of knowledge sharing intention and behavior across multiple studies (Alajmi, 2012), for instance, identified knowledge sharing self-efficacy as the strongest predictor of both knowledge giving and receiving behaviors (Ergün and Avcı, 2018). According to the statement there's trust and social responsibility of social exchange in knowledge sharing as a planned and intend activity.

The knowledge sharing self-efficacy moderates the relationship between trust in coworkers as persons and knowledge sharing behavior, with higher self-efficacy strengthening this relationship (Hao *et al.*, 2022). Trust emerges as another critical component of self-confidence mechanisms in communities of interest. Trust in different community types may appear that identification-trust influences the quality of explicit knowledge sharing in specific industry virtual community (Zeng, Guan and Chen, 2014), as well as it is observed that trust strongly affects self-efficacy, which in turn mediates the relationship between trust and both community-related and personal outcome expectations (Zhou, 2008) and also it was found that affective-based trust positively influences knowledge sharing behavior (Huang *et al.*, 2005). Outcome expectations, both personal and community-related, play a significant role in self-confidence mechanisms, confirmed by that personal outcome expectation significantly affects knowledge sharing (Zhou, 2008), while other study identified community-related outcome expectation as a significant antecedent of knowledge sharing behavior (Park and Lim, 2008). According to interaction with self-efficacy there was identified self-belief and conceptualized as individual and environmental factors as influencing motivation, which in turn affects knowledge outcomes (Hsu, Min and Chou, 2017).

As practical applications of knowledge sharing in communities of interest may vary aligning outcome expectations in studies there're emphasized that helping community members to understand the personal and community-wide benefits of knowledge sharing is crucially important (Cai and Shi, 2020). This could involve the impact of shared knowledge, implementation of recognition systems for valuable contributions demonstrating how shared knowledge contributes to community goals (Zhou, 2008). While extrinsic rewards can motivate participation, some studies suggested they should be carefully implemented to avoid undermining intrinsic motivation. Considerations include non-monetary recognition systems and balancing rewards to community values and goals (Zhang *et al.*, 2017). Fostering supportive climate studies of knowledge sharing suggests creating an environment that encourages knowledge sharing. This might include facilitating easy-to-use knowledge sharing platforms, encouraging constructive feedback and promoting a norm of reciprocity (Cai and Shi, 2020). Applying longitudinal perspective researchers suggest implementing strategies that consider the evolving nature of self-confidence mechanisms, community dynamics and dynamic capabilities over long-term time scale. This could involve regular assessment of community needs and motivations by considering strategies

based on changing member demographics or the long-term membership and community focus providing ongoing support and training for long-term members (Chang, Hsu and Lee, 2015).

2.3 Self-Confidence

While sharing the knowledge self-confidence is defined through various forms of self-efficacy (knowledge sharing, Information and communication technologies (ICT) and social) and is theoretically grounded in five frameworks that focus on personal capability and motivation. Knowledge sharing self-efficacy is the confidence to share, codify, and create knowledge (Alajmi, 2012), although the concept might be extended to cover ICT self-efficacy and social confidence, which includes the willingness to seek knowledge or initiate knowledge requests (Andrews and Delahaye, 2000) which might be explored by adding personal experiences to knowledge sharing. Theoretical frameworks used to explain these definitions emphasize personal capability and motivational context: social cognitive theory declares that self-efficacy along outcome expectations and environmental factors, directly promotes knowledge sharing (Hsu *et al.*, 2007). Self-efficacy theory focuses on beliefs about one's ability to perform knowledge sharing tasks (Alajmi, 2012), While self-determination theory links perceived competence, autonomy, and relatedness to the capacity to share knowledge (Yoon and Rolland, 2012). The theory of planned behavior and the theory of reasoned action incorporate self-confidence as part of perceived behavioral control and intention (Ajzen, 1991), the assumption is that the greater the individual's perceived knowledge sharing self-efficacy, the stronger his/her intention to share knowledge with other community members (Alajmi, 2012). The capability for intentional and purposive action is rooted in symbolic activity (Bandura, 1991), that relates to activity theory model described earlier. Although the self-regulation model highlight internal motivation and social factors that support knowledge sharing which means that members of an online knowledge communities regulate his or her internal motivation, external demands, interpersonal relationships, help-seeking strategies, as well as confidence of capability in utilizing social resources and performing knowledge sharing task (Tseng and Kuo, 2010). The study integrates several theoretical frameworks of self-confidence which is social cognitive theory that indicates importance of environmental factors as well as outcome expectations and the theory of planned behavior where the capability to act intentionally but for purpose emerges activity of knowledge sharing.

Self-confidence was examined in previous research by eight dimensions which are to specify: web-specific, community-related, general, knowledge creation, enhanced knowledge, information security, self-image, and appearance-contingent self-esteem. Some of these types showed direct positive associations with knowledge sharing while one type (knowledge creation self-efficacy) produced inconsistent results, and one (appearance-contingent self-esteem) was linked to reduced sharing in health settings (Brown, Dennis and Gant, 2009). Self-confidence interacts with factors such as trust, reciprocity, and community identification to further promote sharing behavior. The relationship between self-confidence and knowledge sharing behavior emerges as complex and multifaceted across communities of interest. Many studies report a direct positive relationship between self-confidence, particularly knowledge sharing self-efficacy, and knowledge sharing behavior or intention (Alajmi, 2012), self-confidence often acts as a mediator between other factors and knowledge sharing behavior (Brooke, Mohd Rasdi and Abu Samah, 2017) for instance, knowledge-sharing self-efficacy mediates the relationship between community climate and knowledge-sharing intention (Cai and Shi, 2020) or knowledge self-efficacy mediates the relationship between perceived benefits and satisfaction with knowledge sharing (Jin *et al.*, 2013). Differential effects on contributing versus collecting knowledge: knowledge sharing self-efficacy might have different effects on knowledge contributing versus knowledge collecting behaviors (Chen and Hung, 2010).

3. Methodology

The aim of the conducted research was to analyze the knowledge sharing of community of interest uniting mothers in virtual environment for self-confidence.

The methodology used in the research is the case study with qualitative survey and qualitative content analysis methods and observational participation. The collected answers to the survey reached 9 informants and according to qualitative surveys sample requirements the repetition of the gathered information was reached. The tool for the survey was Microsoft 365 tool Microsoft forms and according to ethical principles answers were collected anonymously. The survey was conducted from June 18th to 25th of 2024. According to the social behavior theory, questions in the survey were divided into three dimensions: environmental factors, individual factors and behavior (also understood as an activity).

The community was selected regarding the characteristics of the specified criteria involved: 1. Community unites mothers of Lithuania, 2. Community is operating more than 5 years, 3. Community meets hybrid participation form: virtual collaboration and real events. The current community selected for the analysis is actively operating for more than 8 years, the same age as community members' kids and the community went through all various collaboration stages that today there're in depth discussions and affected transformation from open public community of interest for more than 100 members and through the time scale to private selected active 33 members agreed on settled the rules of the community. Community communication tool has changed several technological platforms and now since 2018 it is based on Facebook.

The research questions (RQ) come from the before discussed activity theory (Figure 2) and social cognitive theory models and were as follows:

RQ1: Why do members of the community of interest share their knowledge?

RQ2: What do they get for social exchange? And how does it affect their self-confidence?

4. Results

The findings of the study are organized into categories and subcategories according to the theories discussed earlier. Social cognitive theory was used for categorization and activity theory for building questions in dimensions.

- Subject, community group – the member of the community (Figure 2.)

Table 1: Q1 How did You notice the need to search for people of same interests in community networks and social media?

Subject		
Category	**Subcategory**	**Affirmative statement**
Individual	*Specific needs*	"First child, **new experiences**, wanted to ***gain more knowledge****.";* "When I started to ***lack like-minded people*** *in my circle.";* "Due to the ***lack of communication*** **on current topics**"; "It was my first pregnancy and there were no pregnant women around, so *everything was interesting from* the start. **Who knows how everything is going**."
Environmental	Expectations	"It was my *first time* expecting, <…>, so I started *looking for information on a forum* where all the expectant mothers with the same month's due dates gathered. <…>. *We* ***shared our troubles, feelings, and helped each other.*** *It grew into our* ***permanent community****, now that the children are 7 years old.*
Behavior	Value	"The need arose as soon as I got pregnant, I wanted *to share my impressions, find answers* to my concerns, *share my experiences*, *get advice and just general understanding, help, and good impressions* from other expectant mothers."

The answers present the motivation for searching for like-minded people raising kids of the same age and keeping on sharing the knowledge for more than 8 years. The expertise of the participants within the second child and beyond ensures trust, insights and collective intelligence for more informed decisions in various situations. Also, there's ability to share diverse perspectives on the same issue, enhance collaboration, creativity even by making live meetings and keeping friendship among moms and kids alive in years. Knowledge sharing creates the community culture and gives self-confidence and variety of solutions to each member when it's needed, and these solutions wouldn't be able to appear in isolation. The next question illustrates the importance of the ability to share experiences and the importance of a suitable community climate to all its members.

Table 2: Q2 What do You think you can give to the community members and what can you get from sharing knowledge and asking questions? What unites the members of this community?

Subject		
Category	**Subcategory**	**Affirmative statement**
Individuals	*Different background* *Sharing*	"To **share our experiences** <…>- to help. <…> Women *from various fields, with* ***different views and experiences,*** *have gathered here, and this provides a wider spectrum of knowledge.";"* <…> they are all <…> from different fields, so <…> each of them shares their knowledge in their field. They <…> raise *more than one child*, so the *topics of conversation grow*, <…>."

Subject		
Category	**Subcategory**	**Affirmative statement**
	Trust	"<…> my perspective on some of the issues that bother them. I get the same <…>. This community *is* ***united by the desire to share our knowledge****.";* <…>*"* We share our experiences, exchange opinions, and that's what unites us, that we are **not afraid to speak up and be criticized**." "**Support, emotions, empathy**. <…>."; "<…>. Most of the time, it's verified and honest."; "We share **understanding, no judgment** <…> in all situations. We share both good news and bad events. <…> differences of opinion, but everything is done very elegantly and intelligently."

From individuals as a subject to the community as a placement of environment lead the following question:

Table 3: Q3 What do You think has led to the fact that the community of interests you belong to has existed for more than seven years?

Community		
Category	**Subcategory**	**Affirmative statement**
Environment	*Tools* *Personal features*	"We have become closer, and *sharing information (and knowledge,* author remark) is still relevant."; "An active core of the group has formed **not only online conversations, but also *live meetings****, shared views and the presence of only active members in the group"* "**Openness, respect for each other.**; "Good sense of humor. **Sincerity** of members" <…> "Sincerity and **common interests**."; "**Community, friendliness, empathy**"; "<…> **friendship, advice and support** in any situation." <…> "<…> usually have similar problems and share all kinds of insights."

- Outcome, division of labor, value for the community (Figure 2.)

Social exchange ensures that the members of the community gains value from being part of the community, and the next question discusses the importance of feedback and interpersonal trust.

Table 4: Q4 How important is feedback and knowledge sharing in the community? What tools facilitate knowledge sharing?

Outcome		
Category	**Subcategory**	**Affirmative statement**
Behavior	Belonging Learning	"Having a **support team** is very important, *not feeling alone*", "Without feedback, there is no desire to share. When you get a response, you know that the **response** was not in vain. <…> . We communicate both *in a group and in person*" <…>. It is important because others **learn new things** <…>. It is facilitated by *smooth communication* <…>.to see at situations from a **different angle. Accessibility** makes it easier; you get answers at any time." "Feedback is important because you are heard, understood, and believed." <…> "Simply **question-answer.**"

Table 5: Q5 What characteristics contribute to the development of interpersonal trust in a community?

Division of Labor		
Category	**Subcategory**	**Affirmative statement**
Behavior	Trust	"Respect for each other, **openness and sincerity**", <…> "support when opinions do not necessarily coincide"; "<…> "don't laugh at stupid questions. You always **feel safe**", <…> "members are able to **communicate ethically,** without conflicts, and in a friendly manner on all topics" Self-criticism, **empathy, friendliness, openness.** "No condemnation, **support** and advice, friendship <…> "certainty <…> "friendliness <…>."

Table 6: Q6 In what situations do you share knowledge? In what situations do you seek the community to share the knowledge they have?

Object		
Category	**Subcategory**	**Affirmative statement**
Environment	Climate	<…> "share knowledge when I have the expertise to do so. <…> I always hope that the community will share their **insights**."
		"<…>where I am **confident in my knowledge** and I can base on scientific articles, books I have read, and experience."
Personal factors	Problem solving	"When I have difficult, unsolvable questions, I want other people's knowledge to be shared with me. I also share <…>".
		"**Discovering something new**. Noticing something that would be valuable both in everyday life and not. Community encompasses **all areas and situations of life**: from children, husbands, family members to vacation planning, house building."
	Self-confidence and expectations	"<…> when you already know people, you **trust them**, and because of some advice you **confirm your opinion and automatically have more confidence in your choice**. And here when you have been in the community for almost 8 years the same people add a positive remark to their own opinion or sometimes you see a different angle that you hadn't thought about."

Table 7: Q7 What value do you get as you belong to the community? What do you think are the chances of the community's longevity and what factors could determine this?

Outcome		
Category	**Subcategory**	**Affirmative statement**
Environment	Active participation	"I appreciate our community and **am proud to be a part of it**. Active participation and meetings at least once a year", "The value is <…> **belonging to a community** <…> "Since children grew up there's opportunity to become more of a **group of"**; "happy to be part of this community <…>.
	Common interests	"Finding **like-minded people, understanding, help, advice**. The community has great prospects for long-term operation, over a long period of time only the most sociable, non-conflict, friendly women have remained here" <…> "**Life experience and new knowledge**. **Motivation**. Periodic meetings and availability at any time virtually **stay in touch**."

Considering why do the members of the community of interest share their knowledge in the relevant environment there are of high importance common interests which gain motivation, ensure active participation and matches expectations. For social exchange individually members get better self-confidence in problem solving, sharing good practice and conducive climate creation in the community.

5. Discussion and Conclusion

Members of the community of interests have a common goal and interests, which provide active participation managing the complexity of emerging issues. The members should have relevant competencies and accumulated experience in a particular field. The assumption of common area of interest creates a common basis for activity and social actions, as well it inspires members to participate in this activity and support the sharing of knowledge as an expression of self-realization (Siudikienė and Jokūbauskienė, 2023) and as self-confidence, promotes the development of each individual and gives meaning to the actions of the members.

Concluding from the research the factors that contribute to knowledge sharing in the community of interest the case of mothers for better self-confidence were identified:

- According to social cognitive theory the environment, personal factors and behavior were selected to use to organize knowledge sharing in dimensions. It is obvious that self-confidence described in the theoretical framework may be managed by personal factors. Though activity theory the suggestion is to consider the common action, active participation, problem solving, expectations, value creation, trust, specific needs, common interest and climate as the means for united activities.

- Regarding trust issues at various levels and the aim of the research, the knowledge sharing process emerges as other critical component of self-confidence mechanisms in communities of interest. Trust in different community types may influence the quality of explicit knowledge sharing in specific interest virtual community (Zeng, Guan and Chen, 2014), and the affective-based trust positively influences knowledge sharing behavior (Huang et al., 2005). According to the statement, the following discussion resumes the future of knowledge-sharing depends on inclusive, accessible, and engaging environments where collaboration thrives, and personal behavior ensures trust.
- Theoretical frameworks define self-confidence in personal capability and motivational context: social cognitive theory determines that self-efficacy is related to self-confidence and the factors of outcome expectations and environmental context (Hsu et al., 2007). The context is interconnected by means of belonging, advisement in daily problems and socialization.
- The study explored the importance of knowledge sharing processes in communities of interest for better self-confidence in several dimensions: environmental, personal factors and behavior. These dimensions ensure self-confidence in collaboration, the appropriate climate of the community, value creation. Individual needs including respect, problem solving, expectations, belonging and trust create the platform for long-term sharing good practice and learning in various areas of interest: from specific small daily issues to solve the high demanding problems and support.

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Ethics declaration: The survey has confirmation of the members of the community to participate anonymously. The link to the survey in MS Forms https://forms.office.com/Pages/DesignPageV2.aspx?origin=NeoPortalPage&subpage=design&id=ghrFgo1UykO8-b9LfrHQEopfikm3gaxPmeZCzghrKX1UNVNNT1lDU0NQV1ROS1I0Sk1GRDRGUkRWTC4u&analysis=false

AI declaration: The tool Elicit was used for the primary research resources for information gathering and systemizing while exploring the research.

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Environmental Knowledge Management in Food Service Industry: A Preliminary Empirical Research Study From Companies in Poland

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Abstract: The last phase of the food chain, the food service industry, stands out because of its significant waste emissions, energy and natural resource consumption. This occurs in the situation of disposing of uneaten, cleaning consumption areas, disinfecting vegetables and fruits, among others. It should be borne in mind that also a very large amount of consumer products constitute waste that is difficult to manage in the system. Therefore, environmental protection in the food service industry requires the implementation of good practices both at the corporate management level, but also these procedures must be put into practice at the lowest operational levels. Therefore, the aim of the study was to assess the functioning of environmental knowledge management in the food service industry. The method of individual interviews was used, which makes it possible to collect a wide range of information regarding the opinions, perceptions and comments of the subject. The interview was based on a semi structured interview form, which consisted of several survey steps. The research was conducted in Poland. Due to the scarcity of publications in this field, it was considered that the individual interview would be a suitable tool for obtaining detailed and in-depth information on environmental knowledge management in the food service industry. The results of the collected data gave a broad picture of the situation of the food service industry in Poland and potential opportunities to increase environmental protection. Undoubtedly, the survey confirmed that better knowledge management in this specific industry is required. Employees' responses indicated a lack of training in this area. Which made it much more difficult for them to make pro-environmental decisions on the job. Posters and other materials in graphic form, which on the one hand would remind of the necessity of pro-environmental behavior but on the other hand would indicate the right course of action, turned out to be good solutions. The research made it possible to draw attention to a very important aspect of knowledge management relating to environmental procedures and principles. Despite the existence of a large number of environmental regulations, it appears that front-line employees are not convinced about the maximum involvement of their companies in pro-environmental activities and there is an area where more could be done.

Keywords: Knowledge management, Environment, Food service, Employees, Waste

1. Introduction

The food service industry is a significant branch of the European economy. Despite some slump as a result of restrictions related to the covid-19 pandemic, the sector is gradually beginning to recover. The value added in the European union combined with the accommodation sector was E203.6 billion in 2021 (Businesses..., 2025). Globally, the food service market is estimated to be worth $3,486.58 billion in 2024, with a forecast of $6,810.86 billion by 2032 (Food Service..., 2025). The food and beverage subsector includes: traditional restaurants, fast-food or take-away restaurants whether as permanent or temporary stands with or without seating, cafeterias, mobile food trucks, catering services, as well as bars, coffee shops and mobile beverage vendors (UNSD Classifications, 2025). This market is increasing its share due to: rising household incomes, increasing numbers of working women and increased logistical utility of food by companies (e.g. deliveries). This market is divided into actors: networked and independent. Chain operators are those that operate under a single brand in several locations with the same name. Their organisation of work, menu or décor are each point very similar or even the same. The largest chains include restaurants such as McDonald's, Starbucks, Domino's or KFC. But when considering the entire market, the number of independent establishments is greater than that of chains (Food Service..., 2025).

The dynamics presented, as well as the prospects for rapid growth, make us reflect on the environmental impact of this industry. In the context presented, it may be significantly burdened by the growth of the food service industry. As environmental protection becomes a major goal in all industries, stringent regulations and consumer awareness will play an increasingly important role in the implementation of these processes. These requirements will not bypass the food service industry.

One possible solution to these problems is to implement environmental knowledge management in companies in the food service industry. The more widely this concept is implemented, the more visible the effects will be on a general scale. As a rule, in this area of the economy, a lot of attention is paid to health, technical and technological issues. So perhaps it is worth looking at organisational and management aspects. Good organisation, management and proper procedures are key to achieving positive end results. Very often, the food service industry remains on the margins of research and interest as an area that could bring significant

benefits in terms of environmental protection. Therefore, the aim of this study is to examine how environmental knowledge is created, stored, shared and used in catering companies operating in Poland. The study aims to identify the level of implementation of environmental knowledge management, good practices, limitations and challenges from the perspective of line employees. The scope of the study includes surveying employees of small, medium and large enterprises with varying lengths of service and from catering establishments with different specificities of operation (cafés, restaurants, fast food). The paper begins with a description of the food service industry and its impact on the environment. It then discusses the concepts of environmental knowledge management. The next section describes the research methodology. The results and recommendations are presented further on.

2. Environmental Impact of the Food Service Industry

The nature and peculiarities of the food service industry result in the consumption of large amounts of basic utilities such as water and energy, which are used to prepare meals and preserve raw materials and finished dishes (Bulhões et al, 2021). Which very often takes place in a refrigerated environment. In turn, their step-by-step processing into a finished product generates a lot of waste and requires energy intake to generate heat (Strasburg and Jahno, 2017). This makes it imperative that sustainability issues and ideas should be particularly relevant and intrinsic to the food service industry and spread among employees.

Improper or lack of waste management and used packaging generated by the food service industry are further areas of environmental protection that suffer heavily as a result of the industry (Jang, Kim and Woo, 2023). These hazards further include the use of non-biodegradable chemicals (disinfectants, preservatives), which can enter the environment as a result of improper handling (Chemical hazards ..., 2019). Finally, the impact on the environmental load depends on the type of food product (Garnett, 2011). Meat and its derived products tend to generate more negative environmental impacts (Clay, 2004). Although not fully informed, consumers and all workers in the industry in this regard are not fully informed. The unavailability of clear and understandable data on the environmental impact that is associated with food production makes it difficult to choose products that generate less negative environmental impact (Marreiros and Ness, 2009). The lack of such information on packaging or menus makes it impossible to compare products and make an environmentally friendly choice. In the absence of such information, some people are not even aware of this possibility. Garnet (2011) points out that just allowing consumers to choose more sustainable food products, can be an excellent initiative to reduce and partly solve the problem of negative environmental impacts. Another factor generating emissions and environmental burden is the increasingly common delivery of food and meals to customers, which customers are not aware of (Varese et al, 2024). In addition, food delivered by suppliers is often packaged in additional plastic packaging. This results in it being over-packaged and generating above-normal waste. Figure 1 presents the level of waste generated by the food service industry. As can be seen, the values are very high.

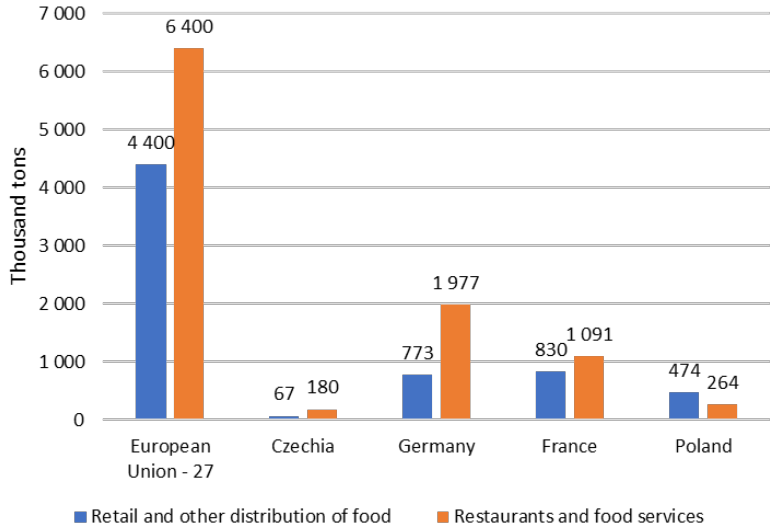


Figure 1: Food waste - bio, household and similar, waste collected in industries related to the food service in 2022

The image of the food service industry's environmental impact described above becomes a challenge for managers and line workers in the sector. Despite many other requirements, such as overseeing economic efficiency, controlling orders and deliveries, or identifying and meeting customer requirements and expectations, environmental protection is another major challenge (Rocha and Viegas, 2023). In this situation, knowledge management and training of employees involved in the production of meals working in the food service industry prove to be very important. This path in the implementation of environmental policies, directly supports the path towards sustainability in food services (Košútová and Jarossová, 2014). This necessity is confirmed by studies on food waste minimisation, which indicate that there is a lack of qualified human capital in the implementation of effective environmental policies (Alamar et al, 2018).

A shortcoming of the food service industry in implementing comprehensive environmental solutions is its fragmentation. There are very many small and micro companies in this market. Research conducted by Llach et al. (2013) in small companies in the mass catering and restaurant segment, showed that their representatives show little attention towards taking measures and increasing their commitment to the environmental issues of their businesses.

3. Knowledge Management for Environmental Protection

Knowledge management, as well as knowledge itself, plays a very important role in the effectiveness and efficiency of an organisation's pro-environmental activities (Krause et al, 2019). The process of environmental knowledge development and its application in an organisation refers to the generation of pioneering skills, innovative solutions, better ideas and more efficient processes, with environmental concerns as the overarching common denominator (Frozza, Lima and Costa, 2023). Modern and progressive management concepts guide knowledge management processes in organisations, maximising the benefits of these practices. One of the many advantages of such an approach is the realisation of ambitious goals related to improving environmental performance (Song et al, 2020). The term green knowledge management dedicated to this phenomenon has emerged in the literature (Cai, Khan and Egorova, 2023). This concept, although relatively young, is defined as knowledge management practices of enterprises regarding the green aspects of business operations and integrating them with knowledge management factors (Abbas and Sağsan, 2019; Abbas and Khan, 2022). The environmental dimension of a company should be understood as its impact on living and non-living natural systems in land, air and water (Baumgartner and Ebner, 2010). This is therefore a very broad approach. By placing emphasis on environmental issues, an organisation can better understand its impact on the environment. It is also important to raise awareness in this area among line employees, who very often have a significant influence on it. Green knowledge management provides opportunities to build a culture of pro-environmental learning and optimise processes within the company (Yu et al, 2022). In addition, a well-functioning green knowledge management system builds an environment that supports innovation and motivates employees to make progress in this area. It should be remembered that many groundbreaking improvements in history have been introduced by line and operational employees. But the key to this was proper motivation and encouragement to innovate. This also includes various types of rewards.

The process of knowledge sharing and distribution seems to be very important, especially at lower positions and in industries where a high level of education is not required. Another example would be industries where there is a high turnover of employees, e.g. in co-operation with employment agencies or where work is seasonal or flexible. The conditions described result, among other things, in a more difficult knowledge retention process (Frozza, Lima, Costa, 2023), which is more difficult to retain in an organisation if there is a high turnover of employees. The food service industry seems to fit the description presented. When employees are more knowledgeable about the environmental aspects and pro-environmental techniques of the organisation, they thus have a lower level of uncertainty and more motivation to apply such measures (Abbas and Khan, 2022; Abbas and Sağsan, 2019). Knowledge management can play an important role in environmental protection activities. A properly managed and organised knowledge management system encourages company employees to seek, implement and share knowledge. The effective and consistent implementation of environmental knowledge can be a key success factor for organisations that choose this path (Martins et al, 2019). Furthermore, the advantages of this approach include placing environmental concerns on a par with the financial benefits of companies. Environmental knowledge management allows companies to take advantage of their own employees' resources without having to incur large financial outlays. Environmental knowledge is a special type of knowledge, and many employees educate themselves in this area, building up a resource that can be used for the benefit of their employer. This is a potential that is worth exploiting. This behaviour is also characteristic of younger generations. Therefore, the proper use of

knowledge management should be very helpful in companies' efforts to generate less and less impact on the environment. Unfortunately, a review of studies conducted by Martins et al. (2019) indicates that the number of studies using knowledge management in the context of sustainable development as a central focus is still small.

Analysing the specifics of the food service industry, factors hindering knowledge management include, but are not limited to: employee turnover - lack of motivation for training, seasonality, short employment time, dispersed organisational structure, difficulty in transferring knowledge between branches, changing legal requirements (sometimes different in different cities/municipalities), time pressure, customer service orientation, diversity of operational models, non-standard working hours of employees - hindered communication, low level of formalisation, strong price competition, lack of reporting systems and the fact that environmental protection is not a priority for customers of restaurants of other food service outlets. It is worth adding that the very high proportion (89%) of companies with 0 to 9 employees confirms the fragmentation of the industry. The fact that such a large number of very small companies exist is not conducive to formalising knowledge management processes within their structures. Detailed data are provided in Figure 2.

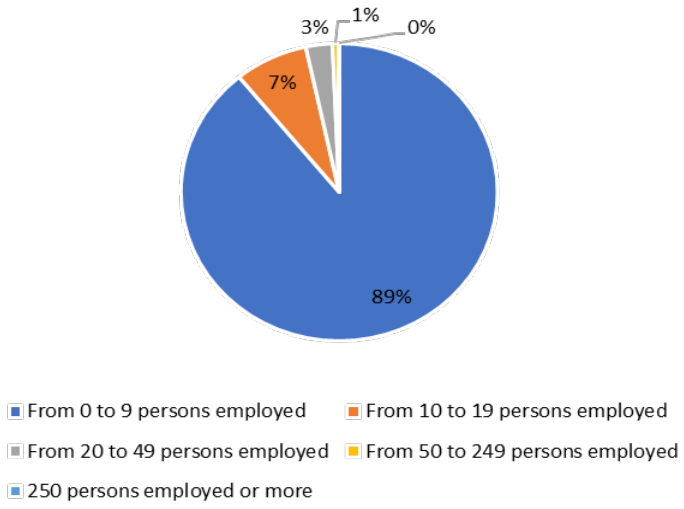


Figure 2: Percent of companies operating in 2023 in the EU food and beverage services industry by number of employees

The conditions described above create difficulties for the introduction of proper knowledge management processes, although informed enterprises should be prepared to do so and counteract the organisational difficulties mentioned. A properly planned environmental knowledge management system in food service industry companies should be resilient and prepared for these disruptions. In view of the presented development and dynamics of the food service industry market, an assessment of the functioning of environmental knowledge management in this industry was taken as the aim of the study.

4. Methodology

The empirical research was conducted based on qualitative research methodology and concepts. The Individual In-Depth Interview (IDI) method was used to achieve the stated aim of the research study, as a valid primary data collection strategy must be based on objectives (Gratton and Jones, 2010). An Individual In-depth Interview is a direct conversation between a researcher and a single respondent without the presence of a third party. This survey is very well suited to deepen the understanding of the phenomenon under study. In this case, these were issues of environmental knowledge management in food service industry companies. The Individual In-depth Interview method allows the emotional and motivational behavioural patterns of respondents to be accessed and allows sensitive issues to be explored. This type of research is well suited to groups characterised by scarcity and difficult accessibility (Filimonau and Krivcova, 2016). This rationale corresponds to the characteristics of the food service industry, where a significant proportion of people are employed part-time, a large number of people are self-employed and there are unpaid family workers in this business who support their relatives (Businesses..., 2025).

4.1 Data Collection

Ten individuals, employees of the food service industry, were invited to participate in the study. The details of this sample and its characteristics are presented in Table 1. Participation in the study was voluntary. Socio-demographic information was collected at the end of each IDI session. Five women and five men participated in the study. Interviews were conducted between December 2024 and March 2025 among employees of companies operating in Poland.

Each interview lasted between approximately 35 min. and 56 min. The content of the interviews was recorded after obtaining consent from the respondents. The interview followed a semi-structured interview script. The questionnaire provided the opportunity to adapt it to the narratives and themes of the respondents when they wanted to share their experiences and insights. The questionnaires were pilot-tested to refine incomprehensible questions and content. This was done in order to make them as comprehensible as possible for food service industry employees.

Table 1: Characteristics of the study sample

Gender	Seniority in food service industry/(total seniority)	Type of business	Range of business
W	4 (4)	Café	Single-company
M	3 (6)	Restaurant	Single-company
W	3 (3)	Café and bakery	Local network company
M	6 (6)	Fast food	International network company
M	3 (4)	Pizzeria	International network company
W	9 (12)	Café	Single-company
M	17 (15)	Fast food	International network company
M	5 (8)	Restaurant	Local network company
W	12 (25)	Restaurant	Single-company

The interview itself consisted of the following stages: introduction, exploration of the creation of environmental knowledge, exploration of ways of storing environmental knowledge, exploration of the processes of sharing environmental knowledge, ways of using environmental knowledge, summary and conclusion of the interview. This arrangement implemented the definition of knowledge management, which considered the following elements of the process to be the most important, namely: knowledge creation, knowledge storage, knowledge sharing and knowledge utilisation. These processes were chosen because they are well established in the literature and thus reflect the full life cycle of knowledge in an organisation. (Davenport and Prusak, 1998; Alavi and Leidner, 2001; Sağsan, 2006). This makes it possible to identify gaps and barriers at each stage. Furthermore, this division seems to be clear and understandable to operational employees in the catering sector. Very often, due to their specialisation, they are not familiar with more complex and specialised concepts of business management. The concept of knowledge management based on its creation, storage, sharing and use seems to be very appropriate for conducting this study (Sağsan, 2006).

4.2 Data Analysis

Before analysis, the interviews were transcribed. A verbatim transcript of the statements was made based on the recordings. In the first stage of the analysis, the collected source data was reviewed, read and initial notes were made. In the second stage, preliminary coding was carried out to generate themes and categories (Braun and Clarke, 2022). Open coding was used, mainly due to the exploratory nature of the study, as the analysis was intended to be exploratory and illustrative (Matthews and Ross, 2010). There are not many studies of this type in the literature, especially those conducted in Poland. Next, a search for themes was conducted. At this stage, the codes were grouped into broader thematic categories. In accordance with the study assumptions, the analysis was focused on four stages of the knowledge management process. These were knowledge creation, storage, sharing and implementation. In the final stage of the analysis, quotations from the study were selected and then included in the text. The aim of this study was to gain a deeper understanding of the under-researched topic of environmental knowledge management in the catering industry and to examine the hidden determinants and relationships related to this issue.

5. Results

The analysis and interpretation of the results was based on the definition of knowledge management, which distinguishes its following components and aspects: knowledge creation, storage, sharing and utilization (Davenport and Prusak, 1998; Alavi and Leidner, 2001; Sağsan, 2006). Accordingly, the qualitative thematic analysis proceeded in the order presented. As a first step, statements regarding knowledge creation in the food service industry were assessed.

The data collected indicate that in companies in the food service industry, there are no systems in place to support the creation of environmental knowledge concerning rank-and-file employees. In the surveyed examples of organisations, there were no mechanisms and motivations to encourage employees to participate in this process. Here is an example of a statement:

> *"...there is always talk about environmentalism, there is talk about replacing plastic with paper and such simple activities that everyone knows about. But it never occurred to me that it might actually be worth changing the lighting, or maybe teaching the employees themselves so that they put these ideas into practice..." (M, 3(6), Restaurant, Single-company).*

The main rationale for managers to take pro-environmental measures is financial benefit. If pro-environmental solutions were more profitable, managers and restaurant owners would be interested in this. The financial motive also proved to be very motivating for the employees who took part in this study. As they often stated, if they got some kind of financial bonus from each reported pro-environmental initiative, they would be more willing to engage in such activities. In employees of organisations with an international reach, there was a perception that managers were not trusted or open with them in creating environmental knowledge on the job. In contrast, employees of smaller companies who were in contact with the owners declared that their ideas could be well received by these owners. However, despite all this, environmental issues in the food industry service sector are regarded as optional and not the most important.

In the next step of the analysis, it proceeded to identify the means of knowledge storage. In this component of knowledge management, forms of physical knowledge storage media were prevalent in food service industry establishments. These included posters, books and manuals. Very often kept in the back room and, as far as content was concerned, limited to basic information, such as how to segregate waste. In this area, the difference between small and larger companies concerned the presence of two aspects. In the large organisations there were procedure books. But according to the employees, the process of obtaining knowledge from them was difficult and inaccessible. Therefore, they hardly used them at all. The second aspect was the e-learning platform training that was provided in large organisations. Depending on the employees, they declared that these trainings were more or less focused on environmental topics, but they were never dedicated entirely to this topic. The practices of storing environmental knowledge, as described above, indicate that the actions taken by the companies represent the illusion of the presence of this knowledge, while its actual role in the operation of these companies is negligible.

The following part of the analysis assesses the processes of sharing environmental knowledge in food service industry companies. The interviews collected indicate that knowledge is mostly shared orally, informally and often intuitively. Employees learn by observing senior employees. This can be referred to as tacit knowledge as defined in the literature. In the course of the thematic analysis, the following themes emerged.

The most common forms of knowledge sharing are interpersonal contacts between employees, without formal procedures. The sources of knowledge are more experienced and longer working colleagues. They are the ones who share knowledge about environmental protection. The following statement from an interviewee:

> *"…There was no information on how to do it. It was just knowledge passed on verbally and you had to ask yourself how to do something. You just had to find out for yourself...." (W, 4(4), Café, Single-company).*

The only examples of systematic knowledge-sharing mechanisms are initial training. This mainly takes place in network companies. However, these trainings are in the form of e-learning and are rare. But even in large companies, there is no culture of continuous learning, which some respondents believe is a problem. In many cases, the role of knowledge-sharing tools is played by passive information media, such as posters on the wall, cards, written instructions. These are a substitute for direct communication and their main function is to remind people of certain established rules of conduct. The interviews identified that there is a lack of motivation mechanisms as to how to engage employees in sharing environmental knowledge and creating

innovation. Even if an employee has an idea, he or she does not know what to do with it, who to approach and wonders whether it is worth presenting it to someone, as the likelihood of it being implemented is low if it does not bring great financial benefits to the company. Nevertheless, the surveyed employees have ideas to reduce the environmental impact of the companies they work for. They want to acquire knowledge in this area and implement it. However, they are most in need of accessible and practical forms of environmental knowledge. The ways of sharing knowledge in the organisation reported by those surveyed are: practical workshops and training. Both activities organised as mandatory. The individual in-depth interviews conducted revealed that employees lack the forms mentioned above and they would be very helpful for them to better manage environmental knowledge in the workplace.

In the last part of the survey, the utilization of environmental knowledge was analysed. Despite the rather pessimistic data collected in the earlier stages, it turns out that the surveyed employees were able to cite some good examples of the operationalisation of environmental knowledge in companies in the food service industry. These data show that, despite the lack of environmental knowledge management procedures and adequate training, employees are capable of implementing pro-environmental measures. Good practices identified during the interviews include (Table 2).

The knowledge of how to reduce food waste is used extensively in practice, although in chain companies it is restricted by rigid and sometimes incomprehensible procedures for employees. The following is an example of what an employee said:

> *"… And there were some internal rules that employees were not allowed to take it after closing. If it doesn't sell, you just have to throw it away. And we were also so much verified out of it, whether it definitely ended up in the bin …" (W, 3(3), Café and bakery, Local network company).*

Table 2: Good practices identified in food service industry in Poland

Constraints in specific areas of company operations in the food service industry:			
packaging materials	**energy consumption**	**resource consumption**	**food waste**
- change of packaging from plastic to paper, - cutlery made from fruit seeds, - dispensing with extra paper bags, - allowing customers to bring their own packaging, - reducing the size of packaging and making it fit the product better.	- replacing light bulbs with energy efficient ones, - switching off advertising banners and appliances at night, - switching off air conditioning and controlling its use, reporting on electricity consumption, - one boiler, heating water for two dishwashers.	- water filter jug for employees, - repairs to "infinity" appliances, - use of own reusable beverage cups for employees, - use of coffee grounds as fertiliser for plants.	- using leftovers to create desserts or cocktails, - food waste for animals, - working with volunteers and food sharing initiatives - failed and unspent dishes can be eaten by employees.

Among all resources, companies in the food service industry save electricity the most. However, this is linked to the need to reduce operating costs. So this is further confirmation that ecology is a secondary effect of economic measures. A thematic analysis of individual in-depth interviews conducted with employees of the food service industry identified areas of improvement for the industry in terms of reducing environmental impact. The directions identified include:

- Improved waste segregation, introduction of fractional bins, labelling and visual instructions at the bins.
- Implementation of compulsory environmental training in the workplace, periodic training, the more detailed and practical the better, ending with a test or other form of knowledge check.
- Introduce a reward system for employees' environmental initiatives, setting up a system to support the submission of ideas.
- Collect, organise and make available good environmental practices used by frontline staff, either digitally or on paper.
- Make top management aware that environmental protection is not a cost but a marketing and image value.
- The need for environmental indicators in companies and their implementation in employee and team appraisal.

6. Conclusion

This research concerns a very important area of environmental knowledge management in a very specific and peculiar industry such as the food service industry. This industry is characterised by very dynamic growth but also by high fragmentation. There are a lot of small and micro companies operating in this market in Poland. As such, they have to cope with high legal requirements and customer expectations regarding environmental standards. Companies are able to cope with these challenges and mitigate their consequences through the early and gradual implementation of environmental procedures. These processes staggered over time and using innovation and employee involvement can be very effective on the way to achieving these goals. In many areas of the world, sustainability issues are gaining momentum and receiving significant consumer attention. However, the implementation of a comprehensive green knowledge management concept is required to reach its full potential.

Research conducted confirms that the food service industry is characterised by a very low level of organisational culture with regard to the implementation and management of environmental knowledge. This is particularly worrying as the industry has a major impact on the environment. The research conducted indicates the need for formal environmental knowledge management systems. Very often, the knowledge used by line employees is bottom-up, or related to the need to save money - if it comes from company management. The companies surveyed did not create an eco-innovator-friendly atmosphere. They did not in any way try to motivate employees to develop environmental opportunities and share these ideas. And, as is well known, the process of food preparation and delivery is complex and provides ample scope for taking action to reduce the negative environmental impact of the industry. The analysis of the material presented leads to the reflection that the best way to reduce the carbon footprint and environmental impact of the food service industry is probably through restrictive regulation.

7. Recommendations and Implications

The results of the study suggest the following practical implications. First and foremost, mandatory training in environmental knowledge should be introduced. Food service industry entities should promote good practices and create systems for reporting and rewarding employee initiatives. Other practical recommendations include the creation of unified, simple and clear tools for sharing and implementing environmental knowledge. From a theoretical point of view, the contribution of this study allows for greater attention to be paid to economic niches where the overall level of management may be low. This research confirms the importance of tacit knowledge in pro-environmental activities. Furthermore, the knowledge management model used (creation, storage, sharing, utilization) appears to be a good tool for describing and improving the food service industry. As for further research, it is recommended that larger-scale quantitative studies be conducted to examine the topic in greater depth and detail. Extending the research beyond one country is highly recommended in order to compare the results.

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Managing Environmental Knowledge in Enterprises: The Perspective of Young Employees

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Abstract: Ever-increasing industrial production and consumption are putting an increasing strain on the environment. Currently, the most unfavourable rates of greenhouse gas emissions and waste generation are recorded. Analysing these data, it is apparent that the political and regulatory measures taken are having insufficient effect. In building public awareness of this issue, it is important to create responsibility among the employees of enterprises, who have a direct impact on environmental protection with their everyday decisions. Very important in this process are the internal systems of companies, which should allow the creation of good environmental practices and solutions. But also the sharing of this knowledge and its implementation in the daily activities of employees. Based on the above premises, the aim of this study was to assess the status of environmental knowledge management processes in enterprises. A questionnaire survey was used to achieve the objective. The questionnaire contained open and closed questions and was distributed via the Internet. The target group of the survey was young employees of enterprises. The results obtained determined that those surveyed are characterised by a high awareness of environmental protection. However, most of them believe that they are not well informed about environmental protection principles when doing their job. Respondents also gave a low rating to the availability of knowledge in this area and the possibility of acquiring and improving it. In only about 2% of cases did the respondents receive training dedicated to environmental protection at their workplace. In contrast, as many as ca. 84% declared that there was no environmental training at their workplace. Respondents indicated knowledge gained individually on the Internet, TV, books and other resources as the main source of their knowledge. The identified state prompts actions to raise the profile and role of employee education and the implementation of knowledge management systems, which will be able to contribute to improving environmental performance on the part of enterprises. It is important to keep in mind that very often line operational staff have a very strong influence on environmental issues. They are the ones who separate waste, package products, use consumables, operate equipment, etc.

Keywords: Knowledge management, Environmental knowledge, Young employees, Employee training, Environment

1. Introduction

In recent decades, we as the earth's population have been experiencing more and more pronounced climate change. This is happening largely due to human activities (Steffen et al, 2018). First and foremost, the burning and exploitation of fossil fuels, which generate emissions of the greenhouse gases carbon dioxide and methane (Rockström et al, 2009). Other significant sources of these gases are landfills, energy production and industry. These activities are causing greenhouse gas concentrations to reach their highest level in 2 million years and continue to rise (World Meteorological..., 2024). Climate change and the current environmental situation are exacerbating the demands that are placed on today's businesses. Putting pressure on the way they do business. The expansion of business and the increasing reliance on natural resources is deteriorating ecosystems which will disrupt human well-being in the long term, albeit observable (Tomalka et al, 2024). This is reflected in, among other things: threats to human health and social problems such as migration and conflict (Talukder et al, 2021).

The gradual implementation of transformational actions in companies involves a number of specific practices and the strengthening of management processes. More environmentally friendly actions by companies will require investments, including in human capital, while taking into account fairness and equity. The transformation of companies towards a green economy requires an integrated approach where the institutional, financial and political levels are aligned with these goals. An urgent need has arisen among companies to create and develop knowledge that reduces the negative impact of the organisation on the environment and its resources. Undoubtedly, this direction of development will result in achieving sustainable competitive advantages over industry rivals (Al-Qudah et al, 2022). Therefore, it is essential to take systemic measures to achieve positive environmental impacts. Their real effect will be to improve human wellbeing as well as the environment as a whole (Tomalka et al, 2024). In view of the risks presented, it is extremely important to utilise environmental knowledge by company employees, who, through the way they perform

their work, can have a significant impact on the level of negative impact on the environment. The impact on the creation, storage, sharing and implementation of knowledge are key elements in a properly organised knowledge management system.

A very important and key factor in the implementation of an environmental knowledge management system in companies is employee awareness in this area. This enables a positive overall effect to be achieved and the prospect of a beneficial impact on the activities of the entire company (Nair and Munusami, 2019). Effective and efficient solving of environmental problems and simultaneous work in line with the company's policies requires awareness and competence in the field of environmental protection among employees. A fundamental factor in the effective implementation of knowledge management systems is determining employee awareness and reviewing their resources and knowledge. This is an input resource for building knowledge management and defining barriers to progress. Therefore, the first research question was posed RQ1: What is the level of environmental awareness among young employees?

Knowledge sharing is crucial to the success of an organisation. It drives innovation, enables effective problem solving and facilitates the flow of information between decision-making levels and structures within the company (Zhao, 2024). Knowledge sharing is an activity in which each employee disseminates and exchanges information, ideas, improvements and previous experiences, as well as mutually transforms and improves it. This process provides an opportunity to create synergistic value within the organisation, thereby improving the innovation potential and adaptability of the entire organisation (Qing and Xumei, 2005). Organisational behaviours involving knowledge sharing are voluntary activities aimed at transferring and exchanging information, expertise, including environmental protection principles, between employees or groups (Hoegl et al, 2003). The correctness and effectiveness of this process can have a significant impact on the success of an organisation (Ga´al et al, 2015). However, the ultimate willingness and motives for sharing knowledge depend on the individual characteristics of employees (Sun et al, 2021). Nevertheless, organisations certainly have a great opportunity to support and motivate this process. The results of Jilani et al (2019) research indicate that knowledge sharing in an organisation has a positive and significant impact on its development. Furthermore, knowledge sharing has a positive impact on business performance. These results confirm the benefits that can be gained from implementing and promoting a knowledge sharing policy. In view of the above, the following research question was adopted RQ2: Are employees informed about environmental protection principles at their workplace?

Continuous education and improvement of skills in the field of pro-environmental activities are essential in achieving the goals of sustainable business. The availability of environmental knowledge and the provision of training, coaching and continuing education in this area drive environmentally friendly activities. This approach allows for the engagement of employee innovation and creativity to achieve sustainable work results. The availability and transfer of tacit and explicit knowledge by encouraging employees to share their skills within the company and facilitating the transfer of information to other parts of the organisation, including through training systems and support for knowledge sharing, are important elements of environmental knowledge management.

Sharing environmental knowledge has a positive impact on the green behaviour of employees (Zhang, 2021). The effectiveness of this process may vary depending on the cultural approach to ecology and regulatory forces (Hossain et al, 2025). Knowledge accessibility is defined by Sadeghi and Rad (2018) as the best way to improve the innovative capacity of organisations (Sadeghi and Rad 2018). The availability and sharing of knowledge about environmental protection builds an organisational atmosphere of cooperation. This is achieved by creating facilities and a willingness to share knowledge. It creates consistency in the actions of employees in using such knowledge. It contributes to the generation of greater and better knowledge about the environment (Sawhney and Prandelli, 2000). Therefore, the following research question was adopted in this study RQ3: What is the availability of knowledge about environmental protection?

The role of management is widely recognised in many circles as crucial in the process of any change within a company. Representatives of organisations, owners and managers are essential catalysts in setting the direction for green transformation. Their involvement is indispensable in the comprehensive implementation of environmental protection at every level (Liefländer and Bogner, 2014). It is the organisational and managerial apparatus of the company that should take the lead in building environmental knowledge management systems. Effective and committed managers are able to create a work atmosphere free of fear and based on mutual trust, in which members are willing and ready to share knowledge with each other

(Donate and de Pablo, 2015). Therefore, the following research question RQ4 was posed next: Are the company and its supervisors involved in environmental protection?

2. Green Knowledge Management

The current environmental situation and the context presented make it necessary for industries to continuously work on reducing waste and emissions in the value chains they create. Such initiatives have wide-ranging benefits. They are observable in the field of: financial savings, improved corporate image, increased competitiveness or access to new markets. He et al (2024) refers to the observed need for sustainable practices within companies as cumulative stress. There are many dominant areas of research in the field of knowledge management. The work conducted concerns the role of knowledge management in innovation (Hameed et al, 2021), efficiency (Rashid and Rasheed, 2023), small business activities (Rehman, 2022) and environmental aspects (Shahzad et al, 2020). Many publications present research results and emphasise the importance of knowledge management in reducing the negative impact of business activities on the environment (Rehman, 2022a; Sahoo et al, 2023). Based on this body of work, it is possible to plan further research on the components and sub-processes of knowledge management in companies.

These conditions have led to an interest in Green Knowledge Management within companies. This term should be understood as: knowledge management's focus on the environmental aspect of sustainability (Gauthier and Zhang, 2020). Green knowledge management promotes progressive growth and environmental awareness within an organisation by changing the way companies deal with innovation and environmental knowledge (Shah, Hussain, and Irshad, 2024). Raising awareness among company management about green knowledge management is the first step towards reducing environmental impact. It provides an opportunity to acquire, understand and effectively use knowledge for environmental purposes (Fong and Chang, 2012). As a rule, board members and senior managers are more knowledgeable and motivated to implement green aspects and work organisation techniques. A well-designed and implemented knowledge management system should equally effectively communicate environmental assumptions and benefits. However, this still requires achieving a higher corporate culture (Song, 2020). Abbas and Khan's (2023) research confirms that green knowledge management is very important to ensure green innovation and corporate green performance. The results of this work confirmed that an organisation's commitment to promoting environmental knowledge and behaviours among employees yields positive results. By extending knowledge management to environmental aspects, the corporate image becomes more responsible in the eyes of business partners and other stakeholders (Abbas and Khan, 2022). In turn, the work of Zhang (2024) confirms that a commitment to green knowledge management positively influences green creativity and green competitive advantage. By the same token, it is a further confirmation of the importance and relevance of effective use of environmental knowledge in companies (Zhang, 2024). The research of He et al, (2024) explains that a culture of environmental knowledge sharing within a company reinforces the benefits of such behaviour, while also contributing to organisational innovation and resilience. The results of Rehman's et al, (2024b) work in SMEs confirmed that an environmental learning mindset plays an important role in improving a company's environmental performance. Acquiring and managing green knowledge in a formalised way translates into better environmental performance for the organisation. This concept places great emphasis on the creation and implementation of environmental knowledge within the organisation's activities. Research by Wang (2022) has shown that companies that adopt an environmental knowledge orientation can expect to reap the benefits of green innovation. As a result, these companies transform into learning organisations, improving the acquisition and implementation of environmental knowledge. This has a broad impact in the form of improved environmental performance.

Gauthier and Zhang (2020) point out that although the issue of knowledge management is sufficiently well researched and makes important contributions to science and practice, the concept of green knowledge management is still insufficiently explored. According to the authors of this work, environmental sustainability is a megatrend that will shape the competitiveness of companies in the near future (Gauthier and Zhang, 2020).

Similarly, Aykol and Leonidou (2015) argued that the implementation of sustainable development concepts in companies has not been sufficiently researched. Most studies on this topic focus mainly on large organisations and developed countries. In view of this opinion, all attempts to conduct empirical research in this area are worthwhile. This is supported both by the underdeveloped base of scientific articles, but also by the social importance of this topic. In view of the above, the aim of this study was to assess the state of environmental knowledge management processes in companies. Due to easier access to young people, the study was

conducted on just such a population. The research gaps presented above provide a solid foundation for the research questions and the aim of the study as presented above.

3. Methodology

A quantitative survey method was chosen to achieve the stated objective. A questionnaire survey was conducted among 104 people. The sampling was characterised by features of purposive and convenience sampling (Novielli, Kane and Ashbaugh, 2023). The survey questionnaire was an original design tool consisting of seven stages. These included respondents' environmental awareness, knowledge of environmental principles in the workplace, the availability and accessibility of this knowledge, supervisors' involvement in this topic and suggestions for improvement regarding the management of environmental knowledge. The questionnaire developed was self-completed by the respondents. It was structured to collect data to assess the status of environmental knowledge management processes in companies. The questionnaire used nominal and ordinal scales, and open-ended questions. After the initial development of the questionnaire, it was subjected to validation and a pilot study. After this stage, minor corrections were made and the final form of the questionnaire was achieved. This process ensured that the questionnaire was comprehensible to the target group of the study. The questionnaire was delivered electronically for completion. It outlined the purpose of the survey and emphasised the voluntary nature of the survey. This was intended to foster confidence and thus encourage respondents to answer honestly and factually. The process of sending out and collecting the questionnaires lasted from January to March 2025. Geographically, the survey was limited to the Małopolska Voivodeship in Poland. The collected results illustrate the knowledge, opinions and assessment of the situation regarding environmental knowledge management in the surveyed sample of respondents. The structure of the sample is presented in Table 1. In accordance with the assumptions of the study, the survey was limited to young age.

Table 1: Characteristics of the study sample

Independent variables	Categories	Structure indicator (%)
Gender	female	55
	male	42
	refusal	3
Age	18-22	64
	23-26	34
	27-35	2
Total length of employment	up 2 years	65
	2-4 years	30
	5-8 years	5
Company size	less than 10 persons	20
	10-49	36
	50-249	15
	over 250	29
Industry	transport and logistics	19
	trade	19
	catering and hotels	17
	manufacturing	16
	other	29

4. Results

The study of environmental knowledge management in companies began by determining the level of environmental awareness of the surveyed respondents. Respondents rated individual statements on a Likert scale. The results of this assessment are presented in Figure 1. The data presented confirms that the surveyed sample of young employees has a high level of awareness. High indications for pro-environmental behaviour were achieved in both surveyed cases. The data shows that between 42% and 44% strongly agreed with these

statements and about 33% tended to agree. Taken together, these two attitudes make up the vast majority of responses (around 75%). Which confirms, the high level of environmental awareness of the surveyed sample of respondents.

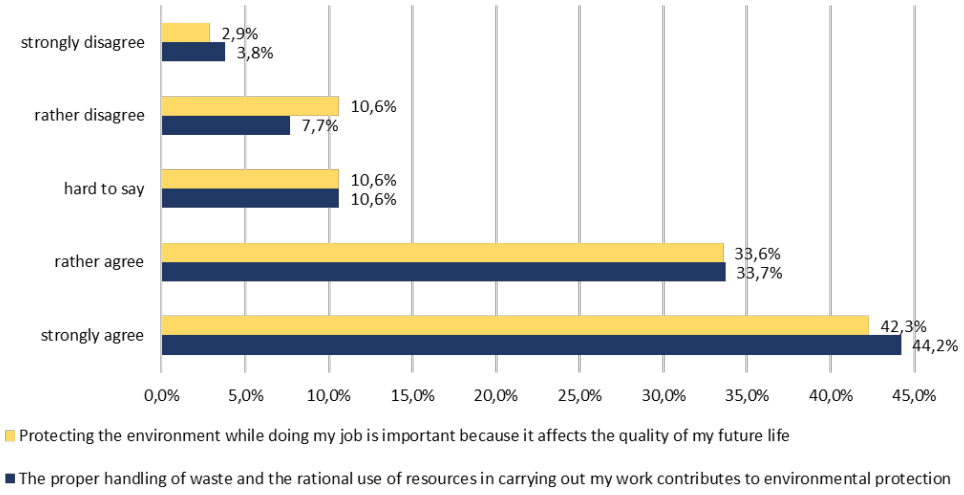


Figure 1: Environmental awareness of the surveyed respondents

For the data that formed the latent variable used to assess their environmental awareness, an internal consistency analysis was performed using Cronbach's alpha coefficient (Revelle, 2023). As can be seen in Table 2, its value was 0,802, which confirms the high consistency of this scale. Removing any of the questions does not increase reliability.

Table 2: Cronbach's alpha coefficient in measuring employees' environmental awareness

	Value
α Cronbach	0,802

The respondents' opinions on the level of their being informed by their employer about the environmental principles at their workplace were further investigated. The data obtained are presented in Figure 2. It can be seen that the majority of the respondents expressed a negative opinion about their information on the principles of environmental protection at work (37,5%). Considering the importance of environmental issues and its widespread publicity, these values are very worrying. For a more detailed examination of differences and opinions broken down by independent variables, a non-parametric Kruskal-Wallis test was performed. Its results are presented in Table 3.

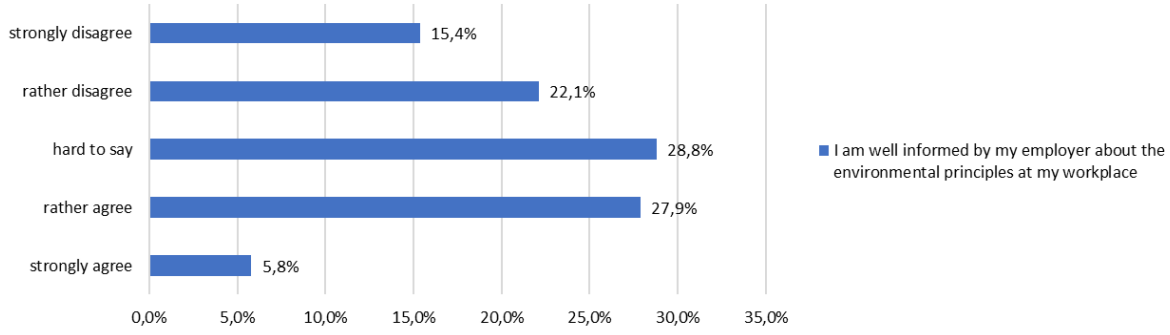


Figure 2: Evaluation of the employer's communication of environmental principles at the workplace

The assessment of employee awareness of environmental protection rules in the workplace was examined in relation to age, company size, scope of company operations and length of service of respondents in order to identify statistically significant differences between these groups. Statistical analysis using the Kruskal-Wallis test (Table 3) did not provide grounds for concluding that there is a statistically significant difference in the assessment of informing respondents about environmental protection principles in the workplace in the groups studied. Significance level α=0,05 adopted.

Table 3: Results of the analysis of differences between groups - Kruskal-Wallis test

Independent variable	χ^2	df	p
Age	0,619	1	0,432
Company size	3,55	3	0,314
Scope of the company's operations	4,13	2	0,127
Length of service	1,42	2	0,491

As a further element of the knowledge management system, employees' opinions on the availability of environmental knowledge were assessed. For this purpose, two statements were used on which respondents declared their approval or disapproval on a Likert scale. The data obtained as a result of the survey are presented in Figure 3. This data shows that the vast majority of respondents believe that environmental information and knowledge is not readily available to them (about 46%), and an equally large proportion of respondents declare that their employer does not facilitate their environmental knowledge (about 63%). These results paint a negative picture of knowledge management systems that are poorly organised and do not provide opportunities for employees to expand their environmental knowledge and put it into practice. The lack of ease in this area discourages individual employees from taking additional action and initiative in their search, a discouragement.

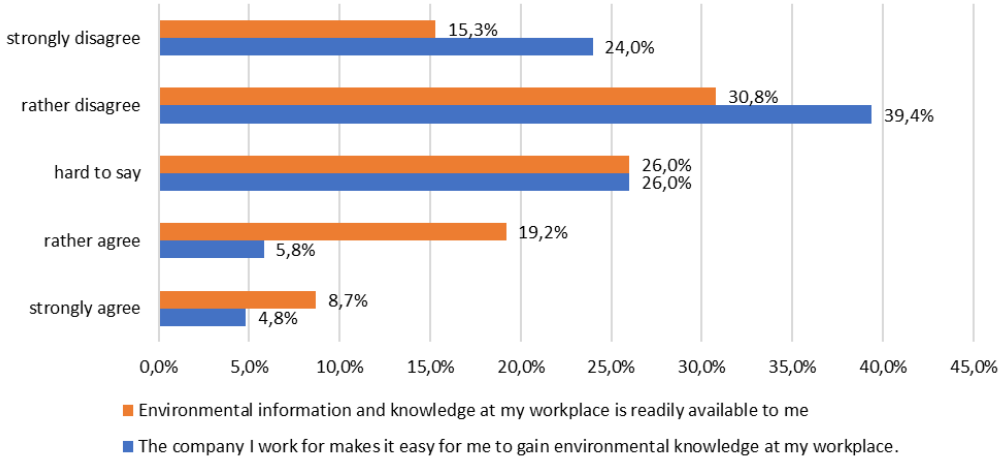


Figure 3: Availability and acquisition of environmental knowledge at the workplace

Cronbach's alpha analysis was used to assess the reliability of this measurement. The results of this analysis indicated that the consistency of responses is at a high and acceptable level (Table 4). This substantiates the conclusions of this study. Removing any of the questions did not improve the reliability of the measurement.

Table 4: Cronbach's alpha coefficient in measuring availability of environmental knowledge

	Value
α Cronbach	0,766

The next stage of the study analysed the availability of training, which can be understood as part of the process of knowledge sharing and implementation in the company. The data collected are presented in Table 5. They show that as many as 83,7% of the surveyed employees do not receive training in which environmental knowledge is imparted at the workplace. In 14,4% of cases, environmental protection was part of the subject matter of more general training. Only 1,9% of the employees declared the existence of training entirely dedicated to environmental protection. Those who declared this were employed in companies with more than 250 employees in the following sectors: automotive and trade. These figures may indicate that companies neither seek to build nor develop the environmental competences of their employees and do not support environmental goals in real and practical terms. This is a manifestation of the lack of systematic and formal implementation of knowledge in this area. This confirms that environmental education of employees is not part of the strategy of these companies.

Table 5: Presence of training in companies dedicated to environmental protection

Answers given by respondents	Percentage of indications (%)
No	83,7
Yes, in my work there is training entirely dedicated to environmental protection	1,9
Yes, there is training in my work that is partly dedicated to the environment protection	14,4

A chi-square test was performed to better examine the relationship. The relationship between environmental training and company size, scope of operations, and employee seniority was verified. The test results are presented in Table 6. In cases where there were grounds for rejecting the null hypothesis and a relationship existed, the V-Cramer coefficient was calculated. The data presented in the table prove that there is a statistically significant relationship between environmental training in companies and company size and employee seniority. The values of the V-Cramer coefficient indicate that this relationship is moderate.

Table 6: Results of the chi-square independence test

Independent variable	χ^2	df	p	V-Cramera
Company size	15,7	6	0,015*	0,275
Scope of the company's operations	8,38	4	0,079	-
Length of service	9,70	4	0,046*	0,216

*- there is a statistically significant relationship $p<\alpha=0.05$

In view of this low level of training in companies, the next step investigated what the main sources of employees' environmental knowledge are. The results are presented in Table 7. As can be seen, the vast majority of employees surveyed (approx. 67%) base their activities on knowledge gained from the Internet, TV, books or other resources. This is followed by declarations of relying at work on knowledge gained from secondary school (approx. 17%) and university (approx. 12%). Only 3% of respondents declared that their main source of environmental knowledge on the job is knowledge gained at work. These data are cause for concern and confirm that environmental knowledge management in companies is hardly functioning in practice. Employees are on their own when it comes to further training. They have to rely on external sources of information. Also noteworthy is the low percentage of indications of formal education, which apparently provides very little environmental knowledge for future employees of companies.

Table 7: The main and greatest source of knowledge on environmental protection at work

Answers given by respondents	Percentage of indications (%)
Knowledge I have gained myself from the internet, TV, books and other resources	67,2
Knowledge gained during my studies	12,5
Knowledge gained at work	3,0
Knowledge gained in secondary school	17,3

In order to examine the relationship between sources of environmental knowledge in greater depth, a chi-square test was used to analyse the relationship. The data obtained during the analysis are presented in Table 8. The study showed that age, gender, company size and scope of activity do not influence the sources of environmental knowledge acquired by employees. However, there is a statistically significant relationship between the sources of environmental protection knowledge and length of service. The strength of this relationship is moderate, as indicated by the V-Cramer coefficient (0,372).

Table 8: Results of the chi-square independence test

Independent variable	χ^2	df	p	V-Cramera
Age	8,34	6	0,214	-
Gender	3,92	3	0,271	
Company size	9,09	9	0,429	-
Scope of the company's operations	6,56	6	0,364	-
Length of service	28,8	6	<0,001*	0,372

*- there is a statistically significant relationship p<α=0.05

In the next stage of this study, the level of commitment of the company and supervisors to environmental protection related to their activities was determined. The data obtained are presented in Figure 4.

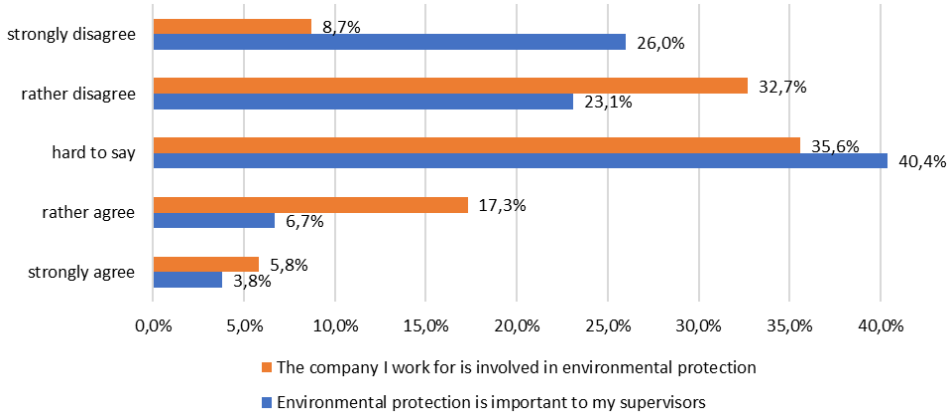


Figure 4: Company and supervisor involvement in environmental protection as perceived by employees

The data shows that there is little commitment from superiors. As many as 49,1% of employees do not agree with the statement that environmental protection is important to their superiors. The commitment of the company as a whole to environmental protection is slightly better perceived. Compared to their superiors' assessment, only 41,4% of employees disagree. This may be due to better promotion and attention to the pro-environmental image of companies, which very often attribute such behaviour to themselves. Nevertheless, it is apparent that employees rate their superiors' and the company's commitment to the environment low. Analysis of these data indicates significant deficits in organisational leadership in the pursuit of ever better environmental performance. Executives do not lead by example and do not foster pro-environmental attitudes in subordinate employees. As in previous cases, the reliability of the scale was analysed. The data obtained are presented in Table 9. Cronbach's alpha was 0,770, which means that the reliability of the scale can be considered acceptable.

Table 9: Cronbach's alpha coefficient in measuring availability of environmental knowledge

	Value
α Cronbach	0,770

In the final stage of the survey, in an open-ended question, surveyed employees were asked to indicate what could be done to ensure that environmental provisions were implemented to a greater extent in their workplaces. The most frequent suggestions and indications included:

- the introduction of training dedicated to environmental protection, preferably in the form of practical workshops, which would increase the knowledge and awareness of employees and employers in this area,
- better segregation of waste, recycling, saving raw materials (water, automatic lighting, avoiding plastics,
- introduction of publicly available materials: posters, brochures, leaflets informing in a pleasant to understand form on how to behave in an environmentally friendly way,
- reducing the use of paper, e.g. through digitalisation and digital documents,
- clearer and more precise guidelines and regular internal audits,
- reduction of excess film and better adaptation of packaging to product size,
- motivating employees through benefits and incentives, encouraging initiative,
- use of sustainable raw materials, e.g. photovoltaic energy, biofuels,
- reporting of environmental data to employees (e.g. resource consumption, energy),
- optimising transport operations management.

As can be seen from the suggestions made by employees, there is a great deal of room for improvement in this area.

5. Conclusion

The research conducted tackles the very important topic of environmental protection in companies. In this case, the research focused on the evaluation of the environmental knowledge management system in companies. Young employees, who do not have much work experience and often occupy line positions, were chosen as the research group. Many times it is their decisions and behaviour that can determine the amount of resources consumed. It is these employees who are responsible for activities such as packaging or waste disposal, and thus their attitude and behaviour have a significant impact on the environmental load. he picture presented by this study of the state of environmental knowledge management is not optimistic. It appears that employees are characterised by a high level of environmental awareness. However, they do not perceive the commitment of their superiors and the company as a whole to environmental problems. Employees mostly rely on knowledge gained from the Internet, TV and other external resources when doing environmental work. In contrast, the companies that employ them provide very little training in this area. Despite the exploratory and non-representative nature of this survey, it highlights a serious problem. This is the insufficient commitment of management and the lack of support for employees to improve their environmental competences at the workplace. It appears that the people surveyed are aware but the company is not interested in their development and in creating an environment of innovation for environmental problems. The potential of these people is untapped in the creation of internal knowledge resources. Through these inefficiencies, the knowledge management system cannot effectively create knowledge, transfer it and apply it to build a competitive advantage in the market.

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Advanced Spiritual Knowledge Management: Main Features of the Concept and Initial Ideas for Implementation in Schools and School Pastoral Care

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Abstract: Purpose: This paper aims to conceptualize and explore *Spiritual Knowledge Management (SpKM)* as an advanced and transformative paradigm within the evolving field of Knowledge Management (KM). It shifts KM's purpose from supporting predefined goals to enabling a learning journey toward the best version of the self or the organization, integrating spiritual, non-rational, and identity-forming dimensions of knowledge. **Research Methodology:** The study combines conceptual development grounded in interdisciplinary literature with empirical data from a large-scale quantitative survey on school pastoral care. The survey, conducted in the Archdiocese of Salzburg, included 844 valid student responses and explored the role of faith, identity, and expectations regarding school pastoral care. **Findings:** The empirical results confirm that spiritual aspects of knowledge are relevant and meaningful in the educational context. Students value faith and spiritual guidance particularly in times of personal challenge and see school pastoral care as a support for identity formation, hope, and holistic personal development—elements strongly aligned with the principles of Spiritual KM. **Implications of the Study:** These findings suggest that school pastoral care is a suitable and impactful domain for implementing Spiritual KM. Moreover, SpKM could inform broader educational strategies by integrating deeper learning processes and resonance-based reflection, thereby fostering wisdom and ethical orientation in knowledge development. **Practicality of the Study:** The study demonstrates how spiritual knowledge can be accessed and applied in real-world educational contexts. It proposes that SpKM principles be integrated into school systems through staff development, pedagogical methods, and strategic design of spiritual learning environments. **Value/Originality of the Study:** This is the first study to apply the emerging concept of Spiritual Knowledge Management to the context of school pastoral care. It contributes to the redefinition of KM by incorporating spirituality and purpose as central components and demonstrates its practical relevance through empirical validation.

Keywords: Spiritual knowledge management, Deep learning, resonance, School pastoral care, Wisdom, Identity, Personal development

1. Introduction

In an age shaped by digital transformation and rapidly evolving knowledge landscapes, traditional approaches to Knowledge Management are increasingly confronted with both emerging opportunities and new demands. The integration of forward-looking methods such as *Learning from the Future*, in combination with innovative practices like *Design Thinking*, presents a unique opportunity not only to adapt KM practices to current challenges but also to proactively shape the future. Technological advancements such as especially artificial intelligence are fundamentally transforming how knowledge is created, shared, and applied. In such a dynamic environment, conventional KM models are reaching their limits. By combining new future-oriented methods with creative, user-centered design approaches, organizations are now in a position to rethink their knowledge systems—or even reimagine their very understanding of knowledge and knowledge management—to better align with the demands of the digital era.

Looking back at the past few decades, we can trace a continuous evolution and shift in the core paradigms of KM itself (Serenko, 2013, 2021; Scharmer, 2001). In the last 10 to 15 years, a "future-oriented approach" has gained momentum, that emphasizes learning from the future and proactively shaping what is yet to come (e.g., Peschl, 2023). This orientation corresponds with the inside-out approach to strategy, as described by Nonaka and Takeuchi (2021).

However, there is growing evidence that the development of KM does not end here. More recent concepts—such as *Spiritual Knowledge Management* (Kaiser, 2024, 2023; Peschl et al., 2023), *Responsible Knowledge Management* (Rocha et al., 2022; Durst, 2021), and *Spiritual Knowledge* (Bratianu and Bejinaru, 2023; Bratianu, 2024)—have begun to shift the discourse. These approaches introduce spiritual knowledge, wisdom, and phronesis as additional, valuable forms of knowledge (Kodama, 2021; Bratianu and Motoc, 2022).

In this paper, we will outline some aspects of **Advanced Spiritual Knowledge Management** and will present an implementation and realization of some of these ideas in the area of school pastoral care, based on the results of an empirical study.

2. The Development of Knowledge Management and Strategy in Recent Decades

When looking at current developments in the realm of AI, one might be tempted to ask what KM is still good for? The seasoned KM professional may have already noticed the blurry distinction in the wording of the terms *knowledge* and *information* – a rookie mistake to illustrate a point that has been emphasized for almost as long as the field of KM has existed: confusing knowledge with information and respectively establishing Information Management systems instead of Knowledge Management Systems. For as simple of a mistake this appears to be, its consequences are far-reaching: Information is – in comparison to knowledge – much more tangible with the concept of information management also genuinely easier to understand. It is about extracting, storing and retrieving – making information explicit and putting into a database, ERP system, Knowledge Graph or, more recently, using it to train the corporate AI model. Overall, a mostly techno-centric approach.

With knowledge on the other hand, it is about creating, learning, understanding and doing – it has a greater action-oriented characteristic with an emphasis on human agency. Sveiby (2001) in that line of thinking speaks of a capacity-to-act that every individual possesses and uses to create value for an organization. The goal of Knowledge Management would thus be to create framework conditions for the creation of value based on the individual's capacity-to-act.

In basic terms, these two approaches are the root for the distinction between *soft* and *hard* approaches to KM that can be identified in the literature (Serenko, 2013, 2021).

Historically, the field of KM as a distinct scientific discipline emerged in the 1990s. From that time on, KM quickly gained popularity, as people had to deal with the ongoing shift towards a knowledge economy. Soon after the wider adaption of KM, the focus shifted from techno-centric to human-centered issues. Along with Nonaka and Takeuchis (1995) seminal contribution about companies creating knowledge in the exchange of explicit and tacit knowledge, KM arguably reached the peak of its popularity. From the late 2000s onwards the field appeared more and more fragmented struggling to reconcile and integrate the technical and human-oriented stream into a coherent frame (Serenko, 2013). Nowadays, the landscape of KM topics is wider than ever with the field appearing as a conglomerate of interdisciplinary perspectives on knowledge related issues (Serenko, 2021).

Approaching the matter from a different perspective – and zooming out a bit, we can allocate KM in the greater field of strategic management and examine the role that knowledge and knowledge management play for organizations from a strategic perspective. Strategic Management is generally concerned with „the long-term direction of an organization" (Johnson et al., 2017, p. 4). This includes setting long-term goals and objectives, elaborating respective courses of action and the allocation of resources, ultimately aiming to achieve competitive advantage (Drucker, 1994). Knowledge, as has been extensively argued in the field of KM, is one of those resources that can be utilized, therefore.

An important aspect of strategy-making is choosing a set of activities to deliver a unique mix of value that differentiates the organization from its competition (Porter, 1996, 1997). This activity in itself requires profound knowledge of the organization, its capabilities, resources and the market environment it is operating in. In other words, the organization requires knowledge of itself to be able to craft meaningful strategy. This reflects in the extensive analysis of the organization's position that should precede all strategic considerations of possible actions. Such an analysis usually covers both external (market share, trends, regulatory landscape, competitors, etc.) and internal aspects (resources, capabilities, human capital, values, purpose, etc.) of the organization (Johnson, Whittington and Scholes, 2017). In both areas, KM can contribute valuable inputs. Yet, what the field of KM appears to realize more recently is that there has been an extensive focus on the perspective of knowledge as a usable resource for the operative side of business. Creating new products, achieving higher levels of efficiency, maintaining customer relations, or improving service quality just to name a few examples, has been focal to most theorizing in the field of KM. The other side – knowledge about the organization as such, its values, underlying beliefs, culture, purpose or the spiritual dimension of organizing have been mostly neglected in the previous discourse in KM.

However, in recent years scholars in KM began to delve deeper into this avenue of research. We see an increase in 'different' approaches to the idea of KM, emphasizing the value of the inside-out thinking when it comes to creating strategy. Nonaka and Takeuchi (2021) speak of more future-oriented, society-focused, dynamic, and human-centric strategies that rely on organizational values. They also emphasize the role of wisdom as guideline

for doing the right things (Nonaka and Takeuchi, 2019). Durst (2021) elaborates on the idea of Responsible KM, meaning that knowledge creation, sharing, and retention should be directed towards greater good (Durst, 2021, p. 6). In a similar manner Kragulj (2022) and Rocha, Kragulj and Pinheiro (2022) elaborate on practical wisdom (`phronesis') as an enabler for responsible KM. Kerschbaum (2022), with particular focus on strategy argues for the inclusion of aesthetics as a non-rational component of knowledge, required to create strategies that align with the organizations purpose.

3. Spiritual Knowledge Management and its key Aspects

Based on the development and history of knowledge management outlined in the previous chapter, we suggest that a promising direction for the future of KM lies in the development of an advanced form of Spiritual Knowledge Management (SpKM). In this chapter, we will outline the basic ideas of this new approach and then explain the most important aspects of an advanced form of SpKM.

3.1 The Basic Ideas

In recent years, the concept of **Spiritual Knowledge Management (SpKM)** has emerged as a novel and transformative extension of the Knowledge Management (KM) field (Kaiser, 2024; Kaiser & Martinez, 2023). It represents a fundamental shift in how we understand the purpose and function of KM. At its heart lies a simple yet profound idea: every individual and every organization seeks to flourish. Reaching such a state of flourishing entails nothing less than becoming the best possible version of oneself—whether on a personal or organizational level. In essence, this is a transformational journey: a continuous movement from the current self toward one's ideal or most authentic form. We use the term "best version of the self" in the sense of the concept of the phronetically enacted self as proposed in (Peschl et al., 2023).

Although this foundational notion has been explored in a variety of disciplines—including organizational behaviour (Boyatzis & Akrivou, 2006), change management (Scharmer & Kaufer, 2013), consulting and spirituality (Kelly, 2017), theology (Rohr, 2012), and psychotherapy (Frankl, 1966)—its integration into the field of Knowledge Management marks a timely and significant innovation. Why is this contextual expansion important? Because the journey toward one's best version can be seen as a deep and transformative learning process. In this process, knowledge is not only generated about the meaning and nature of this envisioned self (the *what* and *why*), but also about the practical steps required to actualize it (the *how*).

Traditionally, Knowledge Management has been defined as "the process of creating, capturing, distributing, and effectively using knowledge" (Davenport, 1994). Building upon this definition, Spiritual Knowledge Management can be rearticulated as: **"***the process of creating, capturing, distributing, and effectively using knowledge in order to realize the best version of myself as a person—or of itself as an organization***"** (Kaiser, 2024).

Figure 1 illustrates the core structure of the SpKM model in a simplified form.

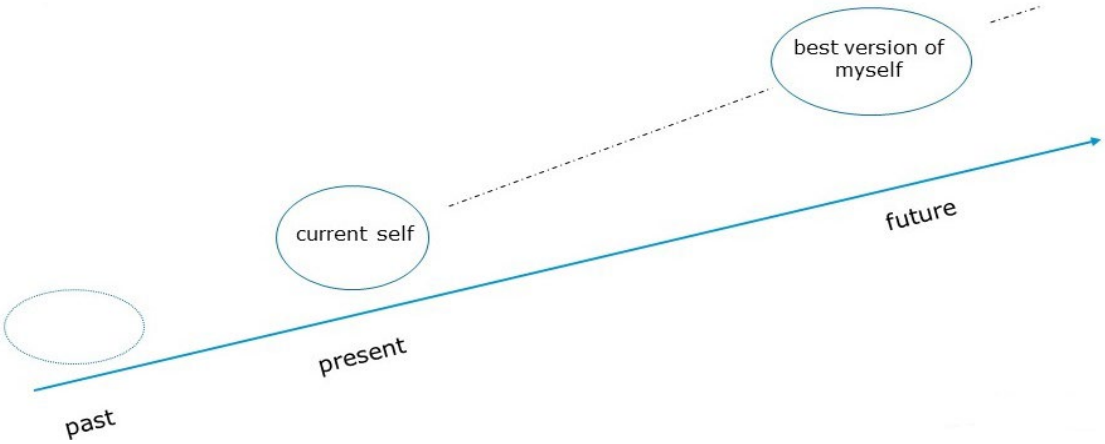


Figure 1: The basic structure and dynamics of the Spiritual Knowledge Management approach

It must be emphasized that the path toward one's best version is not a linear or straightforward process, as the diagram might initially suggest. Like all genuine learning—especially deep and transformational learning—it is a non-linear journey marked by detours, regressions, and emergent insights. Thus, it is better described as a process of *becoming* rather than a conventional change process. Crucially, the destination—the full and detailed vision of the best version—is not entirely known at the outset. Rather, it is gradually discovered along the way.

This type of learning journey demands highly specific forms of knowledge and competencies to be navigated effectively.

3.2 Advanced Spiritual Knowledge Management

However, how could such very specific forms of knowledge be acquired? A key aspect of acquiring such knowledge lies in cultivating resonant relationships with the world — whether through engagement with people, nature, or even non-rational elements such as symbols or artifacts (Rosa, 2019; Kerschbaum and Peschl, 2024). Each authentic moment of resonance carries the potential to be transformed into knowledge, provided it is attentively perceived and reflectively processed. This emerging knowledge can later serve as guidance in entirely different contexts. Over time, the accumulation of such resonance experiences—and the insights derived from them—enables a deeper understanding of what the best version of the self might look like. It is important to recognize that the pursuit of one's best version and the aspiration to live a flourishing life are inseparably linked. The richer the variety of resonance opportunities, the greater the potential to generate meaningful knowledge. Moreover, the more such knowledge one has integrated over time, the more likely it is to foster wisdom. In this sense, wisdom and the realization of the best version go hand in hand.

Very recently, Lauritzen (2025) claimed that the third way AI poses an existential threat to humanity unfolds when people forget what it means to be human. In line with this, Kaiser et al. (2025) discussed initial ideas on how Artificial Intelligence could support this process—particularly by revealing previously overlooked opportunities for resonance that may open up new pathways for experience and learning. Artificial intelligence can significantly expand this space of possibilities by making unconventional and personalized suggestions. However, the actual decision to follow a suggestion, engage with the experience and transform it into knowledge remains in the hands of humans.

If we take Sveiby's definition of knowledge as "capacity to act" (Sveiby, 2001), then wisdom can be understood as the capacity to act *rightly*—that is, in a way that is beneficial for all stakeholders, ethically sound, and aligned with a deeper sense of purpose. In light of the earlier discussion on the "best version of the self," it becomes clear that what is "right" or "good" can be measured by how closely an action moves a person or organization toward that ideal version (Kaiser et al., 2025). From this perspective, Spiritual Knowledge Management is fundamentally about fostering the conditions under which such knowledge—and the wisdom it cultivates—can arise. It is about enabling resonance experiences that catalyse inner transformation and insight (Kaiser et al., 2025).

Resonance, in its most powerful form, aligns current reality with a sensed potential—what we might call the "intended reality." Even when we are startled by what reality presents us, such moments force us to recalibrate our internal map of the world (Rosa, 2019). These are not just interruptions; they are openings. In such moments, we catch glimpses of who we truly are—and who we might yet become.

In this light, the mission of Knowledge Management in the future will be radically redefined. It will not merely serve a predefined goal by managing knowledge in a linear, goal-oriented fashion. Rather, it will be about discovering the goal itself—about unveiling the deeper "why" behind action. Knowledge will no longer be a tool to reach an endpoint; it will be the path to uncovering that endpoint in the first place. Here, artificial intelligence could play a catalytic role—not by providing answers, but by amplifying options for resonance, generating conditions that help human beings encounter themselves in new ways (Kaiser et al., 2025). We propose that an *expanded model of Spiritual Knowledge Management* offers a compelling framework for this new form of KM. It is shown very roughly in figure-2.

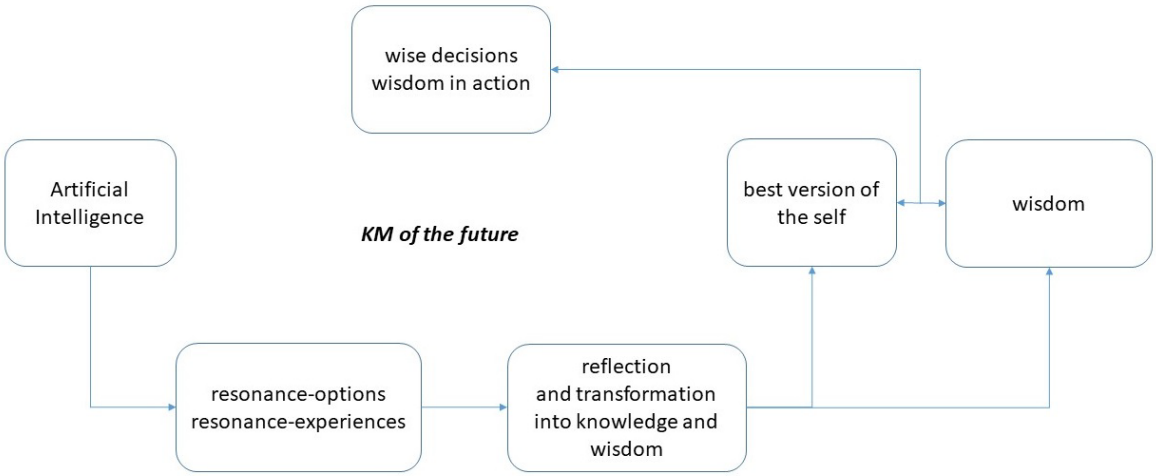


Figure 2: The advanced Spiritual Knowledge Management approach

Central to this model is the "reflection and transformation" phase—a delicate yet crucial stage in which lived experience is distilled into usable knowledge, and eventually, into wisdom. This phase is where transformation truly happens. It is in this space that *self-transcending knowledge* can emerge (Scharmer, 2001). This refers to the capacity to perceive potential before it is actualized, to recognize what is not yet present but already possible (Uotila & Melkas, 2008). Self-transcending knowledge can be seen as the knowledge about the highest future possibility (Kaiser and Fordinal, 2010).

4. Some Empirical Observations From the School Sector and the Field of Pastoral Care

Integrating spiritual aspects into knowledge management is of particular importance for the future, as these aspects address the whole person. The concept of spiritual knowledge management opens up new perspectives and fields of application that venture beyond the traditional boundaries of knowledge management. In this paper, we address school pastoral care as a practical application of the concepts of spiritual knowledge management. Based on a comprehensive empirical study conducted in the Archdiocese of Salzburg in 2024, we show the extent to which principles of spiritual knowledge management are already applied in school pastoral care and the potential that lies within.

4.1 Data Collection and Sample

The present study is based on an extensive empirical study on school pastoral care, which was conducted between October and December 2024 using a standardized online questionnaire. The questionnaire comprised a total of 164 questions, thematically divided into 14 sections. The survey was conducted using the online survey tool SurveyMonkey and was primarily aimed at students from various educational institutions in the Archdiocese of Salzburg – both church and non-church educational institutions.

A total of 867 students took part in the survey, with 23 participants not granting permission for their data to be used, so the final sample includes 844 valid responses. Answering the questions was also voluntary, so that not every question has a full number of answers. The average participation rate was about 700-750 answers per question.

Sociodemographic characteristics of the sample

The participants in the study were predominantly students aged between 14 and 18 years. The gender distribution was relatively balanced, with 51.58% female, 46.39% male and 2.03% diverse participants. The majority of respondents (57%) were in grades 5 to 8 of secondary school at the time of the survey, with various school types represented.

The linguistic homogeneity of the sample is noteworthy: 77.4% of the respondents stated that they spoke German at home. The family situation of the participants was mostly stable, with 83.23% of the respondents stating that they lived with both parents. With regard to the educational level of the parents, the results show an above-average level, with 40.05% having a university degree and 29.39% having a high school diploma. The financial situation was assessed as "good" or "very good" by 84.39% of the respondents.

4.2 Analysis and Results with a Focus on Spiritual Knowledge Management

For the present paper, we have selected two specific areas from the study questionnaire that are particularly relevant to the concept of SpKM. These areas provide deeper insights into the spiritual dimensions of knowledge and its management in the school context.

Role of faith in the context of Spiritual Knowledge Management

In the questionnaire section “Role of faith” (section 08), the importance of spiritual and faith-related aspects and thus of facets of self-transcendence in students' lives was examined. This dimension is of particular importance for spiritual knowledge management, as it provides insights into the integration of non-rational knowledge into everyday life.

The results show a differentiated picture: 51.13% of the respondents rate their faith as “important” or “very important” in difficult life situations (question 56). This result underlines the importance of spiritual resources and non-rational knowledge as a coping strategy and resilience factor and as an essential aspect of shaping one's own self on the way to a best version.

Interestingly, the influence of faith on relationships with others is significantly lower: only 24.54% of respondents say that their faith influences their interpersonal relationships “significantly” or “strongly” (question 57). Similar tendencies can be seen in the question of support in achieving goals through faith (28.38% answer “definitely” or “very much”) and in the experience of faith in everyday life (27.51% answer “definitely” or “strongly”).

The question regarding the importance of faith for one's own identity is particularly relevant for Spiritual Knowledge Management. Here, 30.31% of respondents state that faith is “important” or “very important” for their identity (question 60). This indicates that spiritual aspects of knowledge have an identity-forming function for about one-third of the respondents.

Understanding and expectations of pastoral care in the context of Spiritual Knowledge Management

The second area analysed, “What does pastoral care mean to you?” (Section 12), provides insights into what students expect from school pastoral care and the extent to which it is perceived as a source of spiritual knowledge.

A key finding is that 32.77% of respondents see school pastoral care as a potential support for developing a self-confident life (question 89, answers “distinctly” or “strongly”). This corresponds with the approach of SpKM, which understands knowledge not only as a cognitive resource but also as a holistic basis for development.

The results of question 93, which deals with the growth dimension of faith, are particularly revealing for the connection between school pastoral care and Spiritual Knowledge Management: 24.66% of those surveyed see school pastoral care as an opportunity to “grow in faith that helps in life to become happy”. This perspective illustrates the transformative potential of spiritual knowledge.

Another relevant aspect is the dimension of hope: 34.47% of respondents believe that school pastoral care can help them “never lose hope in life” (question 94). This future orientation corresponds to the future-oriented paradigm of Spiritual Knowledge Management.

The imparting of values is another intersection between school pastoral care and Spiritual Knowledge Management. In response to question 96, 40.82% of respondents state that it is “very” or “quite” important that “school pastoral care reminds us to believe in peace and good in people.” Similarly, 41.97% agree with the statement that school pastoral care could serve as encouragement that “it is better to live with each other than against each other, regardless of belief.”

The importance of reflecting on one's own values is also noteworthy: 64.39% of respondents believe that school pastoral care should support students in “reflecting on and developing their own values and beliefs” (question 102, answers “strongly” or “somewhat”). This high level of agreement underscores the role of school pastoral care as a catalyst for the development of a reflective and holistic understanding of knowledge.

4.3 School Pastoral Care as a Field of Practice for Spiritual Knowledge Management

The results of the empirical study show that school pastoral care offers numerous starting points for the practical implementation of Spiritual Knowledge Management. In particular, the following lines of connection can be seen:

- **Integration of non-rational knowledge**: School pastoral care is perceived by a considerable proportion of respondents as an instance that goes beyond rational knowledge and taps into spiritual dimensions such as hope, faith and meaning as well as self-transcending knowledge. This corresponds to the broadening of the concept of knowledge to include spiritual components.
- **Holistic view of the human being**: Expectations of school pastoral care include not only cognitive but also emotional, social and spiritual dimensions. This holistic perspective is in line with the approach of spiritual knowledge management.
- **Reflexive practice**: The high level of agreement regarding support in reflecting on one's own values points to the potential of school pastoral care as a reflexive field of practice that can contribute to the development of wisdom and phronesis.
- **Future orientation**: The hopeful dimension of school pastoral care is consistent with the future-oriented focus of modern knowledge management.

5. Conclusion and Outlook

Our analysis nicely demonstrates that school pastoral care can serve as a concrete field of application for Spiritual Knowledge Management. The empirical findings show that a significant part of the students surveyed view spiritual dimensions of knowledge as essential and express corresponding expectations toward school pastoral services.

The following implications emerge for future development:

- School pastoral care should be explicitly conceptualized as a space for Spiritual Knowledge Management, in order to fully leverage its potential for holistic education and the personal growth of young people.
- The integration of spiritual forms of knowledge into pedagogical practice should be actively promoted through targeted qualification programs and continuous professional development for school pastoral staff.
- Developing specific methods and tools for spiritual knowledge work in schools will contribute to the professionalization and systemic embedding of school pastoral care.

Within this context, further research is needed to explore how the spiritual knowledge fostered through school pastoral care can be meaningfully integrated with other—and emerging—forms of knowledge, and what impact such integration might have on both the personal and academic development of students.

The findings presented here offer a first step toward establishing school pastoral care as a relevant and forward-looking field of practice within the broader framework of Spiritual Knowledge Management. Moreover, this study highlights its benefit for fostering personal growth—empowering students to realize their potential and to approach challenges not as obstacles, but as opportunities for learning and development

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What Knowledge Management is Not

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Abstract: *Purpose*: This conceptual paper aims to initiate a discussion and raise awareness about some of the misinterpretations of Knowledge Management (KM) that we have observed in recent conferences and academic papers. We contend that continuing to ignore these misconceptions might jeopardize the future of KM within the emerging Super Smart Society. *Method*: The essay begins with an introduction that outlines the problem and its extent. The second section examines significant misuses and misinterpretations of KM in the literature. For each theme, the essay critiques the inappropriate application of KM and offers clarifications to distinguish its true nature. The themes discussed include: KM is not synonymous with *innovation*; KM is distinct from *dynamic capabilities*; and KM is not merely an extension of *organizational learning*. The third section revisits the origins of KM, exploring how seminal scholars originally conceptualized it—shifting the perspective from a Newtonian framework to one that embraces uncertainty through people and practices. The human-centred nature of KM is emphasized, particularly in relation to how individuals address knowledge uncertainties and absences. The essay concludes by reflecting on the future of KM within the paradigm of Society 5.0. *Outcome and Contribution*: The essay highlights numerous instances in which more established fields tend to overshadow knowledge management (KM)—a persistent trend. Old habits die hard, and KM appears increasingly isolated within the strategy literature, particularly in the post-1995 era. A pervasive industrial mindset continues to frame KM as a positivistic tool, despite warnings from seminal scholars. Considering the emerging human-centred paradigm, this essay seeks to reassert KM's centrality as a standalone field within Strategic Management. By revisiting KM's origins and clarifying its distinct identity in relation to adjacent disciplines, the essay contributes to a deeper understanding of the field and its evolving role within the context of Society 5.0.

Keywords: Knowledge management, Innovation, Organizational learning, Dynamic capabilities, Human-centred

1. Introduction

Knowledge Management (KM) remains a relatively young discipline within Management and Organization Studies, having emerged just over 30 years ago. From its tentative beginnings in the early 1990s, it has steadily evolved into a recognized field, supported by dedicated academic journals such as *The Journal of Knowledge Management*, *Knowledge Management Research and Practice*, and *The International Journal of Knowledge Management Studies*. Despite its notable achievements, the future of KM remains uncertain. Adjacent and often more established disciplines are gaining prominence—or are increasingly being conflated with KM—as reflected in recent publications and conference presentations. This paper contends that such developments warrant critical examination and should not be passively accepted.

Why, then, is it crucial for scholars to confront the current ambiguity surrounding KM and ensure that their efforts are directed toward the most pressing and relevant issues? The most immediate reason is tautological: the field has taken its current shape because it is essential and supports organizational development. In the 1990s and 2000s, as value creation shifted from brick-and-mortar (tangible asset-based) businesses to those driven by intangible assets, we must acknowledge the 'magic' that enabled this transformation. Nonaka (1991) emphasized the role of organizational knowledge as a lever for achieving sustainable competitive advantage. As a result, both practitioners and scholars were compelled to engage with this phenomenon, and a language was developed to articulate it (Spender, 2013). A second reason is more forward-looking: for the first time since the Industrial Revolution, we are entering an era that may allow us to place people and the planet at the center of societal development. Japan refers to this vision as *Society 5.0* (Cabinet Office, 2015).

In the first section of this paper, we examine the overlap between Knowledge Management (KM) and neighboring fields—namely innovation, dynamic capabilities (DC), and organizational learning (OL). We provide examples of how these intersections are addressed in the literature, before clarifying what makes KM fundamentally distinct and incompatible with being merely a blend of these domains. KM has emerged as a field whose dimensions and substance have consistently been challenging to define. Therefore, in the following section, we explore the nature of KM, emphasizing its human-centric orientation. The final section envisions the role and evolution of KM within the context of a Super Smart Society.

2. Knowledge Management and Adjacent Fields

2.1 Knowledge Management and Innovation

KM and innovation are not interchangeable concepts, but rather complementary ones. Nevertheless, confusion between the two is frequently observed in the literature (e.g., Nowacki & Bachnik, 2016). This confusion is understandable, as innovation inherently involves the notion of creation, a concept that can be traced back to Schumpeter's theory of *creative destruction*. To clarify the distinction, we will examine several leading theories of innovation and highlight how they differ from KM in both purpose and process.

Von Hippel (1988; 2005) emphasized the role of external users—particularly lead users—as primary sources of innovation, highlighting their involvement in initiating new product development. In contrast, KM focuses on internal organizational processes and the knowledge generated within them. The dynamics of knowledge creation, storage, and retrieval are largely governed by internal mechanisms (Bolisani & Bratianu, 2018). While user-driven innovation centers on the contributions of external actors, KM is more concerned with systematic internal processes and the use of technology to manage knowledge within the organization (Edwards et al., 2005). Moreover, KM encompasses a broader range of dimensions related to the overall management of knowledge—such as its creation, storage, retrieval, and application—not limited to innovation or product development (Kianto et al., 2014).

Similar differences in focus and methodology can be observed in the work of Chesbrough (2003), who introduced the concept of *open innovation*. He proposed that firms should leverage both external and internal ideas and technologies to enhance their innovation processes. Chesbrough emphasizes collaboration with external partners and conceptualizes innovation through an aggregated lens: inbound and outbound flows of knowledge enable organizations to integrate external insights into their internal ecosystems and to commercialize innovations through external channels (Chesbrough, 2007). Following the publication of his foundational book in 2003, Chesbrough's work has centered on the role of business models in shaping how firms create, deliver, and capture value. This perspective contrasts with KM, which is more internally focused and concerned with the systematic management of knowledge across the organization rather than the strategic orchestration of innovation networks.

Although both KM and open innovation aim to leverage knowledge to enhance organizational performance, they differ fundamentally in focus and approach. From a knowledge management systems perspective, KM examines the broader organizational processes through which knowledge is created, stored, shared, and applied to sustain competitive advantage and improve performance (Alavi & Leidner, 2001; Alavi & Denford, 2011). Building on the work of Nonaka and Takeuchi (2021), KM practices emphasize the conversion of tacit knowledge into explicit knowledge and its dissemination across the organization. The ultimate goal is the achievement of *organizational wisdom*—a holistic and strategic orientation that extends beyond product development. While innovation may be a key outcome, it represents a shift in focus from KM to innovation-specific processes (Shafique et al., 2022). Finally, as Chesbrough (2003) describes, open innovation advocates for the creation of ecosystems that facilitate knowledge exchange across organizational boundaries. In contrast, KM relies on systematic internal processes and technologies to manage knowledge within the organization (Magnus & Iguehi, 2017).

Cohen and Levinthal (1989; 1990) introduced the absorptive capacity describing it as an organization s' ability to recognize the value of new external information, assimilate it, and apply it to develop commercial products or services. Their approach emphasizes the importance of identifying and integrating external knowledge into the firm's operations through learning capabilities and innovation mechanisms, rather than through ad hoc KM practices. In this framework, the use of knowledge is treated as a "black box," where assimilation and application occur through the firm's internal capabilities. The focus remains at the organizational level, with little consideration given to the role of the individual. Absorptive capacity theory is notably broad, leading scholars to consider it "as a by-product not only of R&D activities, but also of the diversity or breadth of the organization's knowledge base, its prior learning experience, a shared language, the existence of cross-functional interfaces, and the mental models and problem-solving capacity of the organization's members" (Camisón and Forés, 2010, p. 708).

Considering the approaches of Von Hippel (1988; 2005), Chesbrough (2003; 2007), or Von Hippel (1990), the primary focus lies in the organization's connection to external influences—such as collaboration with external partners, user-driven innovation, and the integration of external knowledge. These perspectives are primarily concerned with product and service development, rather than with the nuanced processes through which tacit

and explicit knowledge are exchanged. What these accounts share is a strategic, aggregated viewpoint, typically situated at the organizational level. In contrast, Knowledge Management (KM) operates across both the individual and organizational levels. KM acknowledges that knowledge originates at the individual level and must be effectively captured, shared, and applied within the broader organizational context.

2.2 Knowledge Management and Dynamic Capabilities

The highly influential Dynamic Capabilities (DC) theory focuses on a firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments. DC are distinct from ordinary capabilities, which support current operations. They involve sensing (opportunities and threats), seizing (mobilizing resources to capture value), and transforming the organization (Teece et al., 2007, p. 1342). While the principles are compelling, DC theory remains broad and difficult to operationalize. It operates at the organizational or meso-level—not the individual level.

Recent literature introducing knowledge-based dynamic capabilities (Kaur, 2019) often positions KM as a sub-field of DC (e.g., Tamirat & Amentie, 2023; Cordeiro et al., 2023; Denford, 2013). Knowledge-based DC (KBDCs) are viewed as an extension of the DC framework. Within this literature, capabilities are defined as essential resources for driving and managing technical change, including skills, knowledge, experience, organizational structure, and linkages (Sinkovics et al., 2018). Kaur (2019) further classifies KM-related processes and capabilities as dynamic capabilities. The DC framework focuses on an organization's ability to adapt to environmental change—essentially, the adaptation of the firm's system (meso level) to the macro environment. Arifin (2017) notes that DCs are knowledge-based, meaning that only knowledge processes and capabilities—treated at the same level—can gather and respond to changes in the business environment.

KBDC is an ambitious framework. Beyond its organizational focus, it relies on KM to engage with the macro level—that is, the environmental conditions to which firms must adapt. Through the sensing, seizing, and transforming structure, KM processes are mobilized to meet the need for dynamism that Teece, and arguably KBDC proponents, have overlooked. While this discussion could be extended, it would stray from our central argument. We view the conflation of DC and KM as an unfortunate development, especially as KM is increasingly treated as a mere toolbox. This integration often neglects the complexity and distinctiveness of KM. The field did not emerge as a set of eclectic concepts to be absorbed by adjacent frameworks. DC is compelling in its simplicity, offering a three-step model with accessible semantics. In contrast, KM models such as Nonaka's SECI (1994) are less widely adopted, likely due to the more abstract interplay between tacit and explicit knowledge. Similarly, Alavi and Leidner's (2001) triadic model—knowledge creation, storage and retrieval, and transfer and application—remains difficult to implement, partly due to the lack of consensus around its core concepts. of knowledge nor on the priority given to the firm's knowledge or the individual's knowledge. More about this in the second section of this paper.

2.3 Knowledge Management and Organizational Learning

A third field that we have identified as threatening the future of KM—regarding the way the concepts are handled—is Organizational Learning (OL). Two examples in the literature help outline the issue. (1) Castaneda et al. (2018) argue that OL processes such as knowledge creation and acquisition are now considered part of KM. Interestingly, the authors suggest in their literature review that KM has absorbed OL, providing more substance or meaning to OL. Another example is owed to (2) Argote et al. (2021), who categorize OL into three processes: knowledge creation, retention, and transfer, defining OL as converting experience into knowledge that impacts future performance. The text criticizes the narrow understanding of KM, which reduces it to a subset of OL, and argues that this approach creates confusion about the true nature of KM. Other examples of the overlap between OL and KM exist in the literature (e.g., Garvin et al., 2008; Noruzi et al., 2013).

These developments suggest that OL and KM are overlapping terms and can be used interchangeably. Our point is not about which field should absorb the other, but rather to emphasize that both KM and OL have their own standing and understanding. Both are relevant as they are for organizations, with OL being concerned with organizations' capabilities and KM with individuals' minds and organizational knowledge. OL and KM might be articulated together for some specific strategies, but claiming that one of these fields should be absorbed by the other is a far stretch.

At this juncture, we argue that KM is in danger of being diluted into neighboring fields. In the above section, we shared only a few examples from the literature where such attempts at dilution are occurring. However, this is a trend we find problematic. KM operates at the micro level of organizations; it goes beyond viewing individuals as mere units of labor, focusing instead on people's know-how and know-what, and how this is aggregated to

form organizational knowledge. KM involves practices (Kianto et al., 2019; Andreeva & Kianto, 2012)—the underlying and often difficult-to-define mechanisms that enable organizational knowledge to emerge and drive firm performance. KM is also a deeply human-centered concept, concerned with the grey matter and emotions that underpin knowledge and knowing. In contrast, innovation, DC, and OL are primarily focused on activities at the organizational level and its interface with the external environment—not at the level of the human mind. KM is positioned at a much earlier stage in the value creation process.

3. Knowledge Management: Why and What

Many attempts have been made to define KM, its dimensions, and its philosophical foundations—whether through dedicated papers (e.g., Demarest, 1997; Rowley, 1999; Barley, Trim, & Kuhn, 2018; Chopra et al., 2021; de Bem Machado et al., 2022) or as part of broader scholarly work (e.g., Nezafati et al., 2023; Sumbal & Amber, 2024; Alfiero et al., 2025). Yet, what KM truly is continues to elude our understanding. Without claiming to resolve this conundrum—which extends beyond the scope of this paper—we offer some reflections on the reasons behind KM's development. We then elaborate on our belief that KM's human-centricity is what fundamentally distinguishes it from innovation, DC, or OL.

3.1 Rationale Underpinning the Emergence of KM

KM as a field can be traced back to scholars who developed the knowledge-based view of the firm (KBV) (Spender, 1996; Grant, 1996) and to those who coined the phrase *organizational knowledge* (Nonaka, 1994). These scholars were concerned with how managers and their organizations faced uncertainty and how they could develop sustainable competitive advantage based on the skills and minds of the firm's workers. To achieve this, a critical reflection on the evolving resource-based view (RBV) of the firm (Barney, 1991; Wernerfelt, 1984) was undertaken. Moving from the Newtonian-inspired RBV to the more empirically grounded KBV required a philosophical shift, as advocated by these same authors. Abandoning Descartes' skepticism about sensory experience and embracing Locke's emphasis on empirical evidence as a source of knowledge was a necessary step—one that laid the foundation for the KBV movement.

Scholars and managers began focusing on the subtle, everyday actions of workers in successful organizations, as seen in Japan (Nonaka & Takeuchi, 1995), uncovering the deep cognitive dynamics linking the human mind to action (Blackler, 1993; 1995), and understanding the firm as a distributed knowledge system (Tsoukas, 1996; Grant, 1996), among others.

KM is more of an emergent concept than a top-down one, where a grand theory can be applied as a recipe for success. Each organization has its own dynamic, and its workers are unique. KM is about understanding and improving the mechanisms behind knowledge creation to enhance performance, while also integrating organizational-level dynamics (Alavi & Leidner, 2001).

3.2 KM is Human-Centred

KM is primarily human-centered. What does this mean? Polanyi (1962), in *Personal Knowledge: Towards a Post-Critical Philosophy*—one of the foundational texts that inspired the development of KM—challenged the dominant view of objective, impersonal knowledge in scientific thinking. In 1975, he expanded the notion of tacit knowledge. His central argument is that all knowledge is inherently personal and involves the active participation of the knower. In *The Tacit Dimension* (1966), Polanyi famously stated, "we know more than we can tell," meaning that much of our knowledge is understood and applied without being explicitly articulated. This challenges the earlier notion of skepticism. Polanyi emphasizes the role of established beliefs and personal commitment in the process of knowing. We argue that this tacit dimension is crucial in how people identify and address knowledge uncertainties and absences.

Moreover, knowledge is fundamentally collective, as people learn from the group before internally processing what they have encountered. Drawing on Wittgenstein's idea that knowledge is inherently social, Tsoukas and Vladimirou (2001) offer one of the most explicit definitions of organizational knowledge: the capability of members to draw distinctions in their work based on collective understandings. For them, KM should focus on identifying unreflective practices and transforming them into reflective ones. This involves elucidating the rules that guide activities and enabling the emergence of heuristic knowledge.

Thus, KM is concerned with the human mind and how it evolves and becomes creative within the collective arena. This involves processes and dynamics rooted in people's experience and deep consciousness. Because knowledge is inherently human, emotions and feelings also play a role in its creation—a dimension often overlooked because it does not align with the Newtonian canon.

4. What's Next? KM and Super Smart Societies

We can conclude that (1) KM is under threat, and (2) it is misunderstood. (1) The first section of this paper introduced three instances where KM was misused and distorted by post-positivist mindsets. In other words, knowledge was objectified and forcefully framed around organizational-level actions. Yet, there is a significant gap between the human mind and organizational capabilities. (2) The second section outlined the nature of KM and, in doing so, highlighted why it is fundamentally incompatible with meso-level concepts such as DC or innovation, which tend to overlook the role of human emotions. The next step in this discussion is to understand why recognizing KM's human-centricity is essential for its future.

In today's context, the value generated by the intangible economy has grown dramatically. With the rise of smart technologies (e.g., smartphones, smart home devices) (Sharma et al., 2023) and super smart technologies (e.g., AI-powered homes, autonomous connected vehicles), intangible assets are reaching unprecedented importance in Western economies. This trend is further reinforced by the pervasive influence of social and digital media, marking the emergence of a digital society (Lindgren, 2021). In other words, while the 1990s marked the shift from industrial to knowledge societies (Bell, 1973; Powell & Snellman, 2004), the late 2010s ushered in digital societies, characterized by high user engagement and widespread social media adoption (Van Dijk et al., 2018).

As we approach the end of the 2020s, the concept of a Super Smart Society, or Society 5.0, is emerging as a new guiding principle for innovation (Fukuyama, 2018). This paradigm explicitly emphasizes a human-centric dimension (Cabinet Office, 2015; Carayannis & Morawska-Jancelewicz, 2022). For the first time, technology is viewed as an extension of the human being—aligning with the human-centric approach at the heart of this new paradigm. There is broad scholarly consensus that knowledge originates in the human mind (Polanyi, 1966; Grant, 1996). We argue that now, more than ever, KM must consolidate its position as a legitimate and distinct research field. The advent of a human-centric Super Smart Society demands a renewed focus on knowledge management.:

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Regional Technology Foresight for Material Technologies

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Abstract: The Silesian Voivodeship is undergoing rapid technological transformation and industrial restructuring. This necessitates a systematic, evidence-based approach to identifying priority technologies that will drive regional development by 2050. The purpose of this article is to present the key results from the initial diagnostic phase of the technology foresight project conducted in the Silesian Voivodeship, focusing on the material production and processing sector. The research employs a multi-method approach, PESTEL analysis, integrating Porter's Diamond Model, the emerald model and SWOT analysis, supported by desk research, expert consultations and focus group discussions to assess technological potential and strategic priorities. The study identifies three critical technology groups: metallic, polymeric, and ceramic materials, as key enablers of industrial innovation. These technologies are of particular importance in several strategic sectors, including but not limited to the automotive, aerospace, chemical, steel, pharmaceutical, renewable energy and advanced manufacturing industries. The detailed analyses were summarized in a synthetic technology assessment using four key criteria: effectiveness of technology, market age, scope of application, and impact on the technology landscape. The results indicate that global trends are increasingly shaping the world within the BANI (Brittle, Anxious, Nonlinear, Incomprehensible) framework. These trends highlight several critical challenges for future scenarios, including the green revolution, achieving climate neutrality, reducing energy and material consumption, advancing automation and digitization, and localizing supply chains while better understanding global markets. The Silesian Voivodeship's robust industrial foundation, cutting-edge research infrastructure, and a highly skilled workforce provide a solid foundation for technological innovation and commercialisation, thereby ensuring sustained economic growth. The analysis emphasises the importance of strategic investments in high-performance materials, additive manufacturing, smart materials, green technologies and advanced recycling solutions. Furthermore, the promotion of collaboration between industry, academia, and local authorities is imperative for the acceleration of technology transfer, R&D commercialisation, and the development of regional innovation ecosystems. Furthermore, the enhancement of interdisciplinary synergies and knowledge-sharing platforms will promote the adoption of emerging technologies. To guarantee a sustainable and competitive position in the global market, the Silesian Voivodeship must develop a long-term innovation strategy that integrates technological foresight with industrial policy frameworks.

Keywords: Technology foresight, Regional policy, Material production, Sustainable development

1. Introduction

For some time, a reality characterised by dynamism, volatility and unpredictability has been referred to by the term VUCA or RUPT. More recently, however, another concept has emerged that most often describes how we look at the future - the world of BANI (Cascio, 2020, Menaria, 2024). In the context of these developments, it appears that the traditional methods of analysis and planning that are commonly used are proving insufficient to effectively diagnose and forecast the development processes of a region. In response to these challenges, the foresight method is introduced, which makes it possible to anticipate changes over a longer time horizon. In addition, this method offers regional authorities the opportunity to look into the future and anticipate the needs related to the development of the innovative capacity of the regions and provides companies with important information on the processes taking place in their regional environment.

The rapid technological progress and industrial restructuring taking place in the Silesian Voivodeship (Poland) require a systematic, evidence-based approach to identifying priority technologies that will drive regional development up to 2050. The activities undertaken as part of the 'Technologies Foresight for the Silesian Voivodeship 2050' project are focused on identifying future directions of technological development in the region. Among the 12 technological areas, a group of material production was singled out, with the technology groups: metallic, polymeric, and ceramic materials, as key enablers of industrial innovation. The technological foresight of the Silesian Voivodeship carried out in the years 2024-2026 assumes the implementation of 3 stages: identification of technological areas and their diagnosis, development of scenarios and strategic findings. In this paper we concentrate on presenting the results of the research of the first stage concerning the identification of technological groups and their diagnosis. Therefore, the main purpose of this paper is a comprehensive technological foresight analysis focused on the material production and processing sector, aiming to enhance regional competitiveness, sustainability and industrial resilience. The research employs a multi-method approach, integrating PESTEL analysis, Porter's Diamond Model (Porter, 1990), the emerald model (Akpinar et

al., 2015) and SWOT analysis, supported by desk research, expert consultations and focus group discussions to assess technological potential and strategic priorities.

The paper consists of 4 parts: theoretical background, research methodology, results of research and conclusion.

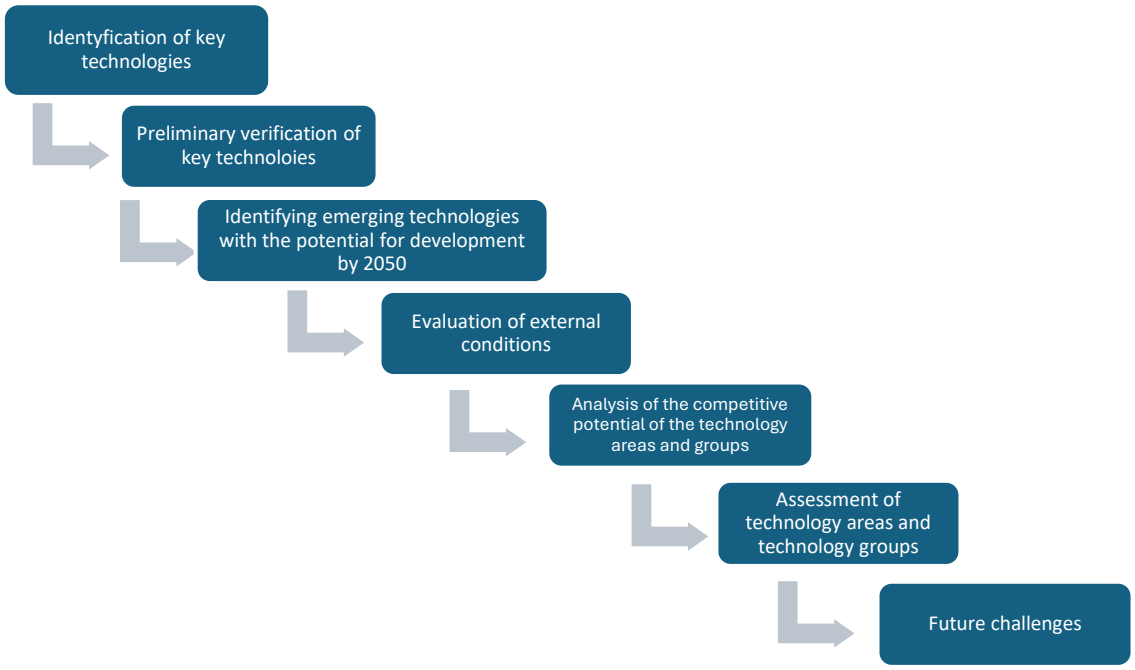
2. Theoretical Background

The term VUCA gained popularity as a tool to describe a dynamic world after the end of the Cold War. The acronym VUCA (Volatility, Uncertainty, Complexity, Ambiguity) was coined to capture the increasing volatility, uncertainty, complexity and ambiguity that characterise contemporary global threats and challenges. In contrast, the BANI Concept, or Brittle, Anxious, Non-linear, Incomprehensible, was created by anthropologist Cascio to capture the increasing complexity and uncertainty of the contemporary world. Introduced in 2020, the concept addresses global challenges such as climate change, the COVID-19 pandemic, political instability and the dynamic development of technology. Cascio introduces BANI as a more appropriate framework for today's landscape, aiming not only to explain current choices, but also to anticipate their wider consequences. He argues that VUCA and BANI are not mutually exclusive; rather, they can coexist and provide complementary insights for navigating the complexity of future scenarios (Cascio, 2020). Research shows that in view of the increasing complexity, dynamism and unpredictability of the environment that the number of regional foresight studies undertaken has increased significantly since 2014 (Amini et al. 2021). Foresight is a method to collaboratively explore, forecast and shape the future (Li, 2017; Marinković, 2022). Foresight is a structured, long-term way of continuously improving collaboration between different communities to create a shared vision of development for the medium and long term, to define its directions and priorities. In this context, foresight involves ongoing decision-making and the mobilisation of collective action (Lozano Platonoff, 2009: 209). The term “Foresight” has been used more often in the sense Martin defined technology foresight is the process involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and the emerging of generic technologies likely to yield the greatest economic and social benefits (Martin, 1995). Often equated with prediction (Jasiński 2007: 1), foresight is seen as a tool for forecasting the future. However, its main purpose is to build a vision of the future, create an enabling environment for collaboration between stakeholders and stimulate action to shape the future. This difference is important and affects the way foresight programmes are implemented, which follows directly from the definition provided. Foresight is of particular importance in the region, helping to identify directions for technological development at the regional level. It allows opportunities and threats to be identified and development strategies to be developed. There are many definitions of technology foresight. An already established classic definition describes technology foresight as the process for bringing partnership scientists, engineers, industrialists, government officials and others together to identify domains of strategic research and the emerging technologies likely to yield the greatest economic and social benefit and which in the long term will sustain industrial competitiveness (Martin & Johnston 1999). Subsequent attempts to define foresight have placed even more emphasis on the process and benefit aspect, e.g. a systematic, participatory process of gathering knowledge about the future and building medium- and long-term visions to make decisions in the present and mobilise collective action (Gavigan & Scapolo, 2001). Nowadays, it is emphasised that technological foresight activities are participatory, resulting from the interaction of a wide range of stakeholders and experts. At the same time, they are prospective in that they focus on identifying new technological opportunities, assessing potential challenges and forecasting future trends (Cuhls et al., 2024). Research confirms the effectiveness of technological foresight (TF) implemented in a collaborative open foresight model, which not only adopts a participatory approach but also promotes openness in terms of collaboration (Wiener, 2020). The foresight programme cycle consists of three iterative stages: thinking through the problem conditions, debating and shaping the future conditions. In the first phase, participants individually analyse different scenarios, then in the second phase they have an open discussion to broaden their thinking and develop a shared vision (High Level Expert Group, 2002). The final phase focuses on initiating decision-making processes and supporting leaders, which influences regional policy and socio-economic development. In the context of technological foresight, technology assessment is extremely important in the Thinking stage. Therefore, the diagnosis (thinking) stage assesses its key parameters, such as: the life cycle of the technology in terms of its competitiveness or efficiency, market age, application or impact on the technological landscape of the region.

3. Research Methodology

The research presented here forms part of a larger project, entitled "Technological Foresight of the Silesian Voivodeship 2050". The objective of this study is to establish a novel vision for the advancement of technology in the region, with a focus on the year 2050. The study encompasses three distinct phases: the identification of

technologies and their diagnosis, the development of future scenarios, and the formulation of strategic findings. The initial phase of the identification and diagnosis study comprised seven stages (cf. Figure 1).



Source: Own work.

Figure 1: Initail phase in process of technological foresight of the Silesian Voivodeship 2050

The process adopted was based on deductive reasoning, i.e. the process of deriving conclusions from what is already known. The process was supported by several methods. Extensive desk research was required for the PESTEL analysis, Porter's diamond, emerald model and SWOT. The data presented were verified during expert interviews and focus studies.

As illustrated in Figure 1, the entire process was divided into seven related stages. The first was the identification of key technologies already being developed in the region, which was achieved by analysing secondary data (desk research) including strategic documents, scientific literature and sectoral reports. This was followed by preliminary verification of these technologies through interviews with industry experts, enabling the identification of the most active actors in the region's technology ecosystem. The third stage was to identify the technologies with the potential for development in the 2050 horizon. To this end, a focus group research method was used with specialists from various fields, allowing for a multi-faceted assessment of future developments. This was followed by an analysis of PESTEL, which was conducted to assess the determinants of technology development in the context of political, economic, social, technological, environmental and legislative factors. A key step in the process was the analysis of competitive potential, carried out using a mix of Porter's diamond model and the emerald model. This allowed the identification of the structural and resource advantages of the region, taking into account demand conditions, supply conditions and supporting sectors. The research tools used at this stage of the research include economic indicators, document analyses of the industry, sector and technology area in question, and statistical data. The sixth stage of the research is the assessment of the technological area and technology group using the SWOT analysis method and synthetic technology assessment using four key criteria: effectiveness, market age, scope of application and impact on the technology landscape. The results of these analyses were validated during subsequent expert sessions, allowing the final diagnosis to be refined. The final stage of the research process aimed to validate the results of the technological area assessment and identify future challenges. It was accomplished by conducting focus groups again with the expert teams that had previously participated in the identification and analysis of the technology potential.

4. Results of the Research

4.1 Scope of the Technological Area

The Silesian Voivodeship is a dynamic region that has been undergoing intensive change for many years due to technological and economic transformation. The challenges of transformation have been joined by a pandemic,

followed by the war in Ukraine. Poland's 2021 Industrial Policy sets out five development axes for the postcovid world: digitalisation, green deal, security, localisation and high-competence society. Policy directions, objectives and instruments are formulated around these axes. The document also identifies key industries, divided into four categories (Industrial Policy of Poland, 2021):

1. traditionally strong industries facing challenges (automotive, steel, chemicals, furniture, paper);
2. industries with high growth potential and dynamics (industries: pharmaceuticals, biotechnology and medical devices, food processing, cosmetics, building materials, electrical engineering, machinery, rail transport);
3. industries with new growth prospects (industries: specialised shipbuilding and yachts, aerospace, BSP, recycling, batteries, advanced energy technologies);
4. services to industry (transport, ICT, business services).

Unpredictable variables mean that the region has to be extremely flexible in dealing with a very rapidly changing market. The experience and know-how that Silesian players have allows them to implement changes also in the production and materials processing sector. Breakthroughs in materials technology have often meant a leap forward in civilisation. Progress in the functional properties of devices, machines or objects made from them depends on the improvement of materials. A strong research and education base in the area of technology and materials research creates a favourable environment for business development. In addition, based on the report Manufacturing of Industrial Products 2019-2023 in 2023, compared to 2019, an increase in the value of sold production was recorded in 24 divisions, including those related to the area under study: metals (by 44.8%), fabricated metal products, excluding machinery and equipment (by 44.3%), rubber and plastic products (by 40.4%), paper and paper products (by 40.1%), wood and products of wood, cork and straw (by 40.0%) and products of other non-metallic minerals (by 36.9%). Poland, and in particular the Silesian Voivodeship, boasts a considerable human resources base in the field of materials technology, and research infrastructure is currently undergoing rapid development, driven by research initiatives. The technological area of materials production and processing in the Silesian Voivodeship is distinguished by the work "Priority technologies for the sustainable development of the Silesian Voivodeship". The findings of these studies have been incorporated into the 'Technology Development Programme of the Silesian Voivodeship for 2019-2030'. Moreover, the Entrepreneurial Discovery Process has identified an additional smart specialisation for the Silesian Voivodeship, namely that of energy, medicine, information and communication technology, and the green economy. These emerging industries are encompassing new or existing economic sectors and value chains, and are evolving into new industries that are future-proof for the region. The concept of emerging industries is predicated on the development of novel products, services, technologies or ideas. The subjects are in an initial phase of development, yet they are demonstrating high growth dynamics. This suggests that they have the capacity to attain new global competitive advantages. The Regional Innovation Strategy (RIS), referring to emerging industries, identifies two specific industries: creative industries and mobility industries. The PPO has identified groups of technologies that are pivotal to the development of emerging industries. These include metallic materials, polymer materials, ceramic materials, nanotechnologies and nanomaterials, as well as design and manufacturing technologies in the aerospace industry, the automotive industry, machine tools and workshop equipment, power transmission systems, special machines and equipment, and the space industry.

The brainstorming and structured interviews with experts in the diagnosis process in the study were based on the traditional division of the field of materials production and processing: metallic materials, polymeric materials and ceramic materials. Composites as a technology combining different materials were distinguished into three basic ones. This division became the basis for a strategic diagnosis of the area of production and processing of materials in the context of the technological foresight of the Silesian Voivodeship.

Metallic materials are a fundamental group of materials in materials engineering, distinguished by their wide range of applications and unique mechanical, chemical and physical properties (García-Rojas et al., 2024). In the scientific literature, their properties are analysed, among others, in terms of fatigue life, which determines the service life of components subjected to cyclic loading (Sawlan et al., 2024). Metals and their alloys are obtained through complex metallurgical processes, divided into ferrous and non-ferrous metallurgy. In Poland, steel accounts for 91% of metallurgical production, copper 7%, and lead and zinc the remaining 2%. Aluminium production ceased in 2009. Steel remains globally essential: in 2022, global crude steel production reached 1885 million tonnes, with over 3,500 grades-75% developed in the last two decades. The Silesian Voivodeship plays a major role in Poland’s metal sector. Metals and metal products make up 22% of regional industry; over 11,000 enterprises (53% of the national sector) are based there (BDL, 2023, Materials management in 2023, 2024). At the diagnosis stage, based on desk research and discussions with experts, the following specific technologies

were distinguished in the group of metallic materials technologies: steel production technologies, steel processing technologies, foundry technologies, non-ferrous metal and alloy production technologies, non-ferrous metal processing technologies, hydrometallurgical process technologies, metal structures and other finished metal products technologies, metal processing and metal coating technologies, composite production technologies, metal waste recycling technologies.

Polymeric materials and the plastics processing industry have been driving economic growth and technological and industrial development for more than a century. As complementary materials to metals, they are constantly being developed, e.g. through modifications of composition and improvements in processing technology. There has been a steady increase in the production of plastics on global and EU markets, although recent years have seen a slowdown due to a pandemic and the "plastics directive" restricting the sale of single-use products. The European plastics sector employs over 1.5 million people in almost 60 000 companies. In Poland, there are about 15 000 companies, of which more than 2 000 operate in the Silesian voivodeship (14% of the national share). Employment in the region exceeds 40 000 people (17.5% of national employment) (BDL, 2024). The Polish plastics industry, incorporating both production and recycling, is a pivotal sector. Despite the absence of prominent multinational corporations, the Silesian Voivodeship assumes a pivotal function as a regional nexus for the processing and recycling of synthetic plastics, thereby catering to the evolving market demands and addressing pressing environmental concerns. At the stage of diagnosis, following a review of the literature and consultation with experts, the following specific technologies were identified as having potential for development in the Silesian Voivodship: technologies for the production of rubber products, technologies for the production of plastic products, technologies for the production of composites, and polymer recycling technologies.

Ceramic materials are a diverse group of substances with non-metallic and inorganic character and unique physicochemical properties (González-Angulo et al., 2023). The importance of ceramic materials is particularly evident in the context of modern technologies and their extensive use in the aerospace, energy, electronics and medical industries (Chung et al., 2023). Poland is the third largest producer of ceramic tiles in Europe, after Spain and Italy. Polish applied ceramics, including porcelain, enjoy a worldwide reputation. The Silesian Voivodeship is distinguished by its wealth of ceramic raw materials, including dolomite mines, and a dynamically developing glass industry. Poland is the fifth largest producer of glass in Europe, and the Silesian Voivodeship is its main base. Glass, thanks to its optical and mechanical properties, is used in the construction and packaging industries. Its growing role is also due to new EU regulations which oblige producers to recyclability of packaging by 2030. The region is home to more than 2,000 companies in the ceramics and glass sector, accounting for 10% of the country's businesses. Employment exceeds 22,000 people (15% nationally), confirming the importance of the Silesian Voivodeship as a key centre for ceramic technologies in Poland (BDL, 2024). At the diagnosis stage, based on desk research and discussions with experts, the following specific technologies were identified in the group of ceramic product technologies with potential for development in the Silesian Voivodeship: technologies for the production and processing of glass, technologies for the production of refractory products, technologies for the production of ceramic building products, technologies for the production of porcelain and ceramic products, technologies for the production of optical fibres, and technologies for the production of composites.

4.2 Technology Assessment in the Area of Production and Materials Processing

The detailed analyses carried out in stages 1-5 of the research process were summarised in a synthetic technology assessment using four key criteria: effectiveness, market age, scope of application and impact on the technology landscape. The results of this analysis were compiled and presented in the form of a technology assessment table, which is a synthetic compilation of expert knowledge and data from R&D and market analysis. Table 1 classifies individual technologies according to four relevant dimensions:

- Effectiveness, i.e. an indication of whether the technology has a baseline, key function or is experimental,
- Market age, enabling an assessment of the maturity and potential growth dynamics of a given technology (from the introduction phase, through growth, maturity and into the decline phase),
- Technology application, referring to the area of application: material, (operation or product) technologies,
- Impact on the technology landscape, i.e. allocation to categories such as niche, critical, disruptive and deep tech.

Such a methodological approach, in line with the assumptions of regional foresight and the adopted research process, makes it possible to effectively identify the most promising technologies in the context of industrial

transformation of the Silesian Voivodeship. At the same time, it enables the detection of technologies of decreasing importance or limited impact, which may require modernisation or withdrawal from strategic priorities.

Table 1: Technology assessment in the area of production and materials processing

	Effectiveness			**Market age**				**Application**			**Impact on the technological landscape**			
Technology group/ Technologies	base technology	key technology	experimental technology	introduction phase	growth and popularity phase	maturity phase	decline phase	material technology	technology of operation	product technology	niche technology	critical technology	disruptive technology	deep tech
Technology group - metallic materials														
steelmaking technologies	x					x			x			x		
steel processing technologies		x				x			x			x		
foundry technologies		x				x			x		x			
technologies for the production of non-ferrous metals and alloys		x				x		x				x		
non-ferrous metals processing technologies		x				x			x				x	
hydrometallurgical process technologies		x				x			x			x		
technologies for metal structures and other fabricated metal products		x				x			x		x			
metalworking and metal coating technologies		x				x			x			x		
metal composite manufacturing technologies		x			x			x					x	
recycling technologies for metallic wastes		x			x				x			x		
Technology group - polymer materials														
rubber product manufacturing technologies		x				x				x	x			
production technologies for plastic products		x				x				x		x		
polymer matrix composite manufacturing technologies		x			x			x					x	
polymer recycling technologies		x			x				x			x		
Technology group - ceramic material														
glass production and processing technologies		x				x		x				x		

Technology group/ Technologies	**Effectiveness**			**Market age**				**Application**			**Impact on the technological landscape**			
	base technology	key technology	experimental technology	introduction phase	growth and popularity phase	maturity phase	decline phase	material technology	technology of operation	product technology	niche technology	critical technology	disruptive technology	deep tech
production technologies for refractory products	x						x		x		x			
production technologies for ceramic building products		x				x				x		x		
porcelain and ceramic product manufacturing technologies		x				x				x		x		
fibre optic manufacturing technologies		x			x				x				x	
ceramic composite manufacturing technologies		x			x			x					x	

Source: Own work.

The technologies assigned to the metallic materials group revolve around the manufacturing and processing of ferrous and non-ferrous metals, casting, recycling and the production of composites. The majority of these technologies have been classified as key technologies, as well as technologies in the market maturity phase. These are well-established industrial solutions that form the basis of the region's industrial activity. In particular, technologies such as steel processing and production or non-ferrous metal processing have also been labelled as critical technologies, highlighting their strategic importance for the further industrial development of the province. At the same time, it should be noted that none of the technologies in this group were labelled as deep tech, which may suggest the need for greater emphasis on innovation and development of technologies beyond standard industrial processes. Foundry technology was also categorised as a niche technology, indicating its limited but specialised potential in specific industries. This can be both an opportunity and a threat - indicating the potential for a high degree of specialisation, but at the same time the risk of limited scalability. Non-ferrous metal processing technology and metal composite manufacturing technology were identified as breakthrough technologies.

In the polymer plastics group, technologies with growing market potential were noted, particularly in the context of the development of biocomposites, green materials and recycling technologies. All technologies were flagged as critical technologies, of which 2 are in the growth and popularity phase (polymer matrix composite technologies and polymer recycling technologies). It is particularly noteworthy that polymer recycling has been classified as a critical technology, reflecting current priorities related to the closed loop economy and the regulatory requirements of the European Union. However, as with metallic materials, the absence of classification as deep tech may suggest a moderate level of R&D in this area. These technologies require further support in terms of product and process innovation, especially in the context of implementing new green material solutions. The production of polymer matrix composites was identified as a breakthrough technology.

Technologies in the ceramics group, including, among others, the production of glass, refractory products, porcelain and fibre optics, show a high degree of specialisation and technological sophistication. They include both critical technologies (glass production and processing, ceramic building products production, porcelain and ceramic products production) and breakthrough technologies (fibre optics production, ceramic composites production), which testifies to their significant impact on shaping modern economic sectors such as

optoelectronics, energy and intelligent building materials. In particular, the production of ceramic building products and the production of porcelain and ceramic products (critical technologies) have been classified as technologies with high potential for impact on the technological landscape, while being strongly rooted in the region (maturity phase). Refractory technologies have a clear tendency to be classified as niche, confirming their potential in specialised sectors with a high barrier to entry but limited competition.

The research carried out also made it possible to identify key challenges, which are becoming necessary to build scenarios. Five key challenges requiring systemic action were identified in the perspective of the long-term development of the Silesian manufacturing and materials processing sector. The first is the green revolution, aimed at decarbonising production processes and increasing environmental efficiency. In this respect, the intensification of low-carbon steel production, the use of hydrogen in steel production and the generation and storage of electricity and hydrogen, as well as the construction of financing systems for the development of green hydrogen technology in production, are of key importance. The second challenge is to achieve climate neutrality, which involves the need to support advanced copper processing, glass packaging production and plastics recycling. There is also a need for actions oriented towards improving the logistics of metal scrap recycling and supporting the development of polymer fuel cell technology. The third priority is the reduction of energy and material intensity, which should be implemented through the development of highly specialised processing technologies, especially in the areas of steel and copper. It is also advisable to undertake cooperation between enterprises in energy clusters and other solutions to reduce energy costs. The fourth challenge is automation and digitisation, which focuses on the development of competences for automation and digitisation of processes. This requires, first and foremost, aiming to reduce the digital and technological gap between large companies and SMEs, promoting automation as a driver of innovation, and creating preferential conditions for companies using automated and digital systems. Lastly, and crucial from the point of view of international competitiveness, is the challenge of locating and understanding the global market. Its implementation is based primarily on the internationalisation of companies in the field of technology, the development of international scientific and industrial cooperation networks, the intensification of the use of global resources and instruments of the digital economy, and the promotion of a new image of cooperation between science and business in international terms.

The research conducted is important for the development of regional policy. Smart specialization strategies (S3) have empowered regions to identify and cultivate their unique technological and industrial strengths, fostering competitive advantage in a rapidly evolving global economy. However, in an era of disruption (BANI world), merely recognizing these strengths is no longer enough. This is where technological foresight becomes critical—by anticipating future trends, challenges, and opportunities, regions can proactively align their innovation ecosystems with long-term economic and societal needs. Integrating foresight into S3 enables: strategic prioritization of high-impact technologies and sectors, Resilience-building against future shocks, enhanced collaboration between industries, academia, and policymakers, sustainable transitions in line with digital and green agendas. Regions that effectively combine smart specialization with foresight not only strengthen their innovation capacity but also position themselves as leaders in tomorrow's economy. This goal is also shared by the Silesian Voivodeship, which, since the beginning of the regional policy-making process, has been a leader in Poland in developing and implementing innovation strategies and technology development programs.

5. Conclusion

In the BANI world, regional policy post-smart specialization focuses on harnessing a region's unique strengths to spur innovation, economic growth, and competitiveness. Building on smart specialization strategies (S3), it emphasizes interregional collaboration, strengthens innovation ecosystems, and tackles the challenges posed by the green and digital transitions. Going beyond mere identification of competitive advantages, this evolved approach actively fosters innovation, cooperation, and sustainable development—both within and across regions. Ultimately, it aims to enhance Europe's economic resilience and global competitiveness. The research presents synthetic conclusions from the first stage of technological foresight conducted in the Silesian Voivodeship, focusing on a single area: the production and processing of materials. The article emphasizes three critical technology groups: metallic, polymeric, and ceramic materials. The assessment of these groups enabled the formulation of future recommendations and identified challenges necessary for building future scenarios. Recommendations include investing in high-performance materials, additive manufacturing, green technologies, and recycling, while fostering collaboration among industry, academia, and authorities to accelerate innovation. Promoting interdisciplinary knowledge-sharing will support technology adoption. To date, comparable research has been conducted across ten key technological areas in the region. Current efforts are focused on developing comprehensive regional scenarios, establishing Delphi groups for expert analysis and

the formulation of strategic insights. This proven methodology holds significant transfer potential, with several other Polish provinces already considering its adoption for their own strategic planning processes. A long-term, strategic approach that integrates technological foresight with supportive policies is essential to maintaining competitiveness and addressing regional challenges through coordinated, forward-looking efforts. Importantly, the key is not merely defining goals and roadmaps but, above all, initiating decision-making processes, supporting leaders, and encouraging participation in joint ventures.

While the presented conclusions may require further elaboration, the project reports already completed serve as a critical foundation for the region's technological advancement. This research delivers value not only to regional policymakers but also to industry leaders and academic institutions. The article's authors bring more than just project expertise—they have years of collaborative experience with regional authorities and actively contribute to strengthening the innovation ecosystem. Their ongoing work developing a Materials Production and Processing Observatory further demonstrates their deep engagement in shaping the region's technological future.

The main recommendation for regional stakeholders involved in regional development is to continue to analyze specific technological areas both the diagnosis of the current state and foresight activities to develop scenarios for future technology development. So far, the results of the assessment of technologies used in enterprises indicate the effectiveness of the involvement of experts from enterprises - users of technologies and academics analyzing and indicating technological trends of a global nature. This principle has so far proven itself in the creation of a regional knowledge management system in the Silesian Voivodeship, and can also be applied in other regions.

A key limitation of the article was the need for a very synthetic presentation of the research results. In addition, effective foresight requires the involvement of various stakeholder groups and reaching out to experts, which was a major challenge. The experts themselves also stressed that foresight is based on current data and knowledge, which means that it may not consider the emergence of new, unexpected changes.

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Knowledge Sharing and Customer Knowledge Management in the Context of Sustainability and CSR: A Case Study of the Fashion Industry in Poland

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Abstract: The fashion industry, long challenged by overproduction, unsustainable resource use, and labor issues, is increasingly pressured to adopt sustainable and ethical practices. Modern consumers expect brands to incorporate corporate social responsibility (CSR) into their operations and transparently communicate these efforts. Knowledge sharing (KS), understood as the internal and external exchange of information and best practices, is key in enhancing operational performance and strengthening consumer relationships. Transparent communication of CSR activities builds credibility, trust, and brand loyalty. Likewise, customer knowledge management (CKM), which refers to collecting, analyzing, and utilizing consumer data, enables companies to align marketing and CSR strategies with customer expectations. In fashion, this includes personalized messaging, eco-focused loyalty programs, and initiatives like clothing return schemes or recycling. This paper aims to examine the role of customer knowledge management and knowledge sharing in the fashion industry within the context of sustainability and corporate social responsibility. Specifically, it evaluates how fashion brands use their websites to implement these practices. A two-phase methodology was applied: (1) content analysis of selected fashion retailers' websites to assess the presence and quality of sustainability information, and (2) evaluation of consumer interaction through CSR engagement and educational content. The study, based on a proprietary evaluation tool, included both international and Polish brands. The results indicate wide variation in the communication of CSR and highlight the need for further research, given the importance of digital channels in shaping consumer awareness and behavior.

Keywords: Fashion industry, Retailers, Knowledge sharing, Customer knowledge management, e-Commerce, CSR

1. Introduction

Between 2000 and 2015, global textile production nearly doubled, and by 2030, clothing and footwear consumption is expected to grow by 63% (Ellen MacArthur Foundation, 2021; European Commission, 2022). In 2024 alone, the European fashion market reached USD 486.9 billion, with Poland emerging as a key regional player – generating USD 15.51 billion in revenue and serving as a distribution hub for Eastern Europe (Market Hub, 2024).

Currently, the average European consumer uses approximately 22 kg of textiles annually, of which around 11 kg are discarded (Adamkiewicz et al., 2022; European Commission, 2022). This contributes to the fashion industry's significant negative environmental impact – it is considered the second-largest polluting industry in the world, following the oil industry (Martínez-Martínez et al., 2024). Within the European Union, it is the fourth-largest contributor to climate change and environmental degradation, and the third-largest in terms of water consumption and wastewater production (European Commission, 2022). Globally, the fashion industry is responsible for 2–8% of greenhouse gas emissions, 20% of wastewater, and 9% of microplastic pollution in water bodies (Adamkiewicz et al., 2022).

On the other hand, there is a growing ecological and social awareness among consumers – especially millennials – who increasingly express a preference for environmentally friendly brands. According to research, 71% of millennials demand that brands be more eco-conscious and ethical, and 61% expect them to be engaged in social issues (Adamkiewicz et al., 2022). Moreover, 2 out of 5 consumers strive to purchase exclusively from socially responsible and environmentally friendly brands (Deloitte, 2023). As a result, fashion companies are being compelled to revise their practices and business strategies in response to this growing consumer awareness and evolving legal requirements (Da Giau et al., 2019; Thorisdottir & Johannsdottir, 2019; Daukantienė, 2022; Fuxman et al., 2020). Consequently, sustainability and corporate social responsibility have become key issues in modern business management in the apparel industry – including the Polish market, where one of the biggest challenges over the next three years will be aligning production with appropriate environmental standards due to regulatory pressures and customer preferences (PARP, 2023).

However, it is not enough for companies to adapt their production processes to sustainability and CSR standards – they must also effectively communicate these efforts to consumers. This is essential not only for shaping

consumer behavior but also for promoting a more sustainable future for the fashion industry (Han et al., 2017; Daukantienė, 2022). A crucial component of CSR in the fashion sector is transparency and honesty. Companies that engage in environmentally and socially responsible practices must demonstrate openness by providing consumers with accurate information about how clothing is produced, what raw materials are used, under what conditions garments are made, and where materials are sourced from. Transparency empowers consumers to make informed purchasing decisions based on the values of sustainability (White et al., 2019; Adamkiewicz et al., 2022; Mandarić et al., 2022).

In light of these developments, it is important to explore how fashion brands are leveraging tools not only to implement but also to communicate their sustainability and CSR practices. This study aims to analyze the extent to which customer knowledge management (CKM) and knowledge sharing (KS) are used by fashion retailers on their websites to support environmental and social responsibility goals. The goal is to evaluate the accessibility, quality, and interactivity of sustainability-related content provided to consumers online. The paper begins by examining how customer knowledge management and knowledge sharing support responsible branding in fashion. This is followed by an overview of best practices for communicating sustainability in online retail environments. It then presents the study's methodology, key findings on sustainability communication in e-commerce, and implications for future research and practice.

2. Customer Knowledge Management and Knowledge Sharing in Building Responsible Fashion Brands

Customer knowledge management (CKM) and knowledge sharing (KS) are essential for fashion brands aiming to ensure transparency, responsibility, and ethical engagement with both the environment and stakeholders. CKM refers to the process of collecting, analyzing, and utilizing knowledge about customers, as well as delivering knowledge to customers, with the aim of better understanding and meeting their needs, preferences, and expectations. It constitutes an important asset in online commerce (Rowley, 2002; Chaithanapat & Rakthin, 2020; Mikuła, 2023). In the fashion industry, managing such knowledge has become crucial in the context of sustainability and CSR, as it enables companies to align their products and marketing strategies with the growing interest of consumers in environmentally friendly, ethical, and transparent practices. Fashion companies that can successfully integrate customer knowledge with CSR activities can develop more effective marketing strategies, better tailor their offerings, and communicate sustainability initiatives more effectively.

Knowledge sharing is the process by which organizations exchange information, experiences, and resources among stakeholders, including consumers. Internally, it promotes integration between departments such as design, production, and marketing, enhancing the organization's understanding of CSR-related requirements and supporting the development of innovative solutions. This makes companies more resilient to changing market and regulatory conditions. In the context of CSR and sustainability, KS plays a critical role, as it enables companies to communicate their actions transparently while raising consumer awareness of responsible production, environmental protection, and ethical standards. This type of transparency provides consumers with a more comprehensive view of corporate efforts, empowering them to make informed decisions aligned with their values (Han et al., 2017; Lee et al., 2020; Daukantienė, 2022). Moreover, open reporting helps prevent greenwashing and contributes to building long-term, trust-based relationships (White et al., 2019; Adamkiewicz et al., 2022; Mandarić et al., 2022).

In the fashion sector, KS can take various forms – from educational campaigns to sustainability reports. What matters is that fashion companies not only declare ecological and ethical values but also provide consumers with accessible, relevant information to support conscious purchasing decisions (Chan et al., 2020; Mandarić et al., 2022). A brand's ability to effectively share knowledge with consumers directly impacts purchase decisions. When companies communicate their sustainable practices – such as the use of organic materials, reduced water consumption, or textile recycling – consumers are more likely to choose their products. This transparency enhances brand authenticity and credibility, which in turn fosters trust and consumer loyalty. Consumers feel more connected to brands when they know their purchases contribute positively to the environment and society (Ceylan, 2019; Lee et al., 2020; Mandarić et al., 2022).

Moreover, this approach not only strengthens consumer relationships but also helps raise ethical and ecological standards across the fashion industry. Transparent and honest communication builds consumer trust, supports public education, and fosters the development of innovative solutions within organizations. It also promotes the exchange of best practices between companies, thereby driving sector-wide improvements and enhancing the effectiveness of global sustainability efforts. CKM and KS are therefore essential for building responsible and

eco-conscious fashion brands. As consumer expectations grow and sustainability becomes one of the main criteria for evaluating companies, brands that successfully implement CKM and KS strategies gain not only consumer loyalty but also a competitive edge (Han et al., 2017; White et al., 2019; Chan et al., 2020; Mandarić et al., 2022).

3. Informing Consumers in e-Commerce About Sustainability and CSR Activities

The growing availability of smartphones and mobile devices has significantly influenced how consumers make purchasing decisions (Fang, 2020) – including in the fashion industry. The dynamic development of technology has contributed to the popularization of e-commerce, which is now one of the main sales channels for clothing and accessories (Gemius, 2024). In this context, the way information is presented on fashion brand websites is of particular importance. As Papatla (2011) notes, the layout and form of content presented on an online store's website affects not only purchasing decisions but also the effectiveness of marketing communication. Śpiewak (2023) emphasizes that if users cannot easily access the information they are looking for – both about the product and the brand's activities – the likelihood of purchase significantly decreases. Therefore, it is essential to ensure the appropriate presentation of information and adapt it to consumer shopping styles (Papatla, 2011).

Modern online commerce presents companies with new challenges, especially regarding transparency in communicating sustainability and CSR-related actions. To support businesses in responsibly providing environmental information, independent organizations under the leadership of the United Nations Environment Programme developed a document that outlines a set of best practices in this area.

According to the guidelines developed under the Consumer Information Programme of the 10-Year Framework of Programmes on Sustainable Consumption and Production, for environmental information about goods and services offered in online commerce to be of high quality and to effectively support consumers in engaging in sustainable consumption, it must meet five key principles that define the minimum requirements (Polanía Giese & Mützel, 2022). These are:

- reliability – providing consumers with accurate, substantiated, and scientifically backed information, as well as offering third-party certified products (e.g., GOTS certification),
- relevance – making all relevant data about products and their impact on sustainability available to consumers, and presenting the benefits of purchasing a given product,
- clarity – avoiding vague or ambiguous information, using clear visual communication methods, and offering consumers guidance that helps improve their shopping behavior,
- transparency – ensuring consumers have access to sufficient relevant information about products and their sustainability aspects, and tailoring messages to the needs and interests of consumers,
- accessibility – ensuring easy access to environmental information and increasing its visibility.

In addition to these minimum requirements, the document lists five additional guidelines aimed at improving how information providers communicate with consumers. These relate to engaging consumers and interacting with them to better understand their information needs. These are:

- three dimensions of sustainability – informing consumers about social, environmental, and economic benefits; providing comprehensive information,
- behavior change and longer-term impacts – engaging consumers and encouraging them to take actions that reduce environmental impact, such as product reuse,
- multi-channel and innovative approach – engaging and communicating with consumers through various channels, delivering complementary information via multiple platforms,
- collaboration – involving other stakeholders to increase consumer acceptance and trust in the information; using inclusive language,
- comparability – helping consumers choose between similar products by enabling product comparisons.

The rapid growth of e-commerce in the fashion sector creates new challenges in communicating sustainability and CSR efforts. As consumer awareness rises, the quality, accessibility, and clarity of information become critical for building trust. From a knowledge management perspective, presenting such content online constitutes a form of knowledge sharing that enhances transparency and supports informed choices. Aligning messages with consumer expectations reflects CKM principles, yet the topic remains underexplored. This study addresses this gap by evaluating how selected fashion brands in the Polish market apply these principles in their online communication.

4. Methodology

To address the research objective, a heuristic content audit was conducted – one of the most established methods for assessing online store usability and business-to-consumer communication (Kamhawi & Weaver, 2003; Krippendorff, 2013). Three experts independently evaluated each website using a custom assessment sheet, and final scores were calculated as the average of individual ratings. Two of the evaluators are also the authors of this paper. A preliminary calibration on two pilot stores (not included in the final ranking) ensured consistency in interpreting evaluation criteria.

The study was divided into two parts. In the first stage, an analysis of the key features of sustainability and CSR claims and their related attributes was conducted. This part of the research aimed to evaluate the content of fashion e-commerce websites, focusing on the presence and quality of information related to sustainability and CSR. In this study, the heuristics were developed by the *Guidelines for Providing Product Sustainability Information in E-Commerce*, published by UNEP (Polanía Giese & Mützel, 2022). Each feature was operationalized using four specific assessment attributes, resulting in a total of 20 evaluated indicators. A model set of website features and their respective attributes is presented in Table 1.

Table 1: A framework of sustainability and CSR-related characteristics of an online store and their defining attribute

Feature	Attributes defining the feature
Reliability	• Information is supported by evidence. • The store presents certifications. • The sources, data, and information used to formulate claims are trustworthy. • Information goes beyond labels and includes detailed descriptions.
Relevance	• The provided information concerns key aspects affecting the product's sustainability. • Statements present a complete picture of the product's impact, not focusing solely on its positive aspects nor omitting areas where it performs poorly. • The product exceeds legal sustainability requirements in the countries of production and sale. • The store offers filtering criteria for sustainable products.
Clarity	• Information is presented clearly and concisely. • Information is easily accessible at various stages of the shopping journey. • Pages include infographics or visualizations that are clear, unambiguous, and help convey key information. • The language used in communication is simple, understandable, and free of overly technical terminology.
Transparency	• Consumers can verify who and how the information was developed. • Information is tailored to the needs and expectations of consumers – from general and easy to understand to more complex and detailed messages where needed. • The store provides detailed information on the methods, data sources, and assumptions used to formulate the claims. • Consumers can verify the credibility of certifications and ecological labels.
Accessibility	• Information is easily accessible from the homepage or a dedicated section. • Information is visible and uniformly presented for all products. • Information is available in various formats (e.g., text, infographics, video) to meet different user preferences. • Access to information is not restricted by technical or navigational barriers.

Source: Own elaboration based on Polanía Giese & Mützel (2022).

Each attribute was evaluated on a scale from 0 to 2 points, where: 0 – criterion not met, 1 – criterion partially met, and 2 – criterion fully met. The results were used to create a ranking of stores in terms of the availability of information regarding sustainability and CSR. The maximum possible score was 40 points, and the minimum was 0 points. The higher the score, the better the availability and quality of information about sustainable products in the online store.

In the second stage, an evaluation of consumer interaction was carried out, focusing on two areas:

- incentives for engagement in sustainability and CSR activities – covering the availability of mechanisms allowing consumers to actively participate in pro-social and pro-environmental initiatives offered by the store,
- consumer education – including both the forms of delivering knowledge on ecology and ethics in fashion, and the possibilities of interaction, asking questions, and participating in dialogue with the brand.

The aim of the analysis was to determine the extent to which brands engage consumers in pro-social and pro-environmental activities, and whether they support them in making informed purchasing decisions through appropriate educational content and interactive tools. Detailed criteria assessed in this stage are presented in Table 2.

Table 2: Areas of evaluating consumer interaction in the online store

Area	Criterion
Engagement	• The store promotes the possibility of participating in social or charitable activities (e.g., clothing drives for people in need). • The store promotes participation in pro-environmental activities (e.g., recycling). • The store presents incentives for sustainable choices (e.g., loyalty programs). • The store promotes consumer actions beyond the purchase itself (e.g., repairing, reusing).
Education	• The store conducts educational campaigns or offers permanent educational content (e.g., blog, guide) on sustainable fashion. • The FAQ section includes answers to questions about sustainable fashion. • The store provides a way to contact them regarding sustainability and CSR issues (e.g., via chat or form), and consumers receive responses to their questions. • The store informs about the environmental and social impact of its operations.

The evaluation of consumer interaction was also conducted using a 2-point scale. In this case, the maximum possible score was 16 points. The higher the score, the greater the store's involvement in engaging consumers in CSR activities and disseminating knowledge about sustainable fashion.

The study examined 10 of the most popular fashion e-commerce websites in Poland (as of 2024) (Gemius, 2024), focusing solely on single-brand stores. Marketplaces were excluded due to limited control over content consistency and credibility, as the information on these platforms may originate from various vendors. Brand-owned websites offer clearer and more standardized sustainability communication, making them better suited to the adopted evaluation criteria. The analyzed stores are listed in Table 3.

Table 3: The list of stores included in the research

Retailer's brand name	Website address	Store owner
H&M	https://www2.hm.com/pl_pl/index.html	H&M Hennes & Mauritz AB
Sinsay	https://www.sinsay.com/pl/pl/	LPP S.A.
Reserved	https://www.reserved.com/pl/pl/	LPP S.A.
Zara	https://www.zara.com/pl/	Inditex S.A.
Bonprix	https://www.bonprix.pl/	bonprix Sp. z o.o.
Cropp	https://www.cropp.com/pl/pl/	LPP S.A.
House	https://www.housebrand.com/pl/pl/	LPP S.A.
Bershka	https://www.bershka.com/pl/	Inditex S.A.

Retailer's brand name	Website address	Store owner
Mohito	https://www.mohito.com/pl/pl/	LPP S.A.
Nike	https://www.nike.com/pl/	Nike, Inc.

5. Results

Due to the lack of consent from the owners of the respective brands to conduct the study, the stores were anonymized and coded from A to J. Preliminary analysis revealed that out of the 10 selected stores, 3 did not communicate or present any information related to sustainability or CSR. Even at this early stage, the results demonstrate significant diversity in the ways companies share knowledge about CSR and sustainability.

Based on the total scores awarded by the evaluation team, Store D received the highest score. Similar scores were obtained by Stores E, B, F, and A. These stores achieved at least 50% of the maximum possible score, which indicates that even the highest-ranked brands in this evaluation do not have well-developed and comprehensive CSR and sustainability communication strategies, and improvements are needed in certain areas. In terms of the evaluated criteria, these stores received comparable scores. The results are presented in Figure 1.

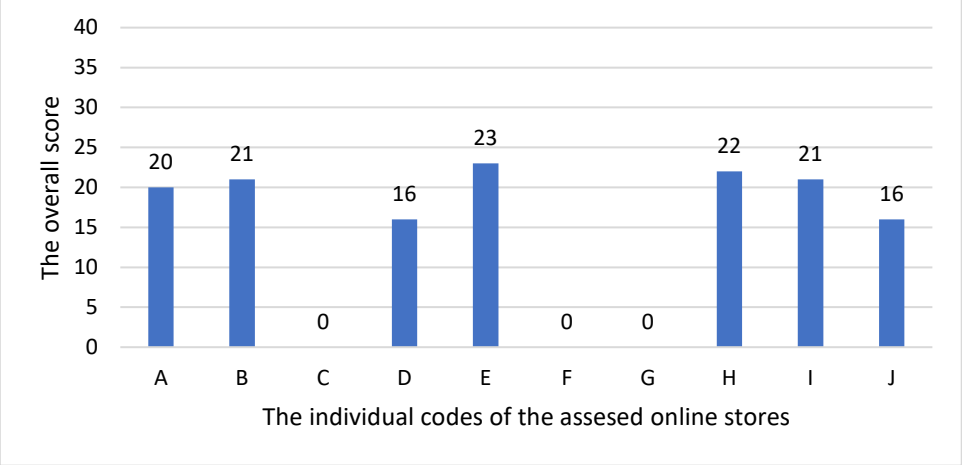


Figure 1: Evaluation results of online stores – stage 1: content analysis

Due to the fact that Stores C, F, and G did not present any content related to sustainability or CSR – making it impossible to conduct any categorization or measurement – they were excluded from the analysis assessing individual criteria. The results of the evaluation for each criterion are presented in Figure 2.

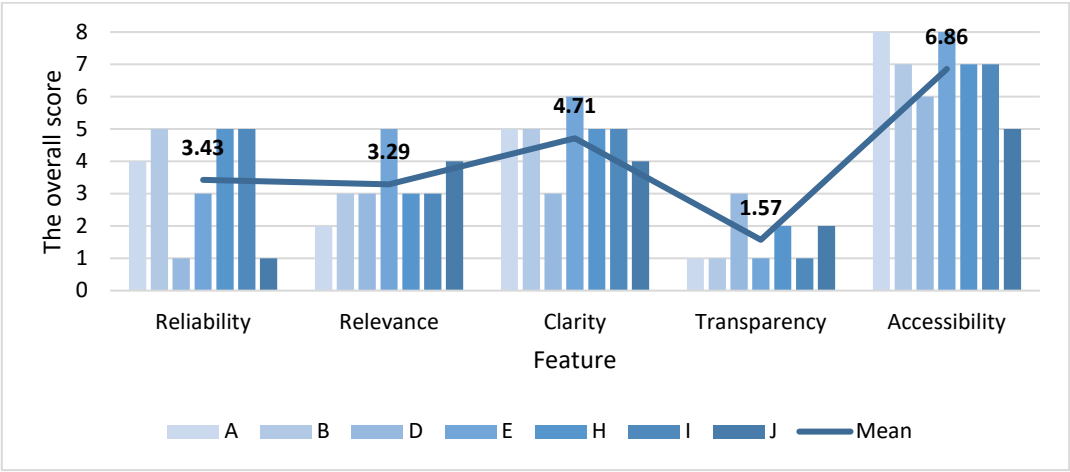


Figure 2: Evaluation results of online stores by individual feature

Considering individual criteria, the best and most consistently rated feature was "Accessibility". Most evaluated stores scored 7 or 8 points. Information regarding sustainability and CSR often appeared in dedicated sections

(e.g., “Our Responsibility,” “Sustainability”) located at the bottom of the homepage, although in some cases, this content was only available in English. When such information was included on product pages, it was presented in a standardized way across all or most of the store's assortment and appeared in various formats – textual, graphic, and audiovisual. Access to information was not restricted, e.g., by the need to create an account. This indicates that over half of the popular fashion brands operating in the Polish e-commerce market provide consumers with relatively easy access to environmental information, regardless of their technological skills or informational needs.

The second highest-rated criterion was "Clarity". In this category, most stores received 5 or 6 points. The content on the websites was presented clearly and concisely, avoiding information overload or technical jargon. This information was often available at various stages of the customer journey – both in general sections and directly on product pages – thus enhancing its usability. Many stores also used simple and easy-to-understand visual formats, such as infographics, icons, or graphic labels, which helped communicate key messages. Although not all stores reached the maximum score in this category, the overall level of clarity can be considered satisfactory. This suggests that companies increasingly understand the importance of clear, accessible, and visually appealing communication in building relationships with customers interested in sustainability and CSR.

Next in line were the criteria "Reliability" and "Relevance", both averaging slightly above 3 points. The “Reliability” criterion showed the greatest variation in scores, suggesting that fashion retailers attach varying levels of importance to the verifiability and accuracy of environmental claims. In the top-rated stores, sustainability and CSR statements were supported by concrete evidence, such as quantitative data, third-party reports, or references to industry standards. However, this information was most often presented in general sections rather than at the product level. Some stores also displayed certifications and eco-labels. In some cases, the provided information went beyond basic labeling and included data such as production location or material origin.

The “Relevance” criterion focused on whether sustainability and CSR messages were truly meaningful from the consumer’s perspective and linked to specific products offered by the store. The results were mixed. All evaluated stores did present contextual information related to their products, such as production processes, materials used, or origin of raw materials. Some stores only partially communicated a broader picture of environmental impact and included potential limitations, but most did not deliver such messages. Furthermore, only two stores offered the ability to filter sustainable products.

The lowest-rated criterion was "Transparency", indicating significant shortcomings in how transparently stores communicated their CSR and sustainability efforts. Although such content was present, in most cases it was not possible to verify who developed the statements and on what basis. One of the major limitations was the restricted ability to verify the authenticity of certifications and eco-labels. While some stores used graphical certification symbols, very few provided the data necessary for verification, such as license numbers, names of certifying bodies, or references to official databases. Additionally, detailed data regarding sources, methodological assumptions, or indicators used in formulating claims were not made available. The best-rated attribute in this category was the variation in the level of detail in the provided information, which in most stores was at least partially implemented, allowing users to adjust the depth of information to their individual needs and cognitive levels.

Regarding consumer interaction, the results revealed clear differences between the analyzed brands. The highest overall score (12 out of 16 points) was achieved by Stores A, D, and J, which provided both concrete opportunities for consumer engagement and educational content. In contrast, the lowest scores (2 points) were recorded by four stores – B, C, F, and G – which provided educational content on sustainability and CSR only after the consumer inquired via a contact form and was redirected to the corporate website of the brand. Detailed results are presented in Figure 3.

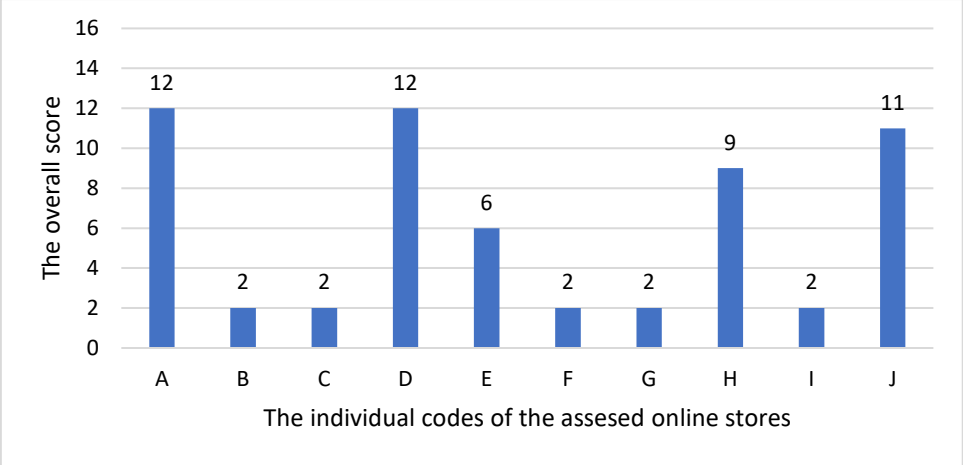


Figure 3: Evaluation results of online stores – stage 2: assessment of consumer interaction

With regard to consumer interaction, the most frequently observed practices included the implementation of used clothing collection programs, the facilitation of product returns, and the adoption of recycling initiatives. In the area of consumer education, only a limited number of online stores provided dedicated content such as blogs, FAQ sections, or contact forms explicitly addressing sustainability and CSR-related topics. The available materials predominantly focused on garment care guidance and detailed information concerning the brand's environmental and social impact.

The findings of this study are consistent with the conclusions of Tickle et al. (2024), who observed that over 90% of the fashion brands they analyzed include sustainability information on their websites – although it is not always easily accessible. These authors also noted that, despite the relatively high availability of eco-related content, verifying CSR and sustainability claims remains challenging, which is also confirmed by the results of the present study. Similarly, James and Montgomery (2017) and Egels-Zandén and Hansson (2015) pointed out that brands are more likely to share information in areas where they feel confident, while avoiding more complex or controversial topics. They also observed that sustainability information available in the consumer market is often fragmented and context-dependent – an issue also reflected in the current findings. Zhao et al. (2022), on the other hand, found that sustainability-oriented brands use both textual and visual communication, which was also evident in the analyzed examples. Conversely, the limited presence of educational and interactive tools noted in this study supports the conclusions of Chan et al. (2020), who highlighted the underutilized potential for engaging consumers in sustainability issues.

6. Conclusions

The findings revealed considerable variation in how popular fashion brands in Poland communicate their sustainability and CSR efforts online. The highest-rated brands were those that not only provided detailed information about their sustainability initiatives but also offered real opportunities for consumer engagement in CSR activities. Among the evaluated criteria, "Accessibility" received the highest and most consistent scores, indicating that fashion e-commerce platforms are increasingly effective at providing consumers with easy and intuitive access to environmental information. The "Clarity" criterion was also highly rated, reflecting a growing awareness among companies of the importance of transparent and understandable communication. "Reliability" and "Relevance" received moderate scores, suggesting a need for greater attention to the credibility of information and its contextual alignment with the products offered. "Transparency" received the lowest scores, revealing significant shortcomings in the ability to verify data sources, methodologies, and environmental certifications.

Clear disparities were also observed in the area of consumer interaction. Only a few retailers offered tangible means for consumer participation or consistent education in the field of sustainable fashion. Several retailers did not provide any relevant content within their online stores, limiting their ability to influence consumers or build trust. Only a portion of the analyzed brands consistently and transparently shared knowledge about their sustainability initiatives. The absence of coherent and visible CSR communication – even when such initiatives exist – reduces the potential to shape consumer awareness and attitudes.

From the perspective of Customer Knowledge Management (CKM), the results indicate an insufficient use of customer insights to tailor messages related to environmental and social responsibility. Only a few brands

offered avenues for two-way communication (e.g., contact forms, chats, or educational FAQs), which limits opportunities for mutual learning and for supporting consumers in making more informed purchasing decisions.

From a practical standpoint, the findings point to a need for stronger integration between sustainability/CSR strategies and communication efforts in online sales channels. Retailers should ensure that their information is not only reliable and up to date but also prominently displayed, easily accessible, and aligned with the consumer's purchase journey. Transparent, clear, and engaging communication about ecological and social initiatives can contribute to increased consumer awareness, brand loyalty, and the promotion of more responsible purchasing behaviors. Based on the findings, key recommendations include improving transparency through verifiable claims and certification data, enhancing product-level sustainability messaging, and expanding interactive and educational tools to engage consumers more deeply. The implementation of filtering options for eco-friendly products would also improve usability and trust.

Theoretically, this study adds to the discourse on CKM and knowledge sharing in digital retail environments, underscoring their relevance for shaping responsible branding practices in the fashion industry. Practically, the results highlight the strategic value of clear, accessible CSR communication as a competitive differentiator in a market shaped by growing environmental and ethical awareness.

However, the study has certain limitations. First, it focused solely on content available on brand-operated e-commerce websites, excluding social media, newsletters, or corporate websites. Second, the analysis was limited to ten of the most popular online stores, and the evaluation tool – while based on international guidelines – did not capture all possible aspects of CSR communication. Future research should consider expanding the scope by including consumer perspectives, cross-country comparisons, and the study of how communication formats influence consumer attitudes and behavior.

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Ethics declaration: This study did not require ethical approval. The analysis was based exclusively on publicly available online content provided by fashion retailers.

AI declaration: During the preparation of this work the authors used OpenAI CahtGPT4 in order to check grammar and spelling. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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The Role of the Transport and Logistics Observatory in Gathering Knowledge for Sustainable Urban Logistics Development

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Abstract: A well-functioning urban logistics system is one of the dimensions that can contribute to the realisation of a smart sustainable city. This is because smart logistics systems are characterised by the sustainability of flows, which requires the use of various types of modern logistics technologies, including storage, transport and information technologies. Sustainable city logistics aims to reduce the nuisance associated with the flow of people and goods in urban areas, while maintaining the social and economic development of the organisations and cities involved. Data on urban flows of people and goods are scattered, as are decisions on how to organise urban flows. This makes knowledge management in such a complex system extremely difficult, especially in the first stage of the process - identifying and collecting knowledge. The article points out that building knowledge resources for effective decision-making in the field of sustainable urban logistics requires the involvement of different stakeholders. Involving stakeholders in building knowledge resources for sustainable flows of people and goods in the city is a task that can be undertaken by public administration units or independent organisations set up for this purpose. The aim of this article is to define the role of an observatory in the process of gathering knowledge on logistics flows in cities. In order to achieve this objective, a literature review was carried out, focusing on the role of stakeholders in knowledge collection, the types of data and knowledge needed to achieve sustainable flows in the city, and the ways in which data and knowledge can be collected. Two models of knowledge gathering were identified - a decentralised model and a centralised model. The centralised model proposes the coordination of knowledge collection by a regional specialist observatory. The case study analysed the collection of data and knowledge by the Transport and Logistics Observatory in the Silesian Voivodeship. The result of the study is the development of a concept for the collection of logistical knowledge in cities in a centralised model and the identification of conditions and limitations for the implementation of such a concept.

Keywords: City logistics, Sustainable development, Knowledge gathering

1. Introduction

As a field of interest for both researchers and practitioners, knowledge management is developing dynamically and covering an increasingly broad range of organisational management areas. Specialists in the logistics industry also recognise the importance of knowledge management in organising material flows (Tah & Carr, 2001; Yeh, 2008; Wang et al., 2008; Cerchione & Esposito, 2016). Research on knowledge management in logistics and supply chains has inspired the development of solutions for the digital transformation of supply chains (Gagliardi, 2023). These two areas have supported each other during the fourth industrial revolution (Sartori et al., 2022). Research into knowledge gathering, processing and transfer has guided the development of IT support for material flows, highlighting the need for tools that facilitate logistics decision-making based on reliable knowledge obtained from suppliers, manufacturing companies, logistics companies, intermediaries in distribution channels and customers. Conversely, knowledge management in logistics systems, including supply chains, relies on the use of cutting-edge technological solutions that facilitate not only the accumulation and processing of knowledge (e.g. big data, cloud computing and the Internet of Things), but also enhance security (e.g. blockchain technology). However, this compatible, symbiotic development of knowledge management in supply chains and digital supply chain transformation is not sufficiently recognised in urban logistics systems. This is a particular concern in an era of challenges related to the sustainable development of cities and regions.

Urban logistics is a complex system that has a significant impact on the quality of life in a city and on the satisfaction of the city's various stakeholders. With increasing urbanisation, the problems associated with the movement of people and goods in a city are intensifying, the most important of which are pollution, noise, vibrations, land use, and thus the external costs of transport (Handbook on the external costs of transport, 2019). Awareness of this problem is increasing among both public administrations and business representatives, while it is much lower among city residents. Environmental factors negatively affected by external costs of transport are one of the three pillars of sustainable development. The environmental pillar is balanced by a social and an economic pillar. These three pillars, as the foundations of sustainable development, also shape sustainable flows of people and goods in a city (Ackerman 2005). Sustainable flows of both people and goods in the city must involve the various stakeholders who interact with the city's logistics system. Different stakeholder groups can

influence the design of sustainable flows in a city in different ways, and at the same time be affected differently by the implementation of sustainable flow solutions. This leads to stakeholders taking on different roles in the design of sustainable flows. The role of stakeholders in the design of sustainable flows in the city was studied by Przybylska, Kramarz, Dohn in 2023. The same authors studied the roles of stakeholders in sustainable flows in the city in 2023. The set of stakeholders was the same in both studies. The following groups were distinguished: inhabitants, production companies, freight transport companies (logistics operators, shippers and carriers), environmental organisations, health-related organisations, arts and culture-related organisations, public safety organisations, organisations related to sport and recreation, R&D organisations, organisations for people with disabilities, other cities, organisations related to food delivery, companies designing smart and logistic solutions in the city, courier and postal companies, hypermarkets and discount shops, wholesale and retail chains, wholesalers and retail shops, service companies, waste management organisations, other municipal companies, tourists and visitors, educational organisations, taxi corporations, transport infrastructure managers, micromobility operators, public transport organisations, estate managers, media suppliers, religious organisations, social welfare organisations.

In their research, the authors point out that working with stakeholders, including how to involve them in the policy of sustainable flows in the city, should depend on the role of the stakeholders. At the same time, taking into account the results of both studies, the authors point out that a given stakeholder group may have a different role in sustainable passenger flows in the city and a different role in sustainable freight flows in the city. The role of a stakeholder influences the way in which it is worked with. The nature of the collaboration is crucial, not only because of the involvement of stakeholders in the creation of innovative urban logistics solutions, but also because of the need to collect data on flows within the urban logistics system and on the development of logistics technologies. This data concerns both the supply and demand side of urban flows and the supply of technological solutions for the movement of people and goods. The dynamics of flows in the city, together with the technologies used in these flows, determine the efficiency of the city's logistics system, affect the quality of life of its inhabitants and the overall attractiveness of the city. Consequently, knowledge management, and in particular the ability to capture data and gather knowledge, is becoming very important. Research on these processes is well advanced at the level of companies, but insufficient at the level of urban logistics systems and sustainable flows of people and goods.

The article therefore seeks to answer the following questions:

- What data are needed to manage sustainable urban flows?
- What are the most effective mechanisms for collecting knowledge on urban logistics flows in a centralised model with a dedicated observatory?

The research was carried out on the basis of a case study of a transport and logistics observatory set up as part of the project "Network of Regional Specialised Observatories in the Entrepreneurial Discovery Process in the Silesian Voivodeship", co-funded by the European Regional Development Fund. The idea behind the Observatory is to carry out tasks related to the identification, monitoring and evaluation of flows in the city's logistics system. The case study (Chapter 4) was preceded by a literature review (Chapter 2), which led to the adoption of assumptions in the developed concept of data collection and knowledge gathering in the city's logistics system (Chapter 3). Chapter 4 also identifies the limitations of the adopted concept and suggests further research directions.

2. Interdependent Determinants of Sustainable Urban Logistics Development: Knowledge Accumulation and Stakeholder Cooperation

2.1 The Problem of Data and Knowledge Gathering as a Step in Building Knowledge Resources in the Urban Logistics System

Knowledge management is a concept that has been researched in management science for many years and the results of this research are being adopted by many organisations. Knowledge management is interpreted as the process of identifying, acquiring and using knowledge to improve an organisation's competitive position (Bennett, Gabriel 1999). Identifying knowledge sources, collecting data and knowledge and building knowledge assets is the first stage of knowledge management (Gupta et al. 2003). There are several models in the literature that present knowledge management as a cycle consisting of several processes. These processes follow one another in a defined sequence, which is cyclical because knowledge building is a continuous process. Botha et al. outlined three key processes: knowledge creation and discovery, knowledge organisation and capture, and knowledge sharing and dissemination. Another model distinguishes between: knowledge creation, knowledge

transfer and knowledge embedding processes (Armistead 1999). Some models list more specific processes, for example: knowledge goal setting, knowledge identification, knowledge acquisition, knowledge development, knowledge sharing, knowledge exploitation, knowledge retention, knowledge evaluation (North, Kumta 2018). The differences in the naming of the processes mentioned by different authors are largely due to the level of detail in the analysis and the research perspective adopted. The entire knowledge management process is supported by four factors: leadership, organisational culture, technology and a measurement system (Probst et al. 2000). The characteristics that distinguish knowledge from other traditional resources are: dominance, inexhaustibility, simultaneity and non-linearity (Loyarte et al. 2018). Interpreting these characteristics in relation to knowledge in a city's logistics system allows for a more precise design of the knowledge collection and knowledge building system. Dominance means that knowledge about material flows, disruptions in these flows, the technologies used, the demand side and the supply side determines the choice of logistics infrastructure and also the organisation of flows in the city. Knowledge is therefore of strategic importance in improving the flows in a city's logistics system. The inexhaustibility of knowledge means that the value of a knowledge resource does not decrease when it is transferred. This is particularly important in a city's logistics system as it needs to be transferred between different actors. It also means that knowledge can be used by many different users at the same time. Knowledge is therefore simultaneous. Furthermore, as research in knowledge management shows, the mere fact of having a large stock of knowledge does not directly determine competitive position. Only the ability to apply it in practice gives such an advantage. Knowledge non-negativity therefore means that organisations that have the ability to use knowledge will build their advantage more strongly with small amounts of knowledge than those that have large amounts of knowledge but are unable to use it in practice. In order to apply knowledge management methods effectively, it is essential to distinguish between information and knowledge and to understand their relationship (Sveiby 2001). Information is a specific category of knowledge: it is data, procedures, rules that have been acquired and recorded in an organisation and are publicly available. Such knowledge exists in the form of documents, manuals, training materials, instructions and other accumulated data. On the other hand, there is still knowledge hidden in the human mind, which is the result of experience, special skills and predispositions of employees (Mannonen, & Hölttä 2013). This knowledge is not written down anywhere and is an important form of intellectual capital. While explicit knowledge can be captured using appropriate databases and information technology, tacit knowledge cannot be extracted directly from even the most perfect databases. This is why the ability to collaborate with those who hold this knowledge is so important. In managing knowledge in an urban logistics system, both explicit and tacit knowledge is dispersed among various stakeholders, including government agencies, residents, infrastructure managers, logistics, manufacturing and trading companies, companies that design and provide solutions for the movement of people and goods, and many others. The innovations in urban logistics systems that have been implemented in recent years promote the collection of data, especially data on urban flows, flow times and various types of disruptions to urban flows (Wang, Pan 2024). In particular, such data is collected by intelligent transport systems. These systems can improve traffic flow by measuring the entry and exit of vehicles into the city centre (Laña, et al., 2021). An intelligent transport system can also influence the reduction of maximum vehicle speeds and reduce the number of required stops, especially on road sections where traffic incidents are common (Meneguette et al., 2018). ITS applications require information about both moving objects, such as vehicles and pedestrians in the vicinity, and stationary objects, such as road signs, infrastructure elements and road maps (Mangiaracina et al. 2017). A common database of information about these objects, used by individual ITS applications, can be stored in what is known as a Local Dynamic Map (LDM). Such maps are standardised to allow the management of vehicle sensor data and static data (related to road infrastructure and maps). Database systems are used for data collection and processing (Shimada, Yamaguchi, Takada, Sato, 2015). The application and development of Collaborative ITS Systems (C-ITS) requires the management of not only the sensor information of a single motor vehicle, but also the sensor information of other vehicles obtained through telecommunication solutions. Local dynamic maps combine the functions of managing both dynamic data from multiple vehicles and data about their surroundings (Liu, Ke 2023). Among the main effects of ITS are indicated: an overall improvement in the efficiency of the transport system (in particular, a reduction in travel time, traffic stops and incidents), an increase in the level of road safety and a reduction in the emission of harmful components of exhaust gases, dust and noise (Zhu et al. 2019). The aforementioned positive effects of implementing IST solutions would not be possible without the collection of large data sets through sensors, cameras and other means. These large data sets collected should form the basis for processing them into knowledge about urban flows. The knowledge itself will be useful when it is used to improve flows, to build the city's logistics strategy and to work with stakeholders. However, knowledge about the organisation of flows by the different actors, the choice of logistics technologies, the motives for certain decisions leading to the choice of e.g. transport mode, place of movement, etc. is scattered among the different actors of sustainable urban

flows. The acquisition of this knowledge is extremely difficult and requires the adaptation of the knowledge acquisition mechanisms to the specificities of the stakeholders. In this respect, it is useful to draw on the experience developed for data collection and the creation of knowledge resources for companies.

2.2 Data and Knowledge Gathering Mechanisms in the Urban Logistics System

Research on knowledge management in organisations has been conducted for many years. Methodologies have been developed to capture both explicit and tacit knowledge. In the area of urban logistics systems, research is not extensive. Among the few studies in this area, the expert study by Iwan et al. (2024) makes a significant contribution. Iwan et al. (2024) investigated the role of knowledge management in city logistics and identified barriers to the implementation of knowledge-based city logistics. A key element of the research process was an expert survey to which 31 international experts specialising in urban logistics issues were invited. The authors analysed the four stages of knowledge management, which according to Dalkir (2013) are "the processes of identifying, collecting, improving and transferring knowledge".

A similar interpretation is adopted in this article. However, attention is focused only on the first phase of knowledge management - knowledge asset building. Knowledge asset building requires consideration of the components of this process, including identification of knowledge sources, data collection, knowledge extraction, knowledge combination and processing. Knowledge asset building, which includes material flows as well as the development of logistics technologies in cities and the region as a whole, is important for increasing the competitiveness of cities and the smart development of logistics systems. A smart city is a sustainable city. It is thus a city that meets the needs of its current inhabitants without compromising the ability of others or future generations to meet their needs, and thus does not exceed local or planetary environmental limits (Höjer, Wangel, 2015).

Rues and Lindner (2023) conducted research on knowledge management systems in smart cities. Their research considered all aspects of smart cities and therefore did not address logistics in detail. Their analysis resulted in the development of 11 assumptions that demonstrate the role of standardisation as a knowledge carrier for replication activities and as a facilitator of stakeholder engagement. The authors highlight the importance of two features in smart city knowledge management - standardisation and replication. They show that these are important not only because of the diversity of stakeholders within cities, but also because of collaboration between cities. The authors show that standardisation in smart city replication enables comparability and supports the dissemination of diverse information through a process that builds trust and consensus. The research by Ruess and Lindner (2023) significantly enriches the conceptual assumptions of data collection and knowledge asset building in a city logistics system.

As mentioned above, technological developments are contributing to the increasing use of new technological solutions in urban logistics, integrating urban logistics systems with the smart city concept. Such solutions include ICT (Information and Communication Technology) systems and the aforementioned ITS (Intelligent Transport Systems), which allow the collection of 'big data' on urban freight transport, GPS (Global Positioning Systems) devices used in vehicles to identify their exact location, IoT (Internet of Things), blockchain technology, drones, autonomous vehicles and robots [Taniguchi et al. 2023, Zenezini et al. 2022]. Effective use of data collection tools requires a broader view of urban processes and appropriate information management. It is emphasised that city authorities should create an infrastructure that promotes an open IT environment that allows external actors to access anonymised city data.

In this context, Rantanen (2007) discusses the possibilities of using collaborative web-based applications to collect and manage local knowledge. He shows how information and communication technologies have provided opportunities for knowledge distribution, representation and sharing in this process. Open source software such as content management systems and web-based GIS (WebGIS) have made expert tools available to the layperson. GIS applications, discussion forums and map-based applications and apps are effective tools for local knowledge building. Urban planning is treated here as an interactive process in which the expert organisation (planners) and the public (residents, associations, other organisations) create, share and process knowledge. The author discussed some definitions of local knowledge and explored GIS as a way to collect, analyse and use knowledge. Theories and applications of knowledge management were explored in relation to participatory planning.

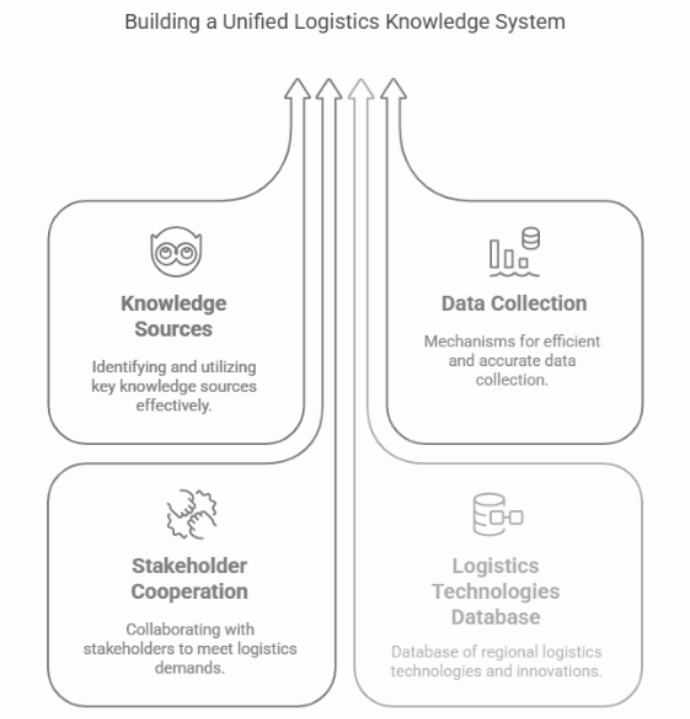
The above approaches to data and knowledge collection should be complemented by methods to capture tacit knowledge in collaboration with stakeholders in sustainable flows of people and goods in the city. The main sources of tacit (implicit/hidden) knowledge are: knowledge gained from task and project activities, knowledge

and observations from tests and studies, feedback, interviews and other forms of feedback, collaborative brainstorming and looking at the problem from another angle (Koskinen, et al. 2003). At the same time, additional characteristics of stakeholders such as altruism, commitment, experience, orientation, access to databases should be taken into account. Because of this complexity, it is worth differentiating between methods of knowledge discovery and acquisition. Each of the methods, such as expert panels, formal and informal meetings with stakeholders, free and formalised interviews, provide different stimuli and stimulate the process of tacit knowledge discovery in a different way.

3. Design of a Regional Knowledge Collection System for Sustainable Urban Logistics Development

In some cities, the plan and specific measures to achieve sustainable urban transport are introduced and implemented as strategic documents of the city government, i.e. urban transport plans or SULPs (Sustainable Urban Logistics Plans). Sometimes SULPs are separate documents, and sometimes they are part of a citywide strategy. The preparation of SULPs is also the subject of international research projects (Matusiewicz 2019). Such solutions usually include concepts of data collection and processing, while very rarely ways of collecting explicit and tacit knowledge.

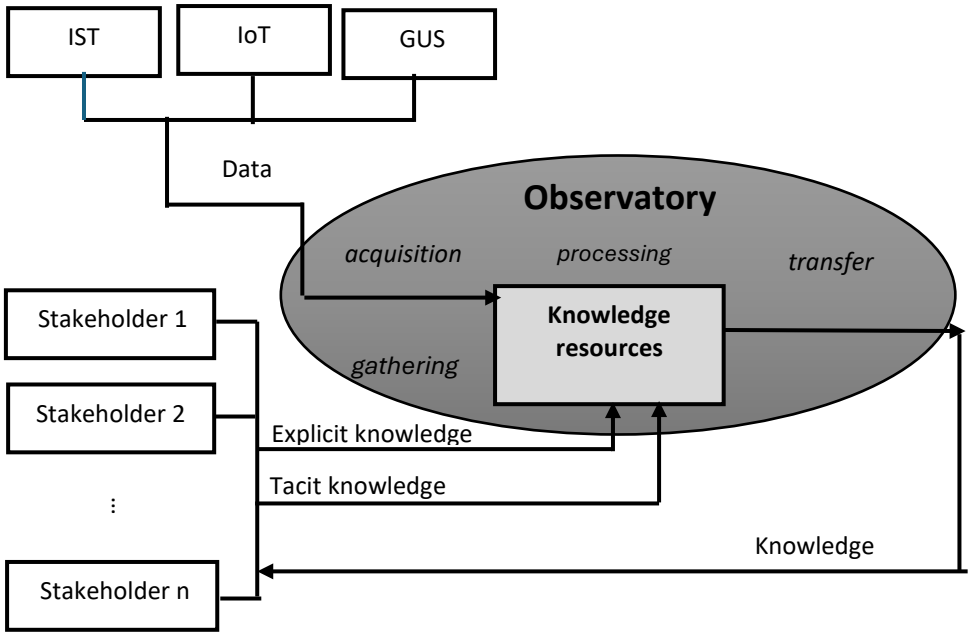
The system of knowledge collection in urban logistics systems can be developed in two variants: The first variant involves the distributed collection of knowledge in different organizational units. The second variant involves shifting the burden of collecting knowledge about urban flows to the transport-logistics observatory, which by definition should be equipped with tools for monitoring all the determinants of these flows. Thus, the second solution focuses on collecting data from primary sources (stakeholder knowledge) and combining them with data from secondary sources (databases). Data should be collected from ICT systems, Intelligent Transportation Systems and other IoT solutions, as well as from industry documents and statistical datasets (e.g. CSO). Knowledge, on the other hand, should be gathered through collaboration with stakeholders of sustainable flows of people and goods in the city (Fig.1.).



Source: Own elaboration with using AI

Figure 1: Identification of data and knowledge in building knowledge resources in the city's logistics system

In the proposed concept, on the one hand, large data sets obtained from functioning information systems and intelligent transportation systems need to be processed to feed knowledge resources. On the other hand, it is necessary to collect and acquire explicit and tacit knowledge from different stakeholders of sustainable flows of people and goods in the city. The knowledge resources created in this way can be processed, refined and transferred in further stages, thus ensuring the cycle of knowledge management.



Source: Own elaboration

Figure 2: Concept of centralized knowledge management in an urban logistics system with an observatory

The data required for the sustainable management of urban flows, which must be obtained from multiple sources, relate to factors that vary in terms of change over time. Therefore, the frequency of measurement of factors will not be constant. Examples of data with characteristics of how they are obtained are given in Table 1.

Table 1: Data extraction mechanisms

Data type	Dynamics of change	Source and acquisition method	Frequency of measurement (frequency of acquisition by the observatory)
Deviations in passenger transport by rail		Railway Transport Office (UTK)	once a year (summary of data collected by UTK)
Deviations in rail freight transport		Railway Transport Office (UTK)	once a year (summary of data collected by UTK)
Congestion in road transport		Inteligent Transportation Systems	Once a month downloading (or daily)
Environmental pollution		IoT	Daily downloading
Transport needs of inhabitants		Data based on mobile apps	Once a year
Availability of storage space		General Statistical Office	once a year (summary of data collected by UTK)
New technologies in passenger transport		Analysis of industry documents, expert research	once a year (summary of data collected by UTK)
New technologies in freight transport		Analysis of industry documents, expert research	Once a month downloading (or daily)
New ICT technologies in logistics		Analysis of industry documents, expert research	Daily downloading

Where:

Day (time)	Week	Month	Year

Source: Own elaboration

As with data collection in knowledge gathering, it is necessary to adapt the mechanisms to the type of stakeholder and the type of knowledge (Table 2).

Table 2: Knowledge gathering mechanisms

Type of knowledge	Nature of knowledge	Stakeholder group (Who has the knowledge?)	Means of knowledge acquisition and frequency
How last mile transport is organised	explicit knowledge	Manufacturing companies, service companies, logistics companies, retail chains	Market research reports and trend analyses Surveys Frequency: once every two years
Transport needs of inhabitants	explicit knowledge	Inhabitants	Surveys Frequency: once every two years
Demand for freight transport realisation by different modes of transport	explicit knowledge	Production companies, trading companies, service companies	Industry reports, workshops, symposia, seminars, cooperation with transport exchanges Frequency: once a year
Quality of transport infrastructure	explicit knowledge	Transport infrastructure managers (e.g. Directorate-General for National Roads and Motorways)	Expert panels Frequency: every two years
Factors determining the choice of means of transport in passenger transport	tacit knowledge	Inhabitants, tourists	Qualitative research (e.g. interviews, focus groups) Observation of transport users' behaviour Frequency: once every two years
Determinants of mode choice in freight transport	tacit knowledge	Production companies, logistics companies	Qualitative research (e.g. interviews, focus groups) Observation of transport users' behaviour Frequency: once every two years

Source: Own elaboration

4. Transport and Logistics Observatory as Coordinator of Knowledge Accumulation for Sustainable Urban Logistics Development in the Silesian Voivodeship

The role of specialised observatories in the innovation ecosystem is increasingly recognised. This is because specialised observatories collect knowledge and data on specific sectors of the economy, which contributes to the development of the region. At the same time, their role is to create a space for communication, cooperation and data exchange between the business community and the scientific and research community, business environment institutions and local government units. In accordance with these needs, within the framework of the system project of the Marshal's Office of the Silesian Voivodeship entitled "Regional Innovation and Management, Implementation and Monitoring of the Regional Innovation Strategy of the Silesian Voivodeship" (3rd edition) within the framework of submeasure 8.2.2 "Regional Innovation Strategies", which was implemented in 2011-2013 in cooperation with the Silesian University of Technology in Gliwice, the University of Economics in Katowice, the Central Mining Institute and the TECHNOPARK Gliwice Science and Technology

Park. The Transport and Logistics Observatory was established in 2020. The aim of the Observatory is to continuously monitor the development of technologies applied in the transport and logistics sectors of the economy of the Silesian Voivodeship. The implementation of the main objectives of the Observatory has led to a broader view of the need to collect data and knowledge on material flows and use it for the sustainable development of logistics systems of cities and enterprises. An inventory of resources and an assessment of the potential of the transport and logistics sector in the Silesian Voivodeship, as well as an analysis of the market and trends, provided the basis for building knowledge resources according to the model shown in Figure 2.

Through networking with different stakeholder groups, expert interviews and questionnaires, explicit knowledge is now being gathered. What is missing from the knowledge pool is tacit knowledge on the determinants of mode choice by stakeholders. A methodology to collect tacit knowledge is being developed. Data on pollution and delays in rail transport are regularly extracted from archival databases. Data received from the CSO are also analysed on an ongoing basis. Difficulties have been encountered in estimating traffic volumes due to the lack of access to data collected by Intelligent Transport Systems in the region. This data is not complete for the region studied. The Upper Silesia and Zagłębie agglomeration consists of 41 municipalities, including 13 cities with county rights (powiat) and 13 urban municipalities. These cities have different levels of implementation of ITS. For similar reasons, it is also difficult to assess the quality of the logistics infrastructure in the region in detail.

In evaluating the proposed concept of knowledge collection and data acquisition, it is worth revisiting the results of the Iwan et al. (2024) study. The results of the study by Iwan et al. (2024) showed that the difficulties in knowledge management in city logistics systems are mainly observed in the processes of data collection and knowledge acquisition. The main reason for the difficulties in this area is the reluctance of city users, retailers, transport and logistics operators to share information. These observations are consistent with the pilot studies carried out by the Observatory. Engaging stakeholders in the development of knowledge resources is an extremely complex process that must take place at multiple levels and utilise a variety of mechanisms. The fundamental challenges associated with the developed model system for knowledge gathering are the large number of different stakeholder groups, their different needs and capabilities, and their different knowledge and needs for cooperation with the city. Involving stakeholders in knowledge building is an extremely complex process that needs to take place at many levels and through a variety of mechanisms. Building trust in the coordinator, the specialised observatory, is crucial. Building knowledge resources therefore depends not only on the ICT technologies available at the level of measuring and monitoring individual factors and at the level of knowledge processing, but above all requires a high level of relational competence on the part of the coordinator, which in the case study is the Transport and Logistics Observatory. The coordinator must develop rules for cooperation with each stakeholder group, adapting the mechanisms for gathering explicit and tacit knowledge to suit each group. The concept developed is universal and can be applied in different regions. The limitation is the availability of data and the complexity of the methodology for collecting explicit and tacit knowledge.

5. Conclusions

Knowledge management in urban logistics systems is an extremely complex but also important problem. The centralised model for building knowledge resources for the sustainable development of urban logistics systems addresses these challenges. There is great potential in the concept developed, which should be exploited in practice and developed further on the scientific side. In particular, it is worth developing research on the relationship between the identified stakeholder roles and the tasks in which they are involved for sustainable urban flows and the way in which they work together to acquire knowledge. The knowledge gaps identified in the pilot study on the translation of knowledge resources built up by the Transport and Logistics Observatory point to the need for further research aimed at standardisation, allowing the replicability of conclusions from the analysis of knowledge resulting from the processing of explicit and tacit stakeholder knowledge and data extracted from different sources. It is important to bear in mind that the knowledge transferred will support not only the stakeholders but also the public administration, which should use it to develop strategies for sustainable flows of people and goods in the city. At the same time, it is worth considering other centralised models that can support both public administrations and stakeholders in sustainable urban flows in regions without specialised observatories. The results of the research indicate a significant need to develop knowledge management in urban logistics systems. This need is becoming increasingly urgent, not only due to the theoretical gaps identified in the transfer of solutions developed for supply chains to urban logistics systems, but also because the developed centralised model addresses these gaps. In the era of the fifth industrial revolution, new challenges are emerging relating not only to sustainable development, but also to the resilience

of urban logistics systems in the face of disruption and crisis. The authors are currently developing this area as a supplement to the presented data collection model.

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Ethics declaration: Regarding the research presented in the article “The role of the Transport and Logistics Observatory in gathering knowledge for sustainable urban logistics development", we report that no ethical approval was required for the research conducted. The research was based on the analysis of data from publicly available sources and reports from transport and logistics institutions, as well as a literature review on sustainable urban logistics development.

AI declaration: This paper uses an artificial intelligence tool to create Figure 1. This tool has been used to create a visualisation that illustrates the identification of data and knowledge in building knowledge resources in the city's logistics system.

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Knowledge Management in the Context of Sustainability Reporting

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Abstract: The evolution of sustainability reporting as a fundamental component of contemporary corporate operations is indicative of its growing significance in the modern business landscape. From being initially used as a marketing tool to build an image of corporate social responsibility (CSR), sustainability reporting has evolved into a key element expected by investors, as well as an obligation imposed by increasingly stringent legal regulations. The aim of this article is to outline how contemporary organisations are using knowledge management in the context of the increasing requirements for sustainability reporting. The article examines how knowledge management is addressed by key standards and regulations such as the Global Reporting Initiative (GRI), the Task Force on Climate-related Financial Disclosures (TCFD), the Sustainability Accounting Standards Board (SASB) and the Corporate Sustainability Reporting Directive (CSRD). The paper also presents case studies of companies that have implemented advanced knowledge management systems, such as databases, business intelligence tools and collaboration platforms, to optimise their sustainability reporting processes. The case studies show that the integration of these solutions allows for increased efficiency, transparency and credibility of sustainability reports, which in turn translates into increased trust among stakeholders. The article concludes with recommendations.

Keywords: Knowledge management, Sustainability reporting, ESG (environmental, social, governance)

1. Introduction

The integration of knowledge management and sustainability reporting presents a multifaceted challenge. However, it concomitantly offers numerous opportunities for enhancing data quality, optimising knowledge utilisation, and cultivating an organisational culture grounded in knowledge and sustainability.

Global economic development based on sustainability is only possible through broadly understood knowledge. The term sustainability is the result of understanding the three aspects: social, environmental, and economic, taking into account the costs of current decisions for future generations. Sustainability is a contemporary and current issue recognized by researchers (Al-Ali Mubarak, Gorgenyi-Hegyes and Fekete-Farkas, 2020) and is the main derivative of this concept for business. The communication of an organisation's performance in its economic, social, and environmental dimensions to the concerned parties is the principal function of the CSR (Corporate Social Responsibility) reporting process. In this way, an enterprise demonstrates the effectiveness of its actions in the area of social responsibility management.

Sustainability is usually defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability reporting is about measuring an organisation's performance against a sustainability goal, reporting on that performance and being accountable for that performance to stakeholders inside and outside the organisation. It is both a management and an accountability tool. The information provided relates to how the organisation integrates sustainability considerations into its operations and the environmental, social and economic impacts of its activities. Recent academic research and industry analysis point to the growing importance of sustainability reporting in business and investment strategies. However, the quality and transparency of these reports remain key challenges, particularly in the face of new regulations.

Sustainability reporting is an instrument of transparency regulation intended to influence management decisions (Wagenhofer, 2024). It is a management and communication tool that allows companies to assess their contribution to sustainability goals and meet regulatory requirements and market expectations. Sustainability reporting is widely analysed in the academic literature, pointing out, among other things, its impact on increasing corporate transparency , increasing stakeholder trust (Maisuradze *et al.*, 2020). The research also highlights challenges related to the quality of reported data and risks „greenwashing" (Boiral, 2013).

Knowledge is an essential resource for all businesses of the globalisation era (Nonaka and Toyama, 2015; Ding *et al.*, 2017; Abdillah *et al.*, 2018; Piersiala, 2024). Knowledge management, as a young field in management sciences, encompasses state-of-the-art methods and techniques to ensure the most effective use of knowledge resources. Over the past decades, knowledge management (KM) has proven itself not simply a trendy movement in research, but a new discipline drawing a growing body of worldwide research. It has been considered a new and influential approach in the science of management. It is KM, a new source of sustainable competitive

advantage that makes organisations all over the globe redefine their business strategies (Ngoc-Tan and Gregar, 2018).

The combination of these two elements offers numerous benefits for business management. Integrating knowledge management with sustainability reporting enhances data quality, leading to more accurate reporting and better decision-making. This integration enables more effective utilization of knowledge in sustainability reporting and strategic decision-making. Improving reporting quality and increasing the accessibility of information on an organization's sustainability performance contribute to greater transparency and credibility. Furthermore, integrating knowledge management with sustainability reporting fosters an organizational culture that values and promotes both knowledge and sustainability. Providing high-quality information on sustainability efforts also strengthens stakeholder engagement.

Nevertheless, this is a complex process that presents numerous challenges. This is due to the broad nature of both knowledge management and sustainability reporting, which can be interpreted in a variety of ways. The absence of consistent definitions and standards can impede the integration of these two areas. The evaluation and reporting of both knowledge and sustainability performance can be challenging due to the inherent complexities involved. This can result in subjective assessments and hinder the capacity to effectively compare data. The effective integration of knowledge management and sustainability reporting necessitates a commitment from both management and staff, in addition to the allocation of adequate financial and technological resources. The integration of knowledge management and sustainability reporting solutions with existing organisational systems and processes is imperative. This integration process can be both time-consuming and costly. The inclusion of data from a variety of sources, both internal and external, is a prerequisite for effective sustainability reporting. The management of such diverse data is a considerable challenge, but is worthwhile to undertake.

Knowledge management (KM) in the context of sustainability (ESG) reporting plays a crucial role in ensuring the consistency, reliability, and transparency of reported data. Knowledge management systems enable the centralization of ESG data from various departments and sources (e.g., financial, operational, and HR reports), automating reporting processes and reducing errors and inaccuracies. Data warehouses and Business Intelligence tools integrate data from multiple sources into a unified structure, enhancing consistency and transparency in reporting. Blockchain technology ensures the immutability and auditability of ESG data, preventing manipulation and facilitating regulatory compliance verification (e.g., CSRD, EU Taxonomy). Meanwhile, AI analyses large ESG datasets, identifies trends, detects inaccuracies in reports, and automates the collection and aggregation of data from different departments.

2. Literature Overview

In recent years, there has been an increasing publication of literature that combines knowledge management and sustainability issues, including reporting. These include general items (Ascani, Ciccola and Chiucchi, 2021; Arduini and Beck, 2022; Gupta and Agarwal, 2023) or alternatively, the focus can be directed towards a specific geographical area (Pizzi and Coronella, 2024; Weerasinghe, Gunarathne and Samudrage, 2025), the industry (Appiah-Kubi, 2024; Valencia-Arias *et al.*, 2024), or a given entity size. A significant number of authors have contemplated the manner in which knowledge management influences the sustainability of companies. A seminal text in this area is 'Knowledge Management and Sustainable Development' by Jack Wu, Man Fung Lo and Artie W. Nga, published in the 2018 Encyclopaedia of Sustainability in Higher Education, which examines the role of knowledge management (KM) in promoting sustainability using higher education institutions as an example. The conclusion drawn therein asserts the capacity of knowledge management to foster sustainability (Wu, Lo and Ng, 2020). However, it is important to acknowledge the challenges that arise in this process and the efforts required to overcome them. The utilisation of sustainability reporting information infrastructures by companies is indicative of the challenges encountered in generating reliable sustainability data (Troshani and Rowbottom, 2024).

The article ‘Implementing Sustainability: What Role Do Knowledge Management and Management Accounting Play? Agenda for Environmentally Friendly Businesses' is a systematic literature review based on articles from the Scopus and Web of Science databases (Broccardo *et al.*, 2025). This has resulted in the following conclusions: the role of knowledge management and management accounting systems in promoting sustainability practices within organisations has been highlighted. The integration of these two disciplines has the potential to enhance the implementation of sustainability strategies. The necessity for further research on the integration of KM in the context of sustainability was identified. The article provides a comprehensive overview of theoretical and

practical implications, emphasising the necessity of integrating knowledge management and management accounting systems to achieve environmental and social objectives.

In „Improving How Sustainability Reports Drive Change: A Critical Discourse Analysis" the authors look at how sustainability reports can more effectively initiate change in organisations (Higgins and Coffey, 2016). Using critical discourse analysis, they examine the content of reports to understand how the language and structure of communication influence the implementation of sustainable development practices. The aim is to identify ways in which reports can not only inform, but also motivate real action towards sustainability.

An article published in the Journal of Cleaner Production analyses the impact of managerial knowledge on sustainability reporting in SMEs, considering the role of perceived benefits and stakeholder pressure (Appiah-Kubi, 2024). The author argues that sustainability knowledge has a positive impact on sustainability reporting practices in SMEs. Perceived benefits play a mediating role in the relationship between sustainability knowledge and sustainability reporting, suggesting that managers who perceive the benefits of such practices are more likely to implement them. Stakeholder pressure moderates the relationship between perceived benefits and sustainability reporting, indicating that greater stakeholder pressure strengthens the relationship. The study highlights the importance of educating and raising awareness among SME managers about sustainability and incorporating stakeholder expectations into business strategies to promote more transparent and effective sustainability reporting practices.

The Journal of Innovation and Entrepreneurship has published the first attempts at a systematic review, analysis, and visualization of the scientific output on knowledge management and sustainable entrepreneurship (Alkathiri *et al.*, 2024). The findings provide a solid understanding and valuable insights into potential future research directions in these disciplines. The article serves as a valuable resource for researchers and practitioners interested in integrating knowledge management with sustainable entrepreneurship practices, offering a comprehensive overview of past achievements and suggestions for future research directions.

The article The Impact of Green Knowledge Management on Sustainable Development Goals and Green Innovation in French Economic Firms: A Structural Analysis by Abdelhaka Alioune analyses the impact of Green Knowledge Management (GKM) on the achievement of Sustainable Development Goals (SDGs) and Green Innovation (GI) in companies in France (Alioune, 2024). It concludes that GKM has a significant impact on both SDGs and GI. The analysis of individual dimensions revealed that the creation and sharing of green knowledge have a significant impact on green innovation, while the acquisition and application of green knowledge showed an insignificant impact on GI.

An analysis of the impact of knowledge management (KM) on corporate social responsibility (CSR) in the context of technology utilization was prepared for the ECKM 2024 Conference (Zoccali *et al.*, 2024). The authors state that knowledge management plays a crucial role in fostering innovation and continuous learning within organizations, which supports the effective implementation of CSR practices. Sustainable knowledge management (SKM) practices promote responsible and ethical knowledge sharing among various stakeholders. In conclusion, the authors emphasize the relevance of this topic and highlight numerous opportunities for researchers to further explore this issue, particularly in the context of rapidly evolving technologies and their impact on knowledge management and CSR practices.

In the context of sustainability reporting, knowledge management has been identified as a crucial element that supports effective data collection, processing and presentation. The following section presents examples of references to knowledge management in the context of reporting, based on company practices and reporting standards. The utilisation of artificial intelligence (AI) for the analysis of voluminous ESG data sets, blockchain for the provision of transparency and credibility to ESG data, and digital platforms for the integration of data from disparate sources and departments, have been identified as potentially beneficial in this context.

3. Interaction Within the Regulatory Framework

As a result of the expectations of public pressure and market practice, a number of regulations on sustainability reporting have emerged. These have both a local - national and international dimension. These can include:

1. European Union (EU):

- The CSRD (Corporate Sustainability Reporting Directive) has been in effect since 2024, replacing the previous NFRD directive. It introduces detailed ESG reporting requirements for companies with more than 250 employees or a turnover exceeding 40 million euros. Reports must comply with the European Sustainability Reporting Standards (ESRS), developed by EFRAG.

- The EU Taxonomy classifies economic activities as sustainable or non-sustainable in accordance with the EU's climate objectives. It applies to large companies and financial institutions.
- The SFDR (Sustainable Finance Disclosure Regulation) imposes disclosure requirements on financial institutions regarding the impact of their investments on ESG factors.

2. United States

- SEC Climate Disclosure Rule (in preparation): The U.S. Securities and Exchange Commission (SEC) plans to introduce mandatory reporting of CO_2 emissions and climate risks for publicly traded companies.

3. International Standards

- ISSB (International Sustainability Standards Board) – 2023
- GRI (Global Reporting Initiative): A voluntary standard used by over 10,000 companies worldwide.
- SASB (Sustainability Accounting Standards Board)

4. United Kingdom

- TCFD Reporting (Task Force on Climate-related Financial Disclosures): Requires the largest companies to report the impact of climate change on their business.
- UK Sustainability Disclosure Requirements (SDR) (in development): Plans to align ESG reporting with EU and ISSB standards.

Global Reporting Initiative (GRI): GRI Standard 102 includes guidelines on knowledge management. In GRI standards, knowledge management is often mentioned as a key element supporting the transparency and credibility of reports. Companies are encouraged to implement knowledge management systems that enable the efficient collection and sharing of ESG data. In GRI-compliant reports, companies often describe how they use knowledge management systems to integrate data from various departments (e.g., environmental, social, and governance). Task Force on Climate-related Financial Disclosures (TCFD): TCFD addresses knowledge management in the context of climate risks. It recommends that companies implement knowledge management systems to facilitate the identification, assessment, and monitoring of climate risks. This applies to both financial and non-financial data. Financial sector companies often describe in TCFD reports how they use knowledge management to analyse climate scenarios and report their impacts on business. Sustainability Accounting Standards Board (SASB): SASB emphasizes the importance of knowledge management in corporate governance and risk management. Companies are encouraged to implement systems that enable the tracking and reporting of key ESG indicators. In SASB-compliant reports, companies often describe how knowledge management supports decision-making processes related to sustainable development. Corporate Sustainability Reporting Directive (CSRD): The European Sustainability Reporting Standard (CSRD) requires companies to implement knowledge management systems that facilitate the collection, processing, and reporting of ESG data in accordance with the new standards. Knowledge management is crucial here to ensure the quality and consistency of reports. Companies preparing for CSRD often describe how they are modernizing their knowledge management systems to meet the new requirements.

4. Selected Case Studies

The next section presents an analysis of selected sustainability reports in terms of interaction with knowledge management. Due to the limited volume of the study, 3 entities were selected: Ergo Hestia, Danon and Calsberg.

Table 1: Analysis of the ERGO Hestia 2023 ESG report in terms of knowledge management

Area of analysis	Strengths	Weaknesses
Knowledge management structures and systems	ERGO Hestia has implemented the 'Power of Information and Community' business strategy, which integrates data analytics with employee competencies to enable effective knowledge management. Key systems include: - ISO 27001 and ISO 27017 information security management system - ensures high standards of data protection and cyber security; - Unified Blockchain technology - used for secure document delivery; - Cloud computing - upgrading IT infrastructure to allow faster access to and efficient analysis of data.	New technologies support knowledge management, but the report does not provide detailed information on the use of these tools by employees at different levels of the organisation.

Area of analysis	Strengths	Weaknesses
Training and competence development	ERGO Hestia invests in the development of its employees and business partners: - An average of 30 hours of training per year per employee, including the code of ethics, anti-corruption and ESG training; - An increase in the number of cooperating agents and brokers - a sales network development that requires effective knowledge transfer and continuous qualification improvement; - Training programmes for agents and brokers - increasing their competence in responsible sales and sustainability.	Investment in knowledge development is significant, but the report does not provide data on the effectiveness of this training, such as the pass rate of tests or the practical application of the knowledge gained.
Cooperation and knowledge sharing	Social stakeholder dialogue - ERGO Hestia engages employees, customers, suppliers and brokers in the process of shaping the ESG strategy. Dual materiality analysis - identification of 13 key ESG areas based on extensive consultation and market analysis. Business Partner Forum - particular focus on understanding the needs of clients and insurance brokers.	The company effectively integrates the knowledge of different stakeholder groups, but the report could include more information on how effectively this knowledge is put into practice.
The use of data and innovation in knowledge management	Climate and ESG risk analysis - ERGO Hestia conducted stress tests and climate sensitivity analyses. Data integration with the Internal Control System (ICS) tool - precise information gathering for risk mitigation. Data quality and cyber security certifications - including EMAS certification and the highest quality data reporting to the Information Centre of the Insurance Guarantee Fund.	ERGO Hestia uses data effectively to make strategic decisions, but it would be useful to provide examples of how specific analytics have impacted operations.

Source: Own compilation based on Ergo Hestia's Sustainability Report 2023.

The ERGO Hestia report for 2023 highlights a range of activities related to knowledge management, including both employee development and the use of information technology for data collection and analysis. The report emphasizes modern IT systems and blockchain that facilitate knowledge management. There is a strong focus on employee and agent training and competence development, as well as active knowledge exchange with business partners and stakeholders. Advanced data analytics are also used to support strategic decision-making. Unfortunately, there is a lack of detailed data on the effectiveness of the training programs. The report does not provide information on how knowledge is applied in operational practice.

Table 2: Analysis of Danone report in terms of knowledge management

Area of analysis	Strengths	Weaknesses
Knowledge management structures and systems	Danone has implemented a number of mechanisms to support knowledge transfer and organisational development: - Interdisciplinary Knowledge Management Structures are well developed and support the exchange of information between teams and stakeholders. The Centre for Analysis and Collaboration 'Food for the Future' - a think tank bringing together experts in nutrition, the environment and consumer trends; - Code of Business Ethics and Human Rights Policy - documents governing collaboration, information transparency and an ethical approach to knowledge management in the organization; - GRI (Global Reporting Initiative) platform - used to report sustainability performance and share data with stakeholders.	
Training and competence development	Danone runs numerous training and education programmes: - Employee Training - covering professional skills development, business ethics and social responsibility; - Internal Trainers Programme - enabling knowledge sharing by experienced employees; - Akademianutricia.pl - an educational platform for doctors, pharmacists and dieticians, containing scientific materials and online courses.	Investing in competence development is an important part of Danone's strategy, but the report could include more information on the effectiveness of these programmes (e.g. course completion rates).

Area of analysis	Strengths	Weaknesses
Cooperation and knowledge sharing	Danone is a member of industry organisations such as the Polish Federation of Food Producers and the Polish Plastics Pact. The company is actively involved in knowledge transfer outside the organisation, involving business partners and scientists in the development of sustainable practices. It runs educational programmes on regenerative agriculture and sustainable production. It funds research and organises educational events to promote healthy eating.	
The use of data and innovation	Robotization of processes - e.g. implementation of RPA (Robotic Process Automation) systems at Nutricia plants. Automation of laboratory analysis - awarded the Digital Lighthouse award by the World Economic Forum for innovative manufacturing processes. Uses data to optimise production and forecast consumer trends.	Investment in technology supports knowledge management, but the report does not provide specific indicators on the effectiveness of these solutions.

Source: Own compilation based on Danon together for a better tomorrow.

The report 'Together for a Better Tomorrow' presents Danone's sustainable development strategy, in which knowledge management is an important element. It encompasses the development of employee competencies, knowledge transfer within the organisation, collaboration with partners and the use of innovation and technology. The company has a clear knowledge management strategy supported by think tanks and learning platforms. It has a wide range of training and competence development programmes. It actively shares knowledge with business partners and researchers. Uses innovation and data analysis to optimise processes. Does not publish data on the effectiveness of training and education programmes. Does little to report on the impact of technology investments on day-to-day knowledge management.

Table 3: Analysis of ESG Carlsberg Polska 2023 report in terms of knowledge management

Area of analysis	Strengths	Weaknesses
Knowledge management structures and systems	The knowledge management structure is based on a clear division of responsibilities and digital monitoring tools. It will be crucial to ensure effective knowledge flow between headquarters and local branches. - Enablon - ESG data management and reporting system to track sustainability performance. - ESG Steering Committee - advises on the implementation of the Together Towards ZERO and Beyond (TTZAB) strategy and monitors progress toward goals. - Local TTZAB Goal Owners - are responsible for implementing the strategy in specific operational areas, indicating a distributed knowledge management system.	
Training and competence development	- Training programs - workshops and webinars are held for employees, especially in the areas of sustainability and the bail system. - Training on ESG policies and regulatory compliance - every newly hired employee receives training related to the Carlsberg Group's ESG policies. - Management competency management - board members and senior management are regularly involved in sustainability decision-making processes	Carlsberg Poland invests in the development of employees' knowledge, but the report does not include data on the effectiveness of these trainings (e.g., the level of participation or their impact on business decisions).
Cooperation and knowledge sharing	- Forum for suppliers and partners - the company emphasizes working with suppliers to minimize carbon footprint and improve ESG standards. - Supply chain carbon footprint study - the analysis includes the impact of business partners on CO_2 emissions, indicating the use of knowledge to optimize processes. - Evaluation: Effective knowledge management within the value chain allows Carlsberg Poland to optimize its environmental activities.	It would be useful to expand information on knowledge sharing mechanisms with suppliers

Area of analysis	Strengths	Weaknesses
The use of data and innovation	Carlsberg Poland is effectively integrating knowledge with data analytics and technological innovation, an important part of the company's long-term strategy. AI and data analytics - the company uses advanced CO_2 and data analytics to optimize production and energy consumption.	

Source: Own compilation based on Rapport ESG (Environmental, Social, Governance) Carlsberg Poland 2023.

The Carlsberg Poland 2023 ESG Report presents the company's strategy for sustainable development, innovation and operational management. When analysing the document in terms of knowledge management, it is important to highlight the clear structure of knowledge management using digital tools, active training and competence development of employees. It works with partners to transfer knowledge and optimise the carbon footprint and also uses AI and data analysis to make operational decisions. However, the report lacks data on the effectiveness of training programmes or detailed information on monitoring the effectiveness of knowledge strategy implementation.

5. Conclusion and Future Work

Knowledge management can be defined as the process of creating, using, sharing and storing information within an organisation with a view to achieving its objectives. It is an interdisciplinary concept that draws from fields such as management and information systems (Wu, Lo and Ng, 2020). The significance of knowledge management in the context of sustainability reporting is evident, as it facilitates the effective collection, processing, and presentation of ESG data by enterprises (see Danon et al., 2019). The relevance of knowledge management to sustainability reporting is further underscored by its presence in established reporting standards, including the Global Reporting Initiative (GRI), the Task Force on Climate-related Financial Disclosures (TCFD), the Sustainability Accounting Standards Board (SASB) and the Corporate Sustainability Reporting Directive (CSRD). Additionally, knowledge management practices are embedded in the operations of numerous companies, as evidenced by Danone, Ergo Hestia and Calsberg. The implementation of knowledge management systems assumes particular significance within the context of increasingly stringent regulatory requirements and stakeholder expectations.

The combination of knowledge management and sustainability reporting is a potential area of research. The strategy should address the organisation's sustainability goals and the role of knowledge management in achieving them. The employment of indicators is recommended, with the objective being the measurement of sustainability progress and the effectiveness of knowledge management. The utilisation of tools and technologies is imperative to facilitate data collection, processing, and analysis, in addition to knowledge sharing. Stakeholder engagement is identified as a pivotal element in ensuring the relevance and utility of sustainability reporting. Organizations should also engage in regular monitoring and improvement of processes related to knowledge management and sustainability reporting.

The study has some limitations. The text includes references to knowledge within the CSRD, GRI, TCFD and SASB, but due to the limitation of the article's volume in a relatively general scope. There is also a lack of specific national regulations, which could strengthen the value of the analysis. The case studies (Ergo Hestia, Danone, Carlsberg) lack detailed figures on the effectiveness of implemented solutions. The companies' reports are analysed mainly in terms of declarations, rather than actual effects of implemented knowledge management strategies.

It is worth continuing to study the use of knowledge management to improve the quality of sustainability reports. In light of dynamic changes in the political, social, economic or environmental space, it is necessary to meet current needs in such a way as not to limit the ability to meet the needs of future generations. Knowledge on this topic should be widespread and understandable.

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Integrating GenAI into Corporate Knowledge Management: A Socio-Technical Approach to Overcoming Knowledge Management Challenges

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Abstract: The growing importance of Artificial Intelligence (AI), especially Generative AI (GenAI), is revolutionising the way knowledge is handled and opening up enormous potential for corporate knowledge management (KM). The rapid development of Large Language Models (LLM) and complementary technologies such as Retrieval Augmented Generation (RAG) or knowledge graphs opens up new opportunities for corporate KM, but also presents companies with complex challenges and barriers. This study examines the integration of genAI into corporate KM, taking into account a holistic socio-technical approach. A AI4KM survey was designed to capture the current state of AI use by asking companies about their use of AI technologies. The survey aims to gain insights into the practical implementation of AI solutions, particularly in relation to KM challenges. Based on the results of the AI4KM survey, a socio-technical TOP approach (Technology - Organisation - People) for the introduction of AI-based KM will be developed, which takes into account not only technical, but also organisational and people-related aspects. By addressing these three factors, the study aims to provide a comprehensive framework that ensures the successful adoption of AI technologies in diverse business environments. Specific recommendations for the development of an effective, holistic AI strategy in KM are developed for the various barriers. Among other things, the importance of human-machine interaction will be emphasised in order to create a seamless link between human expertise and machine intelligence. The results of these studies should help companies, especially small and medium-sized enterprises (SME), to effectively use genAI technologies for their KM, to counteract the loss of knowledge due to demographic change and to increase their competitiveness. The combination of theoretical findings and practical recommendations will build a bridge between research and business practice, contributing to the successful integration of AI into corporate KM and equipping companies for the challenges of the future.

Keywords: Generative AI (GenAI), Corporate knowledge management, Knowledge management challenges, Socio-Technical approach, Human-Machine interaction

1. Introduction

In the context of increasing digitalisation, demographic change, and mounting competitive pressure, the ability of organisations to manage knowledge effectively has become more critical than ever. Knowledge is widely acknowledged as a key strategic resource and a core enabler of organisational performance, innovation, and resilience (Nonaka & Takeuchi, 1995; Spender & Grant, 1996). However, many companies still struggle to operationalise knowledge management (KM) in a way that ensures long-term availability, accessibility, and productive use of organisational knowledge.

At the same time, the emergence of generative artificial intelligence (GenAI), driven by rapid advancements in large language models (LLMs), Retrieval-Augmented Generation (RAG), and knowledge graphs, is profoundly transforming how knowledge is created, structured, and shared. Technology has long been a core enabler of KM. Traditional KM technologies such as knowledge repositories, collaborative platforms, and document management systems have shaped the way knowledge is stored and accessed. More recently, GenAI tools like ChatGPT or Microsoft Copilot have added powerful new capabilities such as contextual search, summarisation, and automation of routine knowledge tasks (Liu et al., 2023; Nazeer et al., 2023). These technologies offer new possibilities for solving long-standing KM challenges – such as knowledge silos, fragmented documentation, or the loss of critical expertise – but also introduce new risks and uncertainties (Davenport & Mittal, 2022). Understanding how these technologies affect KM effectiveness is crucial to leveraging their full potential.

Despite the increasing popularity of GenAI tools, their integration into enterprise knowledge processes remains largely experimental. Many organisations, especially small and medium-sized enterprises (SMEs), lack clear strategies for embedding GenAI in their operational and knowledge ecosystems. In addition to technological issues such as data quality and system interoperability, organisational and human factors often hinder adoption. These include unclear roles, resource limitations, lack of AI competencies, and low user acceptance (Märkel & Lundborg, 2020; BMWi, 2021; Bughin et al., 2018).

The existing literature on KM and AI integration tends to focus either on theoretical models or on specific technologies. Holistic, practice-oriented SME-applicable frameworks that address the socio-technical interplay

between technical aspects (technology) and social aspects (organisation & people) remain scarce (Grüneke et al., 2024). To bridge this gap, the present study explores how companies approach the integration of GenAI in their knowledge environments. The study is based on the AI4KM survey, which captures both current practices and perceived barriers from a socio-technical perspective.

The aim of this paper is twofold: First, it presents key findings from the AI4KM survey on the current use and challenges of GenAI in corporate KM. Second, it introduces a practical framework – the TOP approach (Technology – Organisation – People) – designed to support the effective and responsible implementation of GenAI tools in knowledge-intensive settings. By offering both empirical insights and actionable recommendations, the study seeks to support organisations – particularly SMEs – in leveraging the potential of GenAI while addressing critical implementation challenges. In doing so, it contributes to building a conceptual and practical bridge between AI innovation and KM strategy.

2. Knowledge Management and its Challenges

In today's dynamic and knowledge-intensive environments, the ability to manage knowledge effectively has become a key factor for organisational success (North & Gueldenberg, 2011). KM encompasses the structured processes of developing, preserving, sharing, applying and continuously improving asset knowledge so that it contributes to the achievement of the organisation's objectives, value creation and long-term competitiveness (ISO 30401:2018). Especially in times of demographic shifts, increased complexity, and accelerating digitalisation, KM plays a vital role in preserving know-how, facilitating collaboration, and ensuring continuity.

While KM is a strategic issue across all sectors, its relevance is particularly pronounced in SME. These companies often depend heavily on the expertise of individual employees, yet they frequently lack the formal structures, dedicated resources, or technological support to implement comprehensive KM systems. As a result, knowledge remains undocumented, is difficult to access, or is lost when people leave the organisation. Studies show that SMEs are especially vulnerable to such losses, as informal communication channels and role overlaps dominate daily operations (Orth et al., 2011; Durst & Edvardsson, 2012; Voigt et al., 2016).

In addition to structural limitations, organisations also face a number of persistent challenges in managing knowledge effectively. Fraunhofer IPK conducted a survey of companies and knowledge-intensive organisations on typical KM challenges (e.g. Orth et al., 2011; Orth et al., 2023). The results show that the five biggest challenges are 1) the (re-)use of existing knowledge for new projects and services, 2) the fast integration of new employees into the organization (e.g. systematic onboarding process), 3) the use of knowledge to optimize processes and products as well as 4) the capturing and communicating the knowledge in people's heads and 5) a lack of transparency regarding the internally available competences.

Recent meta-analytical research confirms that knowledge management technologies (KMT) are not merely supportive tools but strategic enablers of organisational performance, particularly in knowledge-intensive environments (Liu et al., 2023). In this context, GenAI technologies offer new possibilities for overcoming persistent KM challenges. Based on large language models, these tools can synthesise content, support classification and retrieval tasks, and generate knowledge artefacts like summaries or documentation. They can, for instance, support onboarding, reduce information silos, or help capture and reuse tacit knowledge (Davenport & Mittal, 2022). As Sumbal et al. (2024) argue, such AI-driven capabilities are reshaping KM from static repositories into dynamic, interactive ecosystems.

However, the integration of GenAI into organisational KM is not without its challenges. Besides technical questions around data quality and system compatibility, issues such as user acceptance, trust, and responsible use are central to successful adoption. The use of AI tools for knowledge work must therefore be embedded not only in IT infrastructures but also in organisational routines and human workflows (Märkel & Lundborg, 2020; Grüneke et al., 2024) – highlighting the need for socio-technical integration.

Although KM and AI have been widely discussed in the literature, research has predominantly concentrated only on statistical surveys, technological architectures, or abstract management models. What is lacking are empirically grounded, practice-oriented frameworks with concrete recommendations for action that acknowledge the complex socio-technical dynamics of GenAI implementation. In this context, the present paper aims to provide both empirical insights and a structured approach to guide the adoption of GenAI in KM settings. The following section presents the design and key findings of the AI4KM survey, which provide the empirical foundation for the recommendations developed in this study.

3. AI4KM-Study: Survey Design and Findings

In light of the growing relevance of GenAI for corporate KM, the AI4KM survey was developed to investigate current application practices, perceived potential, and implementation barriers. The study particularly focuses on capturing how organizations approach GenAI within knowledge processes, what challenges they encounter, and which expectations they associate with its use. Adopting an exploratory, practice-oriented perspective, the study aims to provide empirical insights into the integration of AI technologies in KM. The standardized online questionnaire was implemented using LimeSurvey and made available in both German and English to ensure accessibility across different organisational contexts. Designed to be concise and user-friendly, the survey takes approximately ten minutes to complete. Participation is anonymous and voluntary. The questionnaire comprises four thematic sections: (1) the current state of AI adoption within the company, (2) the anticipated value of GenAI for organization's most pressing KM challenges, (3) perceived barriers to GenAI implementation, and (4) Application Areas for GenAI Solutions. A detailed analysis of the content and findings of these sections is presented in the following sections.

Data collection began in June 2024, with the survey disseminated via professional and academic networks, conferences, and relevant newsletters. Due to its open distribution, the study follows a non-probabilistic, self-selection sampling approach, which is common in exploratory research on emerging technologies where early empirical orientation is prioritized over statistical representativeness. As the survey remains open at the time of writing, data collection is still ongoing, and no definitive response rate can be reported. Rather than targeting a fixed population, the study seeks to gather diverse perspectives from various sectors and organisational types. This methodological setup enables the identification of both common patterns and contextual differences in how companies engage with GenAI in their knowledge environments. It should be noted that the AI4KM survey exhibited a relatively high dropout rate across the questionnaire. As a result, the number of valid responses varies between individual questions. For each question analysed, the corresponding number of respondents (n) is indicated in parentheses. Due to these variations in the base sample, percentages may not always be directly comparable across all questions. Nevertheless, the results provide valuable exploratory insights into the current use, perceived potential, and barriers related to AI and GenAI adoption in corporate KM. They serve as a foundation for the development of actionable recommendations and a socio-technical framework that addresses the interplay between technological, organisational, and human dimensions of GenAI adoption in KM.

3.1 Status quo

The AI4KM survey shows a heterogeneous landscape regarding the current use of AI and GenAI technologies in companies (n = 64). Overall, 39% of participants reported having multiple AI solutions operational, while 17% stated that they had implemented a single solution. Another 17% have conducted pilot tests without operational deployment, and 14% are in the planning stage. Only a small share has decided against AI adoption or has yet to engage with the topic. Focusing on GenAI specifically (n= 63), 36.5% of respondents indicated that GenAI applications are already in operational use. Among those planning adoptions, around 33% expect implementation within the next 12 months, while 20% consider GenAI currently irrelevant to their organisation. These findings suggest that, although early operational use of AI is relatively widespread, GenAI adoption is still emerging, with companies either actively moving towards integration or remaining cautious due to strategic uncertainties.

3.2 GenAI for KM Challenges

Participants were asked to assess the extent to which they expect GenAI tools to support various KM activities (n = 45). The highest expectations were recorded for *fast search and identification of knowledge*, *reuse of existing knowledge for projects and services*, and *optimisation of processes and products*. Also highly rated were *structuring and networking of data repositories* and *knowledge transfer within and between projects*. Expectations were slightly lower – but still clearly positive – for *capturing tacit knowledge*, *knowledge transfer between generations*, and *supporting onboarding*. All average ratings remained above *rather agree* (4) on the six-point scale – ranging from *strongly disagree* (1) to *strongly agree* (6), indicating that companies broadly expect GenAI to contribute meaningfully across a wide range of KM tasks (see Figure 1).

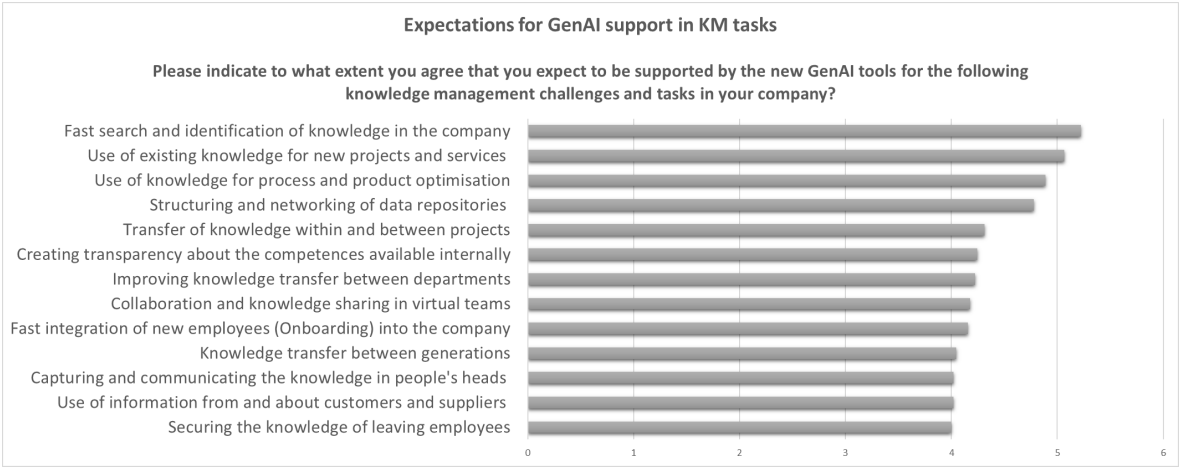


Figure 1: Expectations for GenAI support in KM tasks

Independently of GenAI use, participants ranked their three most pressing KM challenges (n = 42). The most frequently selected issues were *structuring and networking of data repositories*, *reuse of existing knowledge for new projects and services*, and *fast search and identification of knowledge*. Challenges related to *capturing and communicating tacit knowledge*, as well as *knowledge use for process and product optimisation*, also ranked highly. These results underline a strong operational need for better knowledge organisation, retrieval, and reuse mechanisms across organisations.

A comparison of expected GenAI support and current KM challenges reveals a remarkable degree of alignment. Organisations primarily expect GenAI to address exactly those areas where they perceive the most urgent KM challenges. Minor differences are observable: *knowledge transfer between projects*, while highly expected as a GenAI-supported activity, was not prioritised among the top current challenges. Overall, the findings suggest a realistic understanding among organisations regarding both the capabilities and the limitations of GenAI in KM, particularly in socially complex tasks like tacit knowledge capture.

3.3 Barriers to the Implementation of GenAI Solutions

The AI4KM survey also examined the barriers companies face when implementing GenAI solutions for KM (n = 35). Participants rated their level of agreement with several potential barriers on a six-point scale, ranging from *strongly disagree* (1) to *strongly agree* (6). The results show that concerns about *data quality and quantity* were rated highest across all categories, achieving the strongest agreement (see Figure 2). This highlights the critical dependency of GenAI applications on clean, comprehensive, and reliable datasets. Organisational challenges such as the *development of a company-specific AI strategy*, *legal and regulatory issues*, and *the provision of resources* were also identified as major barriers. Respondents indicated significant concern regarding the lack of strategic alignment, compliance risks, and insufficient investment in AI initiatives. Among people-related factors, *competence and skill development* emerged as a substantial hurdle. Many organisations reported gaps in employee capabilities to work effectively with GenAI systems, particularly in areas such as prompt engineering and critical evaluation of AI outputs. Technical barriers, notably the *integration of GenAI into existing IT infrastructures*, were likewise rated high. Additionally, *employee acceptance* and *ethical considerations* – while still relevant – were perceived as slightly less severe barriers compared to other issues. Overall, the findings indicate that companies face a complex mix of technological, organisational, and people-related challenges in embedding GenAI into their KM processes.

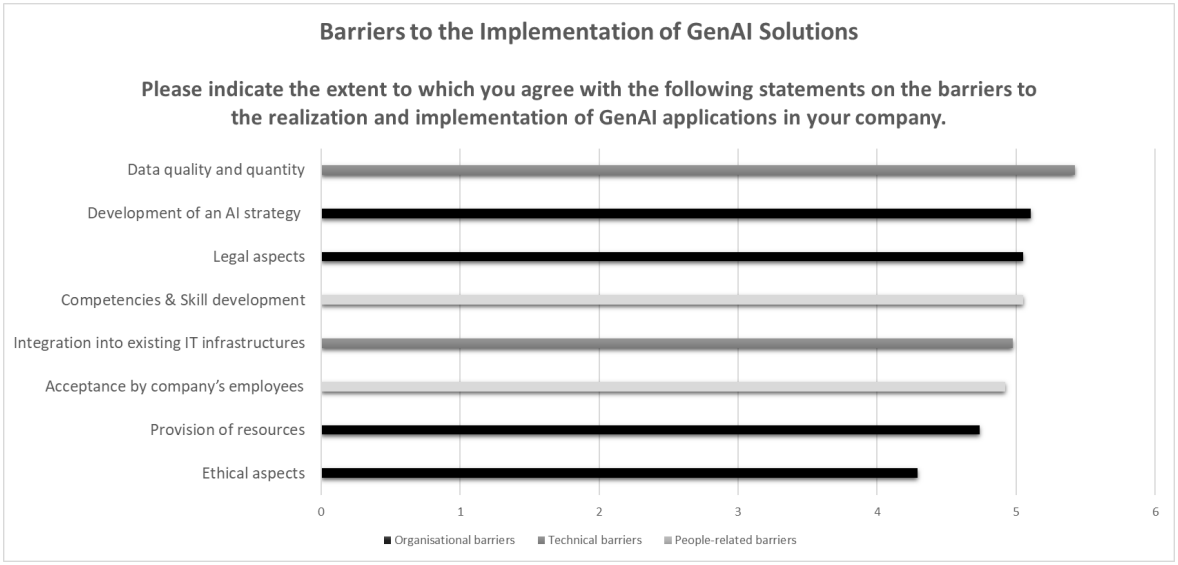


Figure 2: Barriers to the Implementation of GenAI Solutions

3.4 Application Areas for GenAI Solutions

The AI4KM survey also explored how companies assess the potential of GenAI technologies to improve various business processes and functional areas (n = 35). Respondents rated the perceived improvement potential on a scale from *no improvement potential* (1) to *very high improvement potential (6)*. The results indicate that *information technology* and *research and development* are perceived as the areas with the greatest improvement potential (see Figure 3) Companies expect GenAI to enhance IT processes, accelerate research activities, and drive innovation. Other functions, such as *logistics*, *production/service delivery*, and *marketing and sales*, were also rated highly, suggesting that organisations increasingly view GenAI as a tool for operational optimisation and customer engagement. In contrast, functions like *human resource management*, *customer service and after-sales*, *procurement*, and *controlling and finance* received moderate ratings. These areas may present additional challenges for GenAI adoption due to regulatory, relational, or process-specific complexities. Overall, the findings reveal broad optimism regarding the role of GenAI in business processes, with particularly strong expectations in technology-intensive and innovation-driven domains.

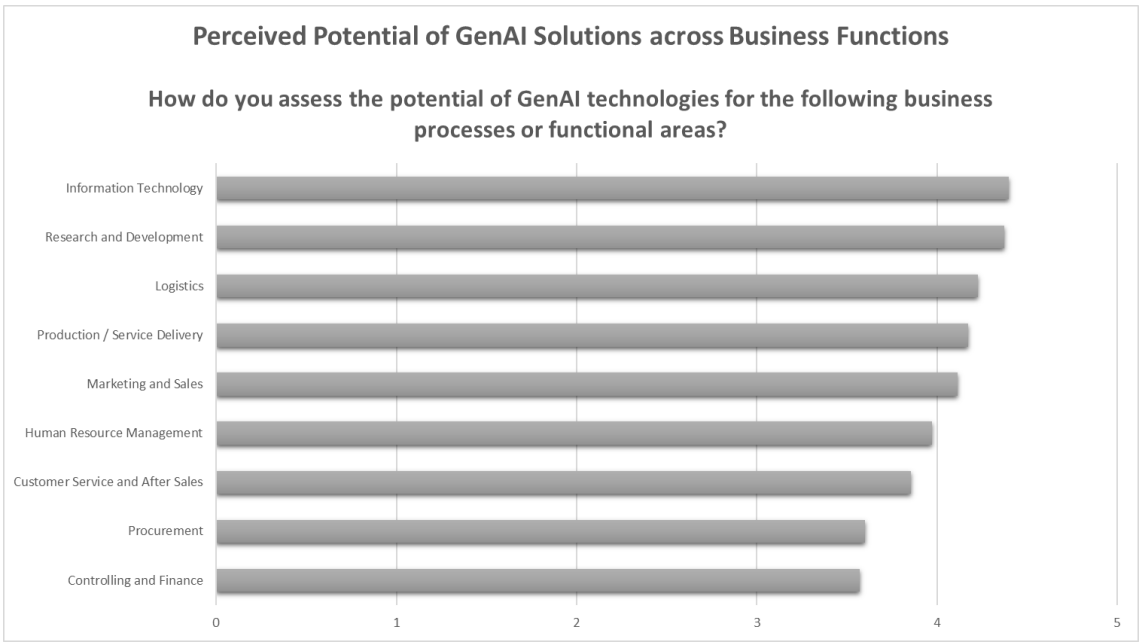


Figure 3: Perceived Potential of GenAI Solutions across Business Functions

The AI4KM survey highlights strong interest in leveraging GenAI for KM and broader business processes. Organisations primarily seek support in knowledge retrieval, reuse, and data structuring, while facing barriers related to data quality, strategy development, and employee competencies. Overall, the findings suggest a cautiously optimistic view: GenAI is seen as a key enabler, yet its successful integration depends on addressing technical, organisational, and human factors simultaneously.

4. Towards Socio-Technical Integration: The TOP Framework for GenAI in Knowledge Management

The integration of GenAI technologies into KM presents both unprecedented opportunities and complex challenges for organisations. While technical innovations such as LLMs and RAG systems offer powerful tools to enhance knowledge processes, their successful and responsible implementation requires more than technological readiness alone. The findings of the AI4KM survey underline that technological, organisational, and human factors all play critical roles in enabling or hindering the adoption of GenAI solutions for KM. To address these interdependent dimensions systematically, this chapter proposes a socio-technical integration framework based on the principles of the established TOM model (Technologie–Organisation–Mensch) and tailored to the specific challenges of GenAI. The adapted *TOP framework* (Technology – Organisation – People) serves as a structured orientation for practice and provides actionable guidance for overcoming identified barriers and achieving sustainable GenAI-supported KM.

4.1 Deriving the Socio-Technical TOP Framework for GenAI Integration in Knowledge Management

The theoretical foundation for the integration framework proposed here draws on the socio-technical TOM model, originally developed by Bullinger, Wörner, and Prieto at the Fraunhofer IAO in 1997 (Bullinger et al., 1998). TOM established that successful KM initiatives depend on the simultaneous and balanced consideration of technological infrastructures, organisational structures, and human factors.

Building on this tradition, researchers at Fraunhofer IPK, including Heisig and Orth further advanced the socio-technical perspective by operationalising TOM principles in practice-oriented frameworks such as GPO-WM® and ProWis (Heisig & Orth, 2005; Orth et al., 2011). These models showed that sustainable KM cannot be achieved through IT solutions alone but requires organisational alignment and human-centred strategies.

In the context of GenAI integration, this socio-technical view gains even greater relevance. While GenAI technologies can automate content generation, support knowledge retrieval, and accelerate knowledge structuring, their full potential can only unfold if embedded in appropriate processes, supported by user competencies, and governed by responsible organisational practices.

The AI4KM survey results confirm the necessity of this integrated approach. Respondents identified major barriers across all three dimensions – technology (e.g., poor data quality, IT integration issues), organisation (e.g., lack of AI strategy, legal uncertainties, lack of resources), and people (e.g., skills gaps, employee resistance).

Against this background, the **TOP framework** is proposed as an adapted, practice-oriented extension for the specific case of GenAI-supported KM:

- **Technology (T)** addresses the deployment, integration, and quality management of GenAI solutions. The focus lies on improving data infrastructures, ensuring interoperability, and embedding GenAI systems seamlessly into existing IT landscapes.
- **Organisation (O)** focuses on strategic alignment, AI governance, regulatory compliance, and resource planning. It ensures that GenAI initiatives are aligned with KM and business objectives and that legal and ethical standards are met.
- **People (P)** targets the development of user competences (e.g., AI literacy, prompt engineering) and the facilitation of change management processes that foster acceptance, trust, and human-machine collaboration.

This three-dimensional framework forms the conceptual basis for deriving targeted recommendations for action, which are detailed in the following section.

4.2 Addressing the Barriers: Recommendations for Practice

The barriers analysed in the AI4KM survey demonstrate that organisations must adopt a holistic, coordinated approach to realise the benefits of GenAI technologies for KM. Based on the adapted socio-technical TOP

framework (Technology – Organisation – People), the following recommendations provide actionable guidance for overcoming the key obstacles identified.

Technology

Ensuring and continuously improving data quality is a foundational requirement. Organisations should establish structured processes for data cleansing and maintenance to guarantee that GenAI systems are trained and operated on clean, representative, and up-to-date datasets (BMWi, 2021; PwC, 2019; Davenport & Ronanki, 2018). In addition, it is crucial to provide sufficient data volumes for GenAI applications. Researchers highlight that the generation and augmentation of synthetic data can significantly enhance training datasets, especially when real data is scarce (BMWi, 2021; Davenport & Ronanki, 2018; Goodfellow et al., 2016; Shorten & Khoshgoftaar, 2019). Building modular and scalable GenAI architectures that ensure seamless integration into existing IT infrastructures is essential. Such architectures should prioritise interoperability, data security, and scalability from the outset (Grüneke et al., 2024).

Organisation

Developing clear legal compliance frameworks is essential to manage risks related to data use and AI-generated content, particularly regarding data protection, liability, and transparency (Ogolla et al., 2020; BMWi, 2021). In parallel, organisations are advised to define ethical guidelines that prioritise fairness, transparency, and non-discrimination (BMWi, 2021; Ogolla et al., 2020). Strategic planning and early securing of resources – both financial and human – is a key success factor for sustainable GenAI initiatives. (Grüneke et al., 2024; BMWi, 2021). The inclusion of interdisciplinary teams, particularly those with domain-specific knowledge, and a proactive resource strategy significantly enhance implementation feasibility (Ogolla et al., 2020). Finally, a company-specific AI strategy is needed that aligns GenAI efforts with overarching business and knowledge management goals to ensure long-term value creation (Grüneke et al., 2024; Liebowitz, 2001).

People

To address skills gaps among employees, companies should launch targeted training programmes focused on AI fundamentals, media competence, and prompt engineering. Such measures build AI literacy and enable confident tool usage (Grüneke et al., 2024; BMWi, 2021). Structured change management processes should accompany the rollout of GenAI solutions to foster acceptance. Transparent communication, participation formats, and support services are critical to reducing employee fears and building trust (Ogolla et al., 2020; Grüneke et al., 2024; Osterloh & Frey, 2000). Establishing human-machine interaction (HMI) as a guiding principle is essential. Organisations should emphasise augmentation rather than substitution of human capabilities, enabling creative collaboration between employees and GenAI systems (Ogolla et al., 2020; Brynjolfsson & McAfee, 2014; Daugherty & Wilson, 2018).

In line with the socio-technical TOP framework and based on the AI4KM survey findings, the following table summarises the key barriers to GenAI integration in KM. Each identified barrier is mapped to the corresponding TOP dimension and paired with specific recommended actions and their anticipated impacts (see Table 1). The recommendations are intended to support organisations in systematically addressing technological, organisational, and people-related challenges, thereby creating the conditions for a responsible, sustainable, and human-centred deployment of GenAI in KM contexts.

Table 1: Actionable Recommendations along the TOP Dimensions

TOP Dimension	Barrier	Recommended Action	Expected Impact
Technology	Poor data quality and availability	Establish structured processes for data cleansing and maintenance; enrich datasets through synthetic data generation where needed	Higher reliability and performance of GenAI systems
	Integration challenges with existing IT infrastructures	Build modular, scalable, and interoperable GenAI architectures with early focus on interfaces, data security, and scalability	Seamless integration and scalability of GenAI solutions
Organisation	Lack of a company-specific AI strategy	Develop a coherent GenAI strategy linked to KM and business objectives	Strategic alignment of GenAI initiatives with organisational goals

TOP Dimension	Barrier	Recommended Action	Expected Impact
	Legal and ethical uncertainties	Create clear compliance frameworks for data usage and content generation; define ethical principles (e.g., fairness, transparency) for GenAI use	Reduced legal risks; enhanced organisational trust and ethical integrity
	Resource bottlenecks	Plan and secure interdisciplinary expertise and financial resources early	Feasibility and sustainability of GenAI implementation projects
People	Skills gaps regarding GenAI usage	Launch targeted training programmes on AI literacy, media competence, and prompt engineering with practical learning scenarios	Increased employee capabilities and confident GenAI tool use
	Employee resistance to GenAI adoption	Implement structured change management initiatives with transparent communication and participative formats	Higher acceptance, reduced resistance, strengthened collaboration culture
	Lack of a human-machine collaboration culture	Establish augmentation as the guiding principle for human-machine interaction, promoting collaborative and complementary working models	Enhanced creative collaboration and meaningful division of tasks between humans and GenAI

The overview illustrates that successful GenAI integration into KM requires coordinated interventions across all three TOP dimensions. While technological readiness remains crucial, strategic governance structures, legal and ethical safeguards, competence development, and a culture of human-machine collaboration are equally important for achieving long-term effectiveness and organisational acceptance of GenAI-supported knowledge systems.

5. Conclusion and Outlook

GenAI offers unprecedented opportunities for transforming KM, especially for SMEs with limited resources. By automating content generation, enhancing knowledge structuring, and improving information retrieval, GenAI technologies can help SMEs overcome traditional challenges related to scalability, knowledge retention, and accessibility.

The results of the AI4KM survey show that companies are well aware of the potential of GenAI for enhancing their knowledge processes. High expectations were recorded for tasks such as the reuse of existing knowledge, the structuring of data repositories, and the acceleration of internal knowledge flows. However, the practical implementation of GenAI in KM remains hesitant. Many organisations are still in pilot stages, with limited operational experience, and only a small share has developed strategic, large-scale initiatives for GenAI integration. The analysis of barriers confirms that technology is only part of the equation. In addition to technical obstacles such as data quality and IT integration, organisational challenges (e.g., lack of AI strategies, insufficient resource planning) and human factors (e.g., skills gaps, resistance to change) present significant hurdles. These findings underscore the necessity of adopting a comprehensive, socio-technical perspective when implementing GenAI in KM.

The TOP framework (Technology – Organisation – People) developed in this study provides a structured orientation for addressing these challenges. It highlights that successful and sustainable GenAI integration requires balanced attention to technological infrastructures, organisational strategies, and human competencies alike. By systematically addressing these three dimensions, organisations can better manage the complexity of GenAI adoption and enhance the chances of achieving meaningful improvements in knowledge practices.

This paper contributes to the discourse on AI in KM by proposing an empirically grounded socio-technical framework, that offers practitioners actionable guidance to overcome implementation barriers and align AI with business goals. By combining theoretical insight and managerial relevance, the study strengthens the link between academic research and organisational application.

Future research should focus on systematically operationalising the individual dimensions of the proposed framework across diverse organisational contexts. This entails developing concrete tools, methodologies, and support mechanisms to translate the elements of *Technology*, *Organisation*, and *People* into practical, context-sensitive interventions. A key initiative in this regard could be the development of a GenAI-specific readiness assessment (AI-Readiness-Check). Based on the TOP framework, such an instrument could help organisations assess their current level of preparedness for GenAI-supported KM initiatives, identify gaps in their

technological, organisational, and human capabilities, and prioritise actions accordingly. A tailored readiness assessment would offer a valuable starting point for companies aiming to move from experimentation to systematic, large-scale GenAI integration. Overall, GenAI holds immense promise for reshaping KM. However, its full potential can only be realised through holistic, well-coordinated approaches that bridge technology, organisation, and people.

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Agile Mindset Leaders and Their Experience-Based Tacit Knowledge Absorption Mastery: Polish-Finnish, Technological, and Non-Technological Leaders' View

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Abstract: Agile mindset leaders are central to agile organizations driven by knowledge. Previous studies have enabled us to assume that constant, tacit knowledge acquisition appears to be a valuable effect of constant agile learning, contributing to the intellectual mastery of agile leaders. Therefore, the question to which this study is dedicated is: Which competencies (demonstrated skills) do agile mindset leaders perceive as critical for their tacit knowledge acquisition? As previous studies have shown, technological and non-technological mindsets can see agile leadership differently. Therefore, this study aims to investigate whether there are any differences in the informal learning habits of agile mindset leaders in the IT sector compared to other sectors, as perceived by employees in Poland and Finland. A qualitative, interpretive approach, supported by MAXQDA software, is employed to achieve this. Results showed that contextual learning, learning from experiences (both positive and negative), learning from failures and mistakes, critical thinking, constant analysis and synthesis, seeking understanding, and systematic self-development are habitual skills – key informal learning activities employed by agile mindsets. Additionally, employees from other sectors highlighted the value of agile mindset leaders' habit of supporting others; IT employees specified these habits as giving constructive feedback and serving as mentors or coaches. Other sector employees also emphasized that 'scenario thinking' and self-discipline are habits that support the informal learning of agile mindset leaders. Apart from minor details, no significant differences were noted between Poland and Finland.

Keywords: Agile mindset leaders, Tacit knowledge, Knowledge-driven organizations, Informal learning

1. Introduction

A perpetual commitment to learning is the key to comprehending the dynamic nature of the surrounding environment that matters for adaptability. Bryans (2017) discovered that 80% of employee learning at work occurs informally and is entirely unplanned, incidental, and mainly experiential. Therefore, most organizational learning is tacit.

Experts' inarticulate scientific knowledge supports their seemingly intuitive judgment, which is, in fact, rooted in the professional tacit knowledge they have collected over time from various practical contexts (Patel et al., 1999; Boerma et al., 2024). So, tacit knowledge-based experts' intuition generates innovative, contextually tailored solutions. The informal aspects of working practice are crucial for comprehending workplace learning and innovation (Derrick, 2020). That means it is essential to accept that the usage of informal practices like informal knowledge sharing, the intentional crossing of knowledge boundaries, perceiving the work peers as reviewers, contextual storytelling, metaphors usage, collective learning by doing and learning by interactions are source of innovations and competitive advantage (Derrick, 2019, 2020). The mastery of being an outstanding expert comes from experience. An expert experiences events and stays mindful and learns profound lessons from them —equally from good and harsh incidents. They are all sources of precious lessons to learn. The attainment of expertise is derived from extensive experience, specifically through continuous, contextual lifelong learning (Laal and Salamati, 2012), encompassing both successes and failures (Kucharska and Szeluga-Romanska, 2025). Experts acquire tacit knowledge in a multifaceted process characterized by social interaction, experiential learning, cognitive development, and strategic knowledge management practices (Kucharska and Erickson, 2023). Emphasizing these dynamics enables organizations to leverage the invaluable benefits of tacit knowledge more effectively in fostering innovation and enhancing performance (Kucharska and Szeluga-Romanska, 2025). Experience-based tacit knowledge absorption mastery refers to the ability to smoothly convert tacit and explicit knowledge, which characterizes agile mindset experts. In other words, they are masters of knowledge socialization and externalization, as the SECI model exposes (Nonaka and Takeuchi, 1995). Experience-based tacit knowledge absorption mastery refers to smoothly converting tacit and explicit knowledge, which characterizes agile mindset experts, including agile mindset leaders.

Agile mindset leaders, according to Kucharska et al. (2024b), 'possess a "hybrid mindset" that masters ambidexterity. It characterizes a kind of person who typically combines previously separate focuses and competencies, such as stability and agility, experimentation and exploitation, flexibility and control, scheme following, and rule breaking, and exhibits simultaneously 'in-the-box' and 'out-of-the-box' thinking. Therefore, the agile leader mindset (AM-L) aligns perfectly with management style, enabling effective management of tensions and paradoxes in response to changing contexts. AM-L is efficient, makes good decisions on time, exposes a remarkable mix of professional and social skills, and exposes expertise-based intuition gained thanks to constant contextual learning, unlearning, and relearning. AM-L's mind constantly analyzes options, predicts impact, and optimizes solutions. AM-L is entrepreneurially oriented (sees opportunities everywhere) and selects those that most empower the organization and employees in the long run (perfect risk manager). AM-L cares about agile and non-agile people, keeps promises, and, therefore, is rewarded in trust. AM-L uses his agile mindset skills to embrace change through primary control skills and smoothly share knowledge and collaborate; inspire, motivate, and support others to share her/his vision of prospective changes as opportunities to generate collectively new value, gain new benefits, and collectively win the market; and use technology to support efficacy. In light of this definition, it is easy to assume that agile mindset leaders must acquire their learning agility through a combination of experiential learning and continuous personal and professional development in dynamic environments. Such a continuous learning process is essential for enabling agile mindset leaders to gain intellectual mastery and respond effectively to rapid changes and uncertainties.'

Therefore, agile mindset leaders continually learn through practice and reflection, utilizing problem-based learning (PBL) and action learning (AL) methods. These methods facilitate the acquisition of new knowledge while encouraging leaders to solve real-world challenges within their organizations actively (Scott, 2017). Such experiential strategies enable leaders to test theories in practice, assess outcomes, and adjust their behaviors accordingly, thereby reinforcing their agile mindset in subsequent situations.

The environment in which leaders operate also influences their learning. Agile leaders excel in cultures that emphasize continuous feedback and knowledge sharing (Abbasi & Ruf, 2020). This collaborative atmosphere fosters open communication, enabling leaders to learn from their peers and subordinates. Further, engagement in mentoring and coaching initiatives has been identified as a vital mechanism through which leaders enhance their learning agility, leveraging these relationships to gain insights and support in their developmental journey (Harvey & Valerio, 2022). So, experiential learning plays a significant role in shaping the learning journey of agile leaders.

Moreover, the distinction between technological and non-technological mindsets presents another layer in understanding how learning occurs in agile leadership. Leaders with a strong technological mindset may approach learning with particular strategies focused on innovation and efficiency. At the same time, those holding a non-technological perspective might prioritize interpersonal dynamics and team cohesion (Kucharska et al., 2024). This adaptability in learning styles reflects an understanding that different scenarios may require different approaches, a core tenet of agile leadership. Previous studies have shown that technological and non-technological mindsets learn differently (Kucharska and Kucharski, 2023) and perceive agile mindset leaders differently (Kucharska et al., 2024a). Therefore, this study aims to explore whether there are any differences in the informal learning habits of agile mindset leaders in the IT sector and other sectors (respectively representing technological and non-technological mindsets), as perceived by employees in Poland and Finland.

2. Literature Review

2.1 Tacit Knowledge and Informal Learning

Tacit knowledge and informal learning are integral components of contemporary knowledge management practices and learning environments. Tacit knowledge articulation is problematic – we know more than we can tell – as Polanyi says (Polanyi, 1966). Therefore, personal experiences usually acquire tacit knowledge in a workplace contextually, e.g., through 'learning by doing' or 'learning by interactions' (Kucharska and Erickson, 2023). Contextual learning encompasses skills and competencies acquired incidentally at work and new ideas, insights, intuitions, and mental models that guide decision-making and problem-solving (Olaisen and Revang, 2018). Tacit knowledge sharing happens mostly through informal channels such as interpersonal interactions and social contexts, emphasizing the significance of environments where individuals learn by doing and observing others (Asher & Popper, 2021). Informal learning, characterized by its non-formalized nature, represents a substantial form of tacit knowledge acquisition, especially in the workplace (Boud & Rooney, 2018). Informal, contextual learning is the opportunity to integrate knowledge gained through practical experiences with the more structured content delivered in formal educational settings. Previous studies have highlighted

that informal learning can improve skills and knowledge retention by allowing individuals to engage unconsciously in the intensive learning process (Callanan et al., 2011). For example, organizations that encourage peer-to-peer interactions and create platforms for informal knowledge sharing often see enhanced productivity and innovation (García-Peñalvo et al., 2014; Griffiths & García-Peñalvo, 2016). Contextual learning allows knowledge workers to leverage their tacit understanding in collaborative scenarios, leading to efficient problem-solving and increased organizational competitiveness and intelligence (Kucharska, 2021, 2025; Kucharska and Bedford, 2024). The concept of "learning in the workplace" underscores the notion that as professionals face challenges, the informal learning that occurs through peer collaboration and guidance is immensely valuable (Jaleel & Verghis, 2015). Moreover, the emergence of communication technology and digital platforms has recently focused on facilitating informal learning dynamics by providing tools to support informal learning processes (García-Peñalvo et al., 2014; Nicolaescu et al., 2014).

Ultimately, both tacit knowledge and informal learning reveal the necessity for organizations to adopt flexible, adaptive learning cultures that recognize and cultivate knowledge in a manner that transcends formal educational frameworks, integrating them into everyday work practices. In conclusion, tacit knowledge and informal learning are interrelated and essential for enhancing organizational effectiveness. This synthesis illustrates the need for organizations to foster environments conducive to informal learning and recognize tacit knowledge's integral role in shaping competencies and driving performance.

2.2 Agility and Informal Learning

Agility in organizations increasingly depends on informal learning (Boerma et al., 2024), which plays a crucial role in adaptability to change (Kucharska et al., 2024a; Kucharska and Bedford, 2024). In agile organizations, where adaptability and quick responses to external and internal change are essential (Kettunen et al., 2022), informal learning is critical (Saini et al., 2018). It is the best and only way to adapt to changing business contexts in real time.

In line with this, former research suggested that agile methodologies, like Scrum or Kanban, thrive on a foundation of informal communication and collaborative problem-solving (Reddy, 2015; Pikkarainen et al., 2008). Agile methods have been found to have a positive effect on problem-solving and resource allocation, which are both positively related to the organizational performance of ventures (Kum et al., 2024). Agile management methods, mostly project management-related, are supported by cultures where relations between co-workers are not formalized. Knowledge, especially tacit knowledge, is exchanged more freely in organizations with highly developed human but also relational and social capital (Kucharska, 2021), e.g., the KLC approach – knowledge-learning and collaboration cultures synergy serves well tacit and explicit knowledge sharing that is critical to organizational intelligence development (Kucharska et al., 2024d; Kucharska, 2025). By emphasizing communication flexibility and supporting the open sharing of experiential learning, agile organizations enable workers to constantly learn contextually as they tackle challenges in their day-to-day tasks (Muduli, 2016; Przybyłek et al., 2025). Moreover, evidence from public sector initiatives suggests that implementing agile practices requires a cultural shift toward openness and innovation. Public servants engaged in innovation fellowships highlighted the profound impact of informal learning on their ability to adopt agile methodologies effectively. Such experiences help develop collaborative competencies that align with agile principles, further demonstrating the significance of an informal learning environment in fostering an organizational culture that promotes agility (Albrecht, 2024; Kucharska and Bedford, 2024). Summing up, incorporating, supporting, and promoting informal learning practices can significantly enhance workforce agility. Organizations that foster a working environment conducive to informal exchanges and encourage reflective practices tend to cultivate a more agile workforce, which is critical for the achievement of agility by organizations (Kucharska et al., 2024a; Kucharska, 2025). This is particularly evident in studies connecting organizational learning with improved responsiveness and proactive behavior among employees (Muduli, 2017). The recognition of informal learning—such as mentoring, coaching, and peer collaboration—offers individuals opportunities to transfer skills and knowledge efficiently, thereby reinforcing agility within the organization (Zajac et al., 2022).

In summary, intertwining informal learning with agile methodologies proves essential for establishing a conducive environment for innovation and smooth adaptation. Organizations that promote informal learning practices bolster their agility and enhance their overall performance and capacity for continuous development in an ever-changing landscape. As stated in the Introduction section, the question this study aims to answer is: Which competencies (demonstrated skills) do agile mindset leaders perceive as critical for their tacit knowledge acquisition? As previous studies have shown, technological and non-technological mindsets can see agile

leadership differently (Kucharska and Kucharski, 2023; Kucharska et al., 2024b). Therefore, this study aims to explore whether there is any difference in the informal learning habits of agile mindset leaders in the IT and other sectors, as viewed by employees in Poland and Finland.

3. Methodology and Results

This study is based on the qualitative data set collected by Kucharska et al. (2024b) and follows the methodology of data analysis applied by Kucharska et al. (2024c). All scientific knowledge is derived from real-world experience, where practical consequences determine truth and meaning (Peirce, 1958). Therefore, Kucharska et al. (2024b-c) employed a reflective approach grounded in pragmatic realism (Morgan, 2020) when performing their qualitative studies. Pragmatism is focused on solving practical problems in the real world (Feilzer, 2010, p. 8) and emphasizes inquiry based on contextual experiences.

The essence of the applied procedure is the abduction method of reasoning (Magnani, 2011). Abduction is a central part of pragmatic philosophy, and the pragmatic maxim derives an object's meaning from its real-life consequences. According to Peirce (1958), all scientific knowledge refers to real-world experience; practical consequences define truth and meaning. Therefore, the study's initial interview questions were designed by Kucharska et al., 2024a-c to focus on practical experiences and did not refer directly to any categories identified earlier in the literature for agile mindsets (Eilers et al., 2022; Kumar & Ray, 2023; Ozkan et al., 2023; Sathe & Panse, 2023).

Discussing the specifics of the analysis procedure applied to this research, the data analysis was limited to two themes (main categories), which were a point of interest: competencies (demonstrated skills) and habits (routine behaviors). Specifically, among all codes identified by Kucharska et al. (2024b-c) belonging to these categories, we selected those related to learning. Next, we performed their analysis per sector and country using MAXQDA software. The results of this analysis are given in Figure 1 below.

Data were collected from a diverse group of knowledge workers experienced in the agility approach in February 2024. The final sample consisted of 85 participants, including 44 volunteers from Finland (19 from the IT sector and 25 from other fields) and 41 from Poland (20 from IT and 21 from other sectors). This representation aims to include both technological and non-technological perspectives. The gender distribution within the sample was not evenly balanced across sectors or positions, with 12 females and 29 males in Poland and 13 females and 31 males in Finland, highlighting a male predominance in both countries. Age was not specifically controlled at this stage of the study. Interviews continued until saturation was reached, meaning that no new insights or meanings were emerging from the qualitative data. This strategy allowed for the effective gathering of rich insights, as the sample structure was derived from the convenience of interviewing volunteers who were genuinely engaged with the topic (study details: Kucharska et al., 2024b-c).

Results (Figure 1) showed that contextual learning, learning from experiences (both positive and negative), learning from failures and mistakes, critical thinking, constant analysis and synthesis, seeking understanding, and systematic self-development are key informal learning activities employed by agile mindsets. Additionally, OTHER sectors' employees highlighted the value of agile mindset leaders' habit of supporting others; IT employees specified these habits as giving constructive feedback and serving as mentors or coaches. OTHER sector employees also stressed that 'scenario thinking' and self-discipline support the informal learning of agile mindset leaders. Apart from minor details, no significant differences between Poland and Finland were noted.

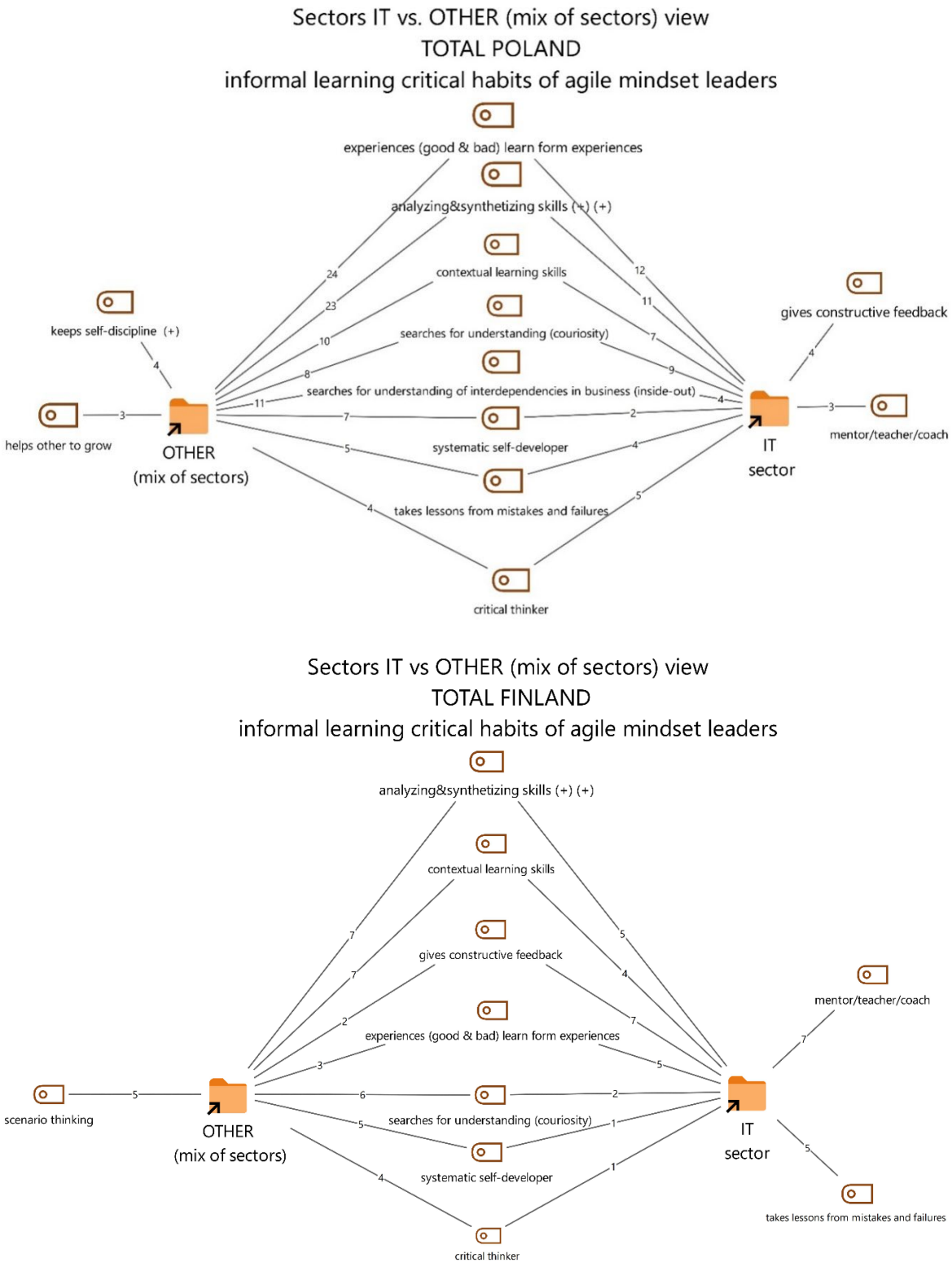


Figure 1: The most frequent codes related to the informal learning of agile mindset leaders: IT vs. OTHER (mix) sectors, Polish and Finnish view N= 85 interviews (41 from Poland and 44 from Finland)

4. Discussion, Limitations, and Scientific Implications

The concept of lifelong learning (LLL) emphasizes the continuous acquisition of knowledge, skills, and competencies throughout an individual's life, from early childhood to post-retirement (Laal and Salamati, 2012). LLL encourages the absorption of both explicit and tacit knowledge, helping organizations stay connected to

real-world economic and sociocultural challenges. This is achieved through both formal and informal learning, enabling dynamic knowledge absorption in the workplace (Kallen, 2013).

This study confirmed that, indeed, the key sources and habits of learning among agile mindset leaders are informal. In line with this, Kucharska and Szeluga-Romanska (2025) highlighted that experts' importance in lifelong learning is the open mind and the remarkable ability to learn from constantly changing contexts, actions, and consequences, and from mistakes (own and others). Trial-and-error learning (Argyris and Schön, 1997) and the ability to "be ready to be wrong" (Senge, 2006) seem crucial.

Since agile mindsets are in the minority in organizations (Ambituuni et al., 2021), they are critical for the development of agile organizations (Kucharska et al., 2024c) to support the implementation of agile practices as routines. According to Kucharska et al. (2024c), “An agile organization (AO) is an efficient adaptive system that critically depends on its employees' agile mindset leadership and employee, agile culture, structure, market orientation, strategic resource identification and security, and formulation oriented to sustain long-term competitiveness strategy.” To build such a system, agile mindsets are critical. To achieve this, it is essential to create organizational conditions that support the growth of agile mindsets. These conditions specifically concern a company culture that prioritizes freedom over control, which is critical for the creation and sharing of tacit knowledge (Kucharska, 2021; Kucharska and Bedford, 2024; Kucharska, 2025). Kucharska et al. (2024d) followed this line of research, suggesting that the knowledge-learning-collaboration synergy (the KLC approach) of these functional cultures supports the growth of an agile mindset and the development of agile organizations, primarily due to its positive impact on organizational intelligence and adaptability. However, no empirical studies directly support directly this point. So, further studies are needed.

Moreover, the current study also indirectly confirms the need to take a step forward and focus more on a company culture that supports agility by defining it in more depth, rather than just through the KLC approach, which may be efficient enough for this point, but might not. Further studies are needed to verify this idea.

Besides, according to Vilas-Boas et al. (2018), leadership is a cultural practice. Such a perspective makes further studies on the implementation of agile culture by agile-minded leaders seem even more urgent.

Ultimately, the study comprises 85 participants from Poland and Finland. While this provides a reasonable qualitative dataset, the findings may not be fully generalizable to other cultural or organizational contexts. Expanding the study to include diverse geographical regions would strengthen its applicability.

In summary, as this study's findings suggest, in light of the existing literature, quantitative studies are needed to draw firm conclusions regarding the support of company culture for agility. These studies should explore this phenomenon in much broader contexts than those given in this qualitative study, whose mission is to inspire and motivate deeper understanding.

5. Practical Implications

This study showed that such practices and habits concerning informal learning, such as contextual learning, learning from experiences (both positive and negative), learning from failures and mistakes, critical thinking, constant analysis and synthesis, seeking understanding, and systematic self-development are habitual skills – are key informal learning activities applied by agile mindsets. Therefore, leaders with the ambition to create agile organizations should establish favorable conditions to facilitate such learning. According to the presented literature, this is reflected in the company culture. Other activities, such as providing constructive feedback to support others and serving as mentors or coaches, are integral to implementing such a culture.

Leaders are responsible for designing, implementing, communicating, and executing a company's culture through their own actions and examples. Our interactions with leaders who embody the company’s values significantly shape our understanding of that culture. Whether in a virtual or traditional setting, leaders are equally accountable for the relational experiences that employees have, which ultimately influence their perception of the company culture. So, the key practical implication is to learn constantly to sharpen your agile mindset and support others in doing so.

6. Conclusion

The study results showed that contextual learning, learning from experiences (both positive and negative), learning from failures and mistakes, critical thinking, constant analysis and synthesis, seeking understanding, and systematic self-development are habitual skills considered essential for an agile mindset leader's acquisition of tacit knowledge. Additionally, OTHER sectors’ employees highlighted the value of agile mindset leaders' habit

of supporting others; IT employees specified these habits as giving constructive feedback and serving as mentors or coaches. OTHER sector employees also stressed that 'scenario thinking' and self-discipline are habits supporting the informal learning of agile mindset leaders. In summary, agile mindset leaders learn through a combination of experiential learning, social interactions, adaptive behavior, and feedback loops initiated within supportive organizational cultures. By utilizing these learning strategies, they develop not only their agile mindset but also their agile leadership style, which allows them to tackle the dynamic challenges of today's business environment. This study's results confirm that informal learning supports the development of an agile mindset. Since agile mindsets are in the minority in organizations, this study's results indirectly support the need to search for company cultures that foster informal learning, thereby facilitating the development of agile mindsets and training.

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AI usage declaration: We used Grammarly to make language corrections.

Ethics statement: Respondents voluntarily participated in the research, and their anonymity was fully respected and secured.

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The Relation Between Learning Climate and Mistake-Acceptance Components of Learning Culture: The Double Bias of Mistakes View

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Abstract: The synergy of the KLC approach components (knowledge, learning, and collaboration cultures) supports a knowledge-driven organization's sustainability. However, given the profound alleged "synergy" between the KLC cultures, the question arises: How does this synergy occur? Based on the former studies, it is assumed that a collaborative culture appears to be the unifying and synergy-driving force of all cultures incorporated into the KLC approach. However, learning culture is at the center of the KLC's power to support collective intelligence development in knowledge-driven organizations. This study aims to study more in-depth how learning culture components, learning climate, and mistakes acceptance component as a source of learning interact, based on Kucharska's and Karwowska's (2025) KLC-sustainability' model. To do so, a moderation analysis is performed based on a sample of 496 Polish knowledge workers using the ordinary least squares (OLS) regression method. Results showed that a strong learning culture has a high potential to neutralize the adverse effects of the double bias of mistakes.

Keywords: Knowledge culture, Learning culture, Collaborative culture, Knowledge organizations, The KLC cultures approach (KLC), Double bias of mistakes (DBM)

1. Introduction

This study focuses on the relationship between the learning climate and mistake-acceptance components of a learning culture observed through the double bias of the impact of mistakes. The inspiration for this research was a study by Kucharska and Karwowska (2025). Precisely, based on their findings, the assumption has been made that the double bias of mistakes (DBM) impact diminishes the supporting power of the learning culture climate component on the mistake-acceptance component. This article aims to provide additional empirical evidence, building on prior studies (Hosseini et al., 2023; Kucharska and Kopytko, 2024; Kucharska and Szeluga-Romanska, 2025) that suggest the double bias of mistakes is detrimental to organizations.

The concept of the double bias of mistakes (DBM) introduced by Kucharska and Bedford in 2023 and further developed by Kucharska and Kopytko in 2024, is based on the cognitive bias known as the "framing effect," first identified by Tversky and Kahneman in 1981 (Clark, 2009; Druckman, 2001a-b; Plous, 1993). The framing effect significantly influences how we judge situations and make decisions (Thomas and Millar, 2011). The mistake bias arises from the belief that mistakes are a natural aspect of humanity, counterbalanced by the negative consequences those mistakes can produce. In organizational contexts, this cognitive bias is compounded by the pervasive belief that "bosses never make mistakes," leading to the notion that only outstanding employees can advance to managerial positions. Consequently, employees may hide mistakes, fearing they will be labeled as "losers." This behavior creates an illusion of both personal and organizational perfection. Self-awareness is crucial for developing intelligence (Kour and Bhatia, 2025). Without acknowledging mistakes, errors, or failures, individuals cannot fully understand their meaning or learn from them. When mistakes are denied or ignored, they fail to become opportunities for reflection and growth for either the mistake-maker or their colleagues (Hull, 1930). Thus, perpetuating this illusion of perfection undermines intelligence. In biased organizations and societies, people often emphasize excellence while concealing mistakes. This dynamic complicates organizational learning from errors. Hidden mistakes can cause harm and represent a loss of value, rather than serving as valuable lessons. This observation aligns with the concept of "negative resource spirals" (Hobfoll et al., 2018), which suggests that the loss of one resource—such as the knowledge gained from mistakes—can lead to further losses. In this context, failing to learn from experience is regarded as waste, which contradicts the principles of sustainability. Kucharska and Karwowska (2025) proved it. Precisely, they examined the structure of the relation between the KLC approach and sustainability. The important part of the complex structure of relations are components of learning culture: learning climate and acceptance mistakes as a source of learning (Kucharska and Bedford, 2020).

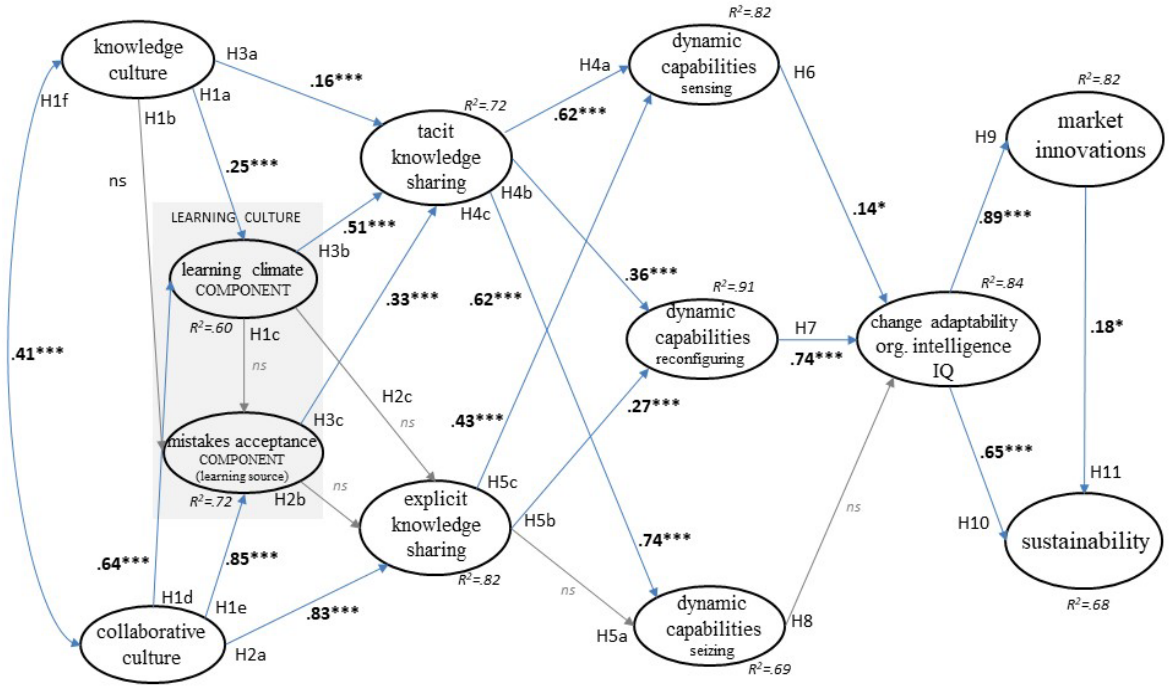
2. The KLC Approach

The synergy of KLC cultures shifts knowledge-driven organizations (Kucharska and Bedford, 2023). According to these authors, knowledge culture is a shared organizational appreciation for knowledge as a critical company resource that makes knowledge culture a central point of the proposed KLC approach. However, suppose a

learning culture does not support a knowledge culture impact on an organization. In that case, the organization is at risk of getting stuck at a particular level of knowledge exploitation, securing and controlling its status. Therefore, learning culture matters for a shared organizational motivation for constant knowledge expansion. Organizations that rely chiefly on proven knowledge often prefer to "keep things as they are" and "avoid any risk." They prefer maintaining a "safe, control-oriented environment based on well-known routines" (Kucharska and Bedford, 2023, p.55). These organizational attitudes may hinder organizational development. The solution to this problem appears to be a continuous learning culture. To be efficient, the learning cultures of learning organizations must be multilevel. And to be multilevel, they must be collective by definition. From the organizational perspective presented by these authors, there is no culture of learning without the culture of knowledge, and there is no learning without collaboration. In summary, knowledge culture focuses on exploiting knowledge, whereas learning culture focuses on its exploration; collaborative culture makes both multilevel.

These three cultures are exponentially valuable for tacit and explicit knowledge sharing, dynamic capabilities, innovations, and sustainability development. When it comes to explicit knowledge, sharing it can be imposed by organizational policies, rules, and procedures. This approach does not apply to tacit knowledge. Tacit knowledge is contextual and strictly personal and can only be shared voluntarily (Polanyi, 1996; Olaisen and Revang, 2018; Saint-Onge, 1996; Kucharska and Erickson, 2023). So, company culture is the best and the only organizational tool to support tacit knowledge sharing, which is critical for human capital development. Therefore, the triple power of KLC—the KLC approach—is expected to be the most efficient tool for tacit and explicit knowledge sharing, dynamic capabilities, innovations, and sustainability development. Kucharska and Bedford (2023) claim that when all three get implemented together—they are much more potent than any of them alone.

Kucharska and Karwowska (2025) proved that the KLC approach supports sustainability (Figure 1).



Source: Kucharska and Karwowska (2025)

Figure 1: The KLC approach impact on knowledge sharing, dynamic capabilities, org. intelligence, innovations and sustainability

Note: n =496; ML–maximum likelihood; χ2 =1694.161 (533); CFI =.915; TLI =.918; RMSEA =.066; Cmin/df =3.18; *p <.05; **p <.01; ***p <.001; ns—not significant result

The entire structural model given above confirms that KLC culture's synergy fosters knowledge sharing (tacit and explicit) that is vital for dynamic capabilities development, which, in turn, influences organizational intelligence (change adaptability), innovativeness, and sustainability.

3. The Double Cognitive Bias of Mistakes (DBM) Affects the Culture of Learning

Based on Kucharska and Karwowska's (2025) findings (Figure 1), this study focuses on the relationship between the learning climate and mistake-acceptance components of a learning culture observed through the double bias of mistakes' impact. The assumption has been made that the double bias of mistakes (DBM) impact diminishes the supporting power of the learning culture climate component on the mistake-acceptance component.

Following Kucharska and Karwowska's findings (2025, Figure 1), H1a (β = .25***) confirms that knowledge culture positively supports the learning-climate component of a learning culture, but the mistake-acceptance component is not supported by knowledge culture, so H1b is not confirmed. The expected positive influence of the learning-climate component on the mistake-acceptance component of learning culture is also not confirmed (H1c). Hypothesis H1d (β = .64***) confirms a strong, positive influence of collaborative culture on the learning-climate component of a learning culture, and H1e exposes an even stronger effect of collaborative culture on the mistake-acceptance component of a learning culture (β = .85***). The correlation between collaborative and knowledge cultures is also confirmed (H1f: β = .41***). Summing up, collaborative culture is the strongest influence among the KLC cultures and thus is the center of the KLC approach. But the negative verifications of hypotheses H1b and H1c require deeper investigation. It might be, following the former studies by Hosseini et al. (2023), Kucharska and Bedford (2023), and Kucharska and Kopytko (2024), that the double bias of mistakes (DBM) seriously concerns collective organizational learning. Based on the H1c verification results of the mentioned prior study (Figure 1, Kucharska and Karwowska, 2025), the following hypothesis post-hoc was formulated as follows:

> ***Hypothesis:*** *The DBM impacts diminish the supporting power of the learning culture climate component on the mistake-acceptance component*

4. Method and Results

To sustain or reject this post-hoc hypothesis, an OLS regression analysis was run using SPSS PROCESS (Hayes, 2018). The DBM identification procedure was applied according to Kucharska and Kopytko's (2024) detection method. Briefly, this entails measuring and comparing attitudes toward mistakes with their acceptance as a potential learning source; if the contradiction is noted, bias is detected. Following this procedure in this study, the sample was divided into two groups—with bias (n = 184) and without bias (n = 312) detected. Next, the OLS regression results obtained for these two groups were compared to explore how DBM affects the learning culture climate component's influence on the learning culture mistake-acceptance component. Details of this analysis are presented below (Figure 2).

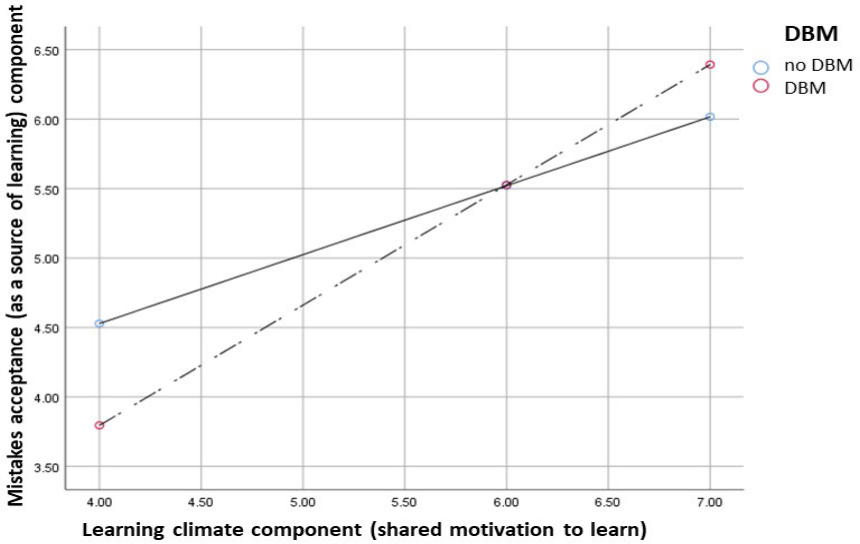


Figure 2: The relation between learning-climate and mistake-acceptance (as a source of learning) components, viewed through the prism of the double bias of mistakes (Authors' model)

********** PROCESS Procedure for SPSS Version 4.2 **********

Model : 1 Y : Bam4 X: Ba4 W: DB Sample Size: 496

OUTCOME VARIABLE: LCm

Model Summary

R	R-sq	MSE	F	df1	df2	p
.5154	.2656	1.3326	59.8005	3.0000	496.0000	.0000

Model	coeff	se	t	p	LLCI	ULCI
constant	2.5439	.2458	10.3476	.0000	2.0608	3.0269
LCc	.4961	.0422	11.7538	.0000	.4132	.5790
DB	-2.2120	.8728	-2.5343	.0116	-3.9269	-.4971
Int_1	.3697	.1434	2.5789	.0102	.0880	.6514

Product terms key: Int_1 : LCc x DB

Test(s) of highest order unconditional interaction(s):

	R2-chng	F	df1	df2	p
X*W	.0098	6.6507	1.0000	496.0000	.0102

Focal predict: LCc (X) Mod var: DB (W)

Conditional effects of the focal predictor at values of the moderator(s):

DB	Effect	se	t	p	LLCI	ULCI
.0000	.4961	.0422	11.7538	.0000	.4132	.5790
1.0000	.8658	.1370	6.3191	.0000	.5966	1.1350

Data for visualizing the conditional effect of the focal predictor:

Paste text below into a SPSS syntax window and execute to produce plot.

```
DATA LIST FREE/ LCc DB LCm .
BEGIN DATA.
 4.0000 .0000 4.5282
 6.0000 .0000 5.5204
 7.0000 .0000 6.0165
 4.0000 1.0000 3.7952
 6.0000 1.0000 5.5268
 7.0000 1.0000 6.3926
END DATA. GRAPH/SCATTERPLOT=
 LCc WITH LCm BY DB .
```

********** ANALYSIS NOTES AND ERRORS **********

Level of confidence for all confidence intervals in output: 95.0000

Figure 2 shows that in the group characterized by DBM, acceptance of mistakes as a source of learning is lower when the level of the learning culture climate component is low. However, when the level of the learning culture climate component grows, the mistake-acceptance component also grows, and it grows faster than observed for the non-biased group. This means that the learning culture climate component matters for learning culture mistake-acceptance component development, especially for individuals who experience DBM, and only if the learning culture climate component level is very high. The non-biased group also demonstrates a higher level of

learning culture mistake-acceptance component when the learning culture climate component grows, which is not as evident for the biased group.

Thus, the hypothesis is partially confirmed. The hypothesis is true only for a low level of the learning culture climate component. When the learning culture climate component level is high, the acceptance of mistakes as a source of learning grows faster for the biased group than for the non-biased group. It suggests that the learning climate component can be seen as an antidote to the double bias of mistakes. So, a strong learning culture can be critical to neutralizing the DBM's negative effects. Summing up, the hypothesis is conditionally sustained. Therefore, this issue requires deeper exploration.

5. Discussion, Limitation and Further Research Directions

First of all, it is essential to highlight that this short research related to the double bias of mistakes phenomena (Kucharska and Bedford, 2023) is part of a broad line of studies related to general organizational learning through mistakes proposed by such prominent authors as e.g., Edmondson (1996) Eggers, (2015) Fischer et al. (2006); Frese and Keith (2015) Gelfand et al., (2011) or Keith et al., (2020). So, the given findings are part of a considerable scientific discussion whose conclusion suggests that companies must support their organizational maturity in wise learning from failures to grow. Building on the findings of this short study, they contribute to a considerable scientific discussion by revealing that the double bias of mistakes may be a significant barrier to the desired maturity of organizational learning. Moreover, it can discourage young generations of employees who are highly sensitive to company culture and avoid those that hinder their psychological well-being (Graczyk-Kucharska and Erickson, 2020).

To see it clearly, the context of this finding is worth discussing. Precisely, the negative verification of H1b (Kucharska and Karwowska, 2025; Figure 1) study that the knowledge culture supports the acceptance of mistakes as a source of learning component is probably related to the fact that DBM diminishes the supporting power of the learning culture climate component on the mistake-acceptance component, was only partially confirmed. More insight into the issue can be gained from the findings of Kucharska (2021), who explored the relationship between learning culture components across sectors. Her results revealed that the relationship between learning culture components can be sector-related. Precisely, she exposed that significant support of the learning climate for the mistake-acceptance component is noticeable for the healthcare and IT sectors but not for the construction and higher education. It means that some industries can be more biased than others, probably those in which knowledge cultures dominate over learning cultures. So, the effect of DBM on the relationship between learning culture components may also vary when analyzed by sector. Summing up, this issue requires further study.

Another research window opened by this study's findings concerns the DBM. Specifically, the effect of the DBM on the relationship between learning-culture components across different sectors. Those sectors that rely more on knowledge culture than learning culture may be more affected by the DBM (knowledge culture does not support the acceptance of mistakes component of learning culture, as the findings showed). This issue also requires further study. From here, other related questions arise: How should organizations address the existence of DBMs to be more adaptive and innovative, thereby securing growth, rather than being more controlled and predictive to ensure safety? Additionally, it would be interesting to know how artificial intelligence (AI) addresses the existence of DBM. Algorithms are as intelligent as the people creating them. Is collective organizational intelligence intelligent enough to detect a DBM and its influence on decision-making? Is AI intelligent enough to detect a DBM and its influence on decision-making?—All these questions remain open.

Moreover, this study is limited to a single country and a diverse range of sectors and does not consider the gender or position factors in any form. Given that a company's culture is influenced by national and sectoral cultures (Kucharska and Bedford, 2023) and gender and position in management often determines perceptions and behaviors (Kucharska and Kucharski, 2025; Kucharska and Szeluga-Romanska, 2025), replicating this study in other countries and specific sectors can shed further light on the explored mechanisms.

6. Practical Implications

This research has several practical implications. First, because the Double Bias Model (DBM) can significantly hinder organizational learning, it is essential to neutralize its effects. The most effective way to achieve this is by implementing both key components of a learning culture: a learning climate, which fosters shared motivation to learn, and the acceptance of mistakes as valuable learning opportunities.

It is important to clarify that we do not endorse negligence. Instead, we advocate for a human approach, which contrasts with an unrealistic expectation of perfection. We promote an attitude of acceptance, recognizing that mistakes are a natural part of working in dynamic and uncertain conditions, even when we are diligent. This acceptance is at the heart of learning from experience in a changing environment.

Moreover, the broader context of this study showed that implementing the KLC approach can be very beneficial regarding organizational learning ambitions. The desired behavior regarding learning culture is the constant pursuit of learning from both good and bad experiences. If a mistake is made, it should be claimed, reported, and discussed to prevent similar events in the future through proper procedural corrections. The KLC approach supports it.

7. Conclusions

This brief study on the phenomenon of double bias in mistakes (Kucharska and Bedford, 2023; Kucharska and Kopytko, 2024) is part of a broader research initiative focused on organizational learning through mistakes. The key message is that for knowledge-driven companies to thrive, they must enhance their organizational maturity by learning effectively from failures. The findings of this study contribute to this crucial scientific discussion by highlighting how the double bias of mistakes can significantly hinder the desired maturity in organizational learning. Still, a strong learning culture can mitigate the adverse effects of this double bias.

AI usage declaration: We used Grammarly to make language corrections.

Ethics statement: Respondents voluntarily participated in the research, and their anonymity was fully respected and secured.

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The Erosion of Scientific Inquiry: Economic and Ethical Aspects of Fake Knowledge and GenAI

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Abstract: The article explores the increasing prevalence of fake knowledge as a substitute for scientific knowledge and examines its economic drivers. It highlights the rising retraction rates of scientific papers due to fraud, and paper mills, demonstrating weaknesses in peer review. The author argues also that knowledge generated by GenAI and scientific knowledge on the other hand can be perceived as marketable goods, where the former serves as a lower-cost alternative, making it accessible despite its unpredictable lack of validity. The article presents a theoretical approach to examining recent trends in the knowledge market. It discusses economic factors and how they affect shifting consumer preferences from scientific knowledge (SK) to fake knowledge (FK) and GenAI. While top universities remain in demand, financial constraints have pushed some students toward alternative, often less reliable, sources. Apart from income polarization, the proliferation of GenAI has accelerated the spread of fake knowledge by lowering knowledge creation costs and bypassing traditional information gatekeepers, such as peer-reviewed journals or experienced scholars. Furthermore, Generative AI tools and fake knowledge are facilitated by social and psychological tendencies, as people seek knowledge—regardless of its accuracy—to reduce uncertainty. The article concludes by considering fake knowledge in the context of business ethics. It suggests that the dissemination of fake knowledge may serve political and economic interests, particularly in influencing public opinion, destabilizing and eroding trust in public figures and institutions. Given the role of digital platforms in spreading fake knowledge, AI researchers can explore how algorithms influence the visibility of misinformation and what ethical considerations should guide content recommendation systems. Research is needed to examine the interplay between income distribution, digitalization, and the propagation of fake knowledge from sociological, psychological, and economic perspectives; and to investigate the role of cognitive biases, social trust, and political motivations in knowledge preferences.

Keywords: Fake knowledge, Knowledge economics, Knowledge management, Higher education, Misinformation, Income inequality, Job polarization, Peer review, Academic fraud, GenAI

1. Introduction

There has been a drastic increase in the quantity of supplied fake knowledge in the last decades (Zhou and Zafarani, 2018; Richie, 2020; Gómez-Rodríguez, G. and González Reyes, R., 2022). Hopf et al. (2019, p. 4) claim that "*the percentage of scientific articles retracted because of fraud has increased by an order of magnitude since 2000 and high rates of retraction are seen for the most prestigious journals, illustrating both the extent to which flawed claims are perpetrated by scientists seeking prominence and weaknesses and even fakery in the current practice of peer reviewing*". Richie (2020) highlights how journals and the media sometimes fail to scrutinize sensational claims before spreading them. Richie (ibid.) presents inter alia the case of Brian Wansink, a well-known food researcher who engaged in p-hacking—adjusting data analysis until results appeared statistically significant, the misconduct by Diederik Stapel, a prominent Dutch psychologist who fabricated data for dozens of studies creating entirely fake datasets while claiming they were from real experiments. Stapel's works were published in prestigious journals that influenced social psychology before the scam was exposed.

Generative Artificial Intelligence (GenAI) has greatly affected the phenomenon of creating and disseminating fake news and fake knowledge. Fake news has been around for millenia, but GenAI has elevated it to new heights. Now, it enables the automated creation of vast amounts of high-quality and even personalized fake news. Paradoxically, Generative AI also plays a crucial role in detecting misinformation (Loth, Kappes, and Pahl, 2024).

This paper suggests a microeconomic framework to shed light on the changes in the knowledge market. It must be noted that the presented concept approximates the reality of supply-demand in knowledge acquisition. Consequently, sociological and psychological determinants are omitted intentionally and explicitly. The supply-demand model is interesting, as it applies to many of the organic aspects of life, and yet so limited, as many psychological and epistemological mechanisms are rooted either in our unconsciousness (microbiology), or subconsciousness (educational, ethnical, or socio-economic background), which makes studies on human behavior and knowledge management truly challenging. It is noteworthy to mention that sociological and epistemological, or any other than mathematical axioms are paradigmatic, and thus restrained to particular organizational and cultural settings.

2. Science and Fake Knowledge

The demarcation problem in defining the quality of knowledge is a huge problem in epistemological studies which has been discussed since ancient times. Both intentionality in knowledge sharing and even the definition of what is true, and what is fake is not always easy to establish. For instance, why do some call electro-mobility fake or pseudo-ecological while others see it as a valid approach to sustainability? The scope of this article is however not to discuss the problem of verification and replicability of knowledge, cognitive bias, methodological rigors, and peer consensus, ideologies, and traditions on what is accepted as knowledge, but to conceptualize the supply-demand of different versions of knowledge.

Now, let us assume that fake knowledge (*FK*) is a substitute for scientific knowledge, a different version of information goods. As far as conventional information goods are concerned, a common strategy for producers to attract customers from distinct market segments is to create high- and low-quality variations (or 'versions') of the original good, "*thereby selling at a high price to those who have a high value for the product, and a low price to those who value it less*" Varian (1999, p. 2). Hence fake or pseudo-scientific knowledge and output produced by the GenAI could be seen as different versions of informational good, in contrast to knowledge generated by the scientific inquiry. As noted by Fanelli (2019, p. 45), scientific knowledge can be characterized as a manifestation of human cognition among many. It is a pattern-encoding activity that "*reduces uncertainty about one phenomenon by relating it to information about other phenomena*". One could argue that people use any knowledge, regardless of its quality, to reduce uncertainty. The difference between fake and scientific knowledge is that the latter is valid. This is obvious in the so-called hard (natural) sciences but less in knowledge management and social sciences. Nevertheless, any kind of knowledge – whether fake or scientific – is a manifestation of information compression as noted in Fanelli (2019), and hence the proposition to treat fake or pseudo-scientific knowledge as variations of the same good (knowledge, *K*) seems reasonable.

If knowledge has become an easily available commodity, why would people want to consume less scientifically evidenced knowledge (*SK*) if its price has fallen? Why do we so fancy easily generated knowledge, as is the case with the GenAI? Brynjolfsson and McAfee (2014) have argued that the nature of recent digital, combinatorial, and exponential technological changes undergirds the whole economic system, hence the effects can be now observed in the broadly understood knowledge market. The change in customers' knowledge preferences could be attributed to technological changes in terms of skill-biased technical change (SBTC) and routine-biased technical change (RBTC). The aforementioned phenomena have favored more educated and skilled labor causing job and income polarization by eliminating middle-paid jobs in favor of high- and low-paid jobs respectively.

2.1 The Income Effect

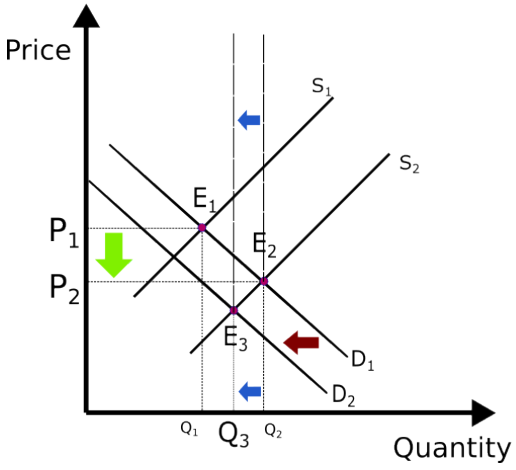
The income distribution is claimed to be the worst since the late 1920s (Alvaredo et alia, 2018), and *"in most OECD countries, the gap between rich and poor is at its highest level since 30 years"* (Cingano, 2014, p. 6). An interesting exemption from this trend can be seen in the Netherlands – a country where the gap has decreased; "*a substantial reduction of overall inequality: the bottom 50%'s share of income increases from 21 to 29%, while the top 10%'s*" (Bruil, et al., 2022, p. 2). One of the indicators for the changes in income distribution is the share of earned income by the richest 1% of the population. The development of that share for the Group of Seven (G7) countries in the past four decades has been alarming: "*The gap between rich and poor in Organisation for Economic Co-operation and Development (OECD) and European Union (EU) countries has reached its highest level over the past three decades*" (Cohen and Ladaique, 2018, p. 31). Also, the changes in household expenditures and disposable income are influenced by changes in macroeconomic factors. The impact of the global economic crisis in 2009 caused a reduction of household expenditure ca 5% and was higher in the OECD countries compared to the global average value (Varlamova and Larionova, 2015).

The income growth pattern has differentiated dramatically especially in the United States over the last four decades. Whereas the lowest quintile - the families in the bottom 20 percent of the income distribution - had an increase by only 2.3 percent between 1980 and 2016, the middle quintile saw their real incomes rise by ca 25 percent over the same period. Meanwhile, the incomes of the top 20 percent grew by 75 percent (Frank et alia, 2019). According to another measure of the income distribution, the Gini coefficient, the income inequality in the United States was significantly lower (0.39) in 2019 (OECD, 2020) than the estimates for the World average (0.634-0.684), based on the 2005 data (Hillebrand, 2009). It is noteworthy to say, that the Gini coefficient among other indicators has its limitations. For instance, countries with similar Gini coefficients might have different income distributions and thus ranking countries with it can be misleading (Bellù and Liberati, 2006).

Goos et alia in (2014) have observed that job polarization has been pervasive across studied 16 advanced Western European economies in the years 1993-2010 and offshoring has been identified as one of the reasons to cause middle-paid work to disappear from the United States (Banister and Cook, 2008). Simultaneously, the share of low-paid service work and highly paid managerial/specialized work has increased and this has given rise to the increasing income inequality in the rich OECD countries since the 1980s. The reasons for increased income inequality according to e.g. Salvatori and Malfredi (2019) is not job polarization per se but rather that some (even high skilled) jobs that have traditionally been associated with certain income have failed to deliver it the way they used to. This might be linked to what Brzezinski (2017, p. 9) suggests meaning "*that growing income inequality in Poland is correlated with the decline of trust in political institutions*".

As far as Central and Eastern Europe (CEE) is concerned, there is evidence indicating the possibility of a substantially higher increase in wealth inequality than previously thought. The largest increase in wealth inequality during the transition from central to market economy occurred in the "*Baltic countries (by more than 10 percentage points), while somewhat less significantly for countries such as Hungary, Poland and Slovakia*" (Brzezinski, Sałach and Wroński, 2019, p. 17; Sawulski, Brzeziński and Bukowski, 2024). Also, Brzezinski's earlier (2018) study shows statistically significant increases in Gini for disposable incomes throughout 2008–2012 for Bulgaria, Estonia, Hungary, and Slovenia, only small changes were observed in income distribution in Poland. Nonetheless, Poland's income inequality is still considerably higher than the average of the wealthier EU member states and in line with the average level of highly developed countries. However, the income inequality is smaller compared to countries of a similar level of affluence. Poland is also the only CEE country that did not experience a drop in GDP per capita during the financial crisis of 2008, and the country's unemployment rates are now among the lowest in the OECD. However, there are doubts that the official figures are far worse than thought and the problem lies in their correctness - the access to valid data (Sawulski et alia, 2024). Furthermore, also the degree of accumulation of ICT capital and robot stocks plays an important role in the future development of income distribution. ICT deployment should press down technology prices further enhancing automation of jobs and de-routinization of the Polish labor market. If SBTC and RBTC will continue, further technological advancements can bring forth wage polarization.

The question is then, could the disappearance of middle-income jobs and the income polarization be largely responsible for not only the declined demand for scientific knowledge but also the increased quantity demanded and consequently the supply of fake knowledge (*FK*)? Mostagir and Siderius (2022) found that communities with limited access to accurate information are more vulnerable to misinformation. They suggest that income polarization can compromise the overall quality of information consumed across different societal segments. Also, Glenski, Weninger, and Volkova (2018) suggest that users with lower income and education levels are more likely to share content from deceptive news sources. The study concluded this based on an analysis of 11 million Twitter posts. Their (ibidem, p. 1) "*analysis by demographics showed that users with lower annual income and education share more from disinformation sources compared to their counterparts.*" If the decreased income is the cause of increased fake knowledge supply and consumption it should also have a negative impact on the scientific knowledge demand as depicted below in Figure 1.



Source: Own elaboration

Figure 1: The income effect decreases the demand for scientific knowledge

2.2 The Substitute Effect

The argumentation above implies that the demand curve for scientific knowledge produced will be shifting left to a new equilibrium reinforced to a certain extent by 1) the emergence of a substitute commodity offered by the GenAI, the MOOCs (the substitute effect) and due to 2) the increase in demand-supply of fake knowledge (caused by the income effect). These changes are depicted in Figure 1 above which illustrates hypothetical changes in the supply-demand of scientific knowledge. It shows both the reduction of knowledge production cost (from P_1 to P_2), increased aggregated supply (AS_1 to AS_2), and how a negative shift in income (I_1 to I_2) leads to a decrease in the aggregated demand for scientific knowledge, represented as a downward shift of the demand curve D_1 to D_2.

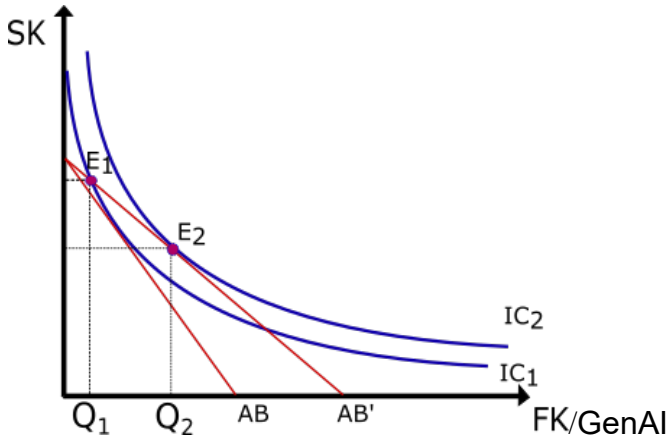
Another possible factor in facilitating fake knowledge production can be technological. Namely, digital technologies – Gen AI and the social media – have made it cheaper to produce and distribute fake/fabricated knowledge. According to Hopf et alia (2019, p. 3), fabricated knowledge is cheaper to produce than scientific knowledge because of "*the Internet and the capacity it provides for anyone in the world to be a publisher—to communicate any information they wish, true or false, instantly and globally"* while *"avoiding the gate-keeping role of the traditional press"* (Meddaugh, 2010, p. 377). In other words, the production cost of scientific knowledge is higher than the production of any other kind of knowledge (Kutrzeba, 2024). Consequently, as far as the market economy is concerned, the price for *FK* should be lower than the price of *SK* and this might have led to a change in consumer preferences due to the plummeting prices of *FK* relative to the prices of *SK*. The price for *SK* could be represented e.g. by the opportunity cost of investing in HE, the money invested in Research Institutions (data collection, instruments, grants etc.) and – where applicable – the tuition fees. The opportunity cost should be understood as "*… the income that would have been earned while a student is in school instead of working*" (Bloom and Rosovsky, 2007, p.447).

Defining the correct type of substitutability between such intangibles as knowledge is complicated though. Ungar (2000, p. 308) assumes "*that most of the public is not motivated to be scientifically literate*" but that such variables as the need-to-know perspective have a positive effect on knowledge acquisition – people with heart diseases tend to be more interested in the state of the art technologies around treatments for heart conditions in comparison to those that have not encountered heart diseases themselves. Apparently, the demand for HE is far greater than the supply, in other words, there are more applicants than places available as far as top European, Asian, African, and American universities are concerned (Trow, 2007; OECD, 2022). However, the reasons why people choose to invest in higher education (HE) seem to be explicitly linked to instrumental values such as employability factors (Sulkowski, 2016; Tavares, 2017) or parental expectations (Sojkin et alia, 2012) rather than educational ones (Tomlinson, 2018) and therefore the demand for HEs cannot constitute a sole indicator for the general preferability of *SK* over *FK* nor HE over the Massive Open Online Courses (MOOCs) as presented in Kutrzeba (2024). The latter was treated as a close substitute in the discussion above but MOOCs could be also treated as complementary goods as both of them are tuition-free in the EU yet there are still significantly more people (in the official total numbers) 'consuming' at traditional HE. Obviously, there must be something else than the price of the HEIs that makes them preferable to the MOOCs. The total amount of consumers at public HE in the EU is estimated at around 19,6 mln and 21,9 mln (Educationdata, 2019) in the US whereas MOOE had around 220 mln users worldwide in 2021, excluding China (Shah, 2021). Yet, the completion rate is 10 times greater for HE than for MOOE (Eurostat, 2016; Rothkrantz, 2017; Lee et alia, 2018).

Taking into account that the biggest decline in the demand for HE in Poland has been observed in the private sector, where tuitions apply, in contrast to the public sector where knowledge is provided 'free of charge', one could argue that the demand for scientific knowledge is relatively elastic. The situation is somehow different in the US and the UK where people are still massively attending costly universities even when the tuition fees have skyrocketed (Trow, 2007; Wilkins, Shams, and Huisman, 2013) although certain decreases in the overall enrollment rate might be inevitable in the forthcoming decade especially due to the falling demographics in the US (Grawe, 2018). In Germany, Bahrs and Siedler (2019, p. 118) have found evidence suggesting *"that even modest tuition fees of €1,000 per academic year can have considerable adverse effects on the educational plans and choices of high school students."* Consequently, the problem of defining the substitutability between the HEIs and the MOOCs becomes far greater as one considers that additional costs of education are associated with higher quality (Lima, R., Sampaio, L. M. B., and Sampaio, 2024). Hence, as far as higher education, scientific knowledge and the quality of Gen AI are concerned, it would be interesting to examine knowledge as a type of luxury good in its own right.

Taking into account the natural human inclination to seek and use scientific knowledge - which traditionally results from the scientific method - it could be assumed that fake knowledge is more likely to be a close rather than a perfect or complement substitute to scientific knowledge. Knowledge generated by GenAI on the other hand resembles a complement substitute because of its staggering accuracy, although easily distorted by eg. deliberately prompting fake data by the user. Consequently, fake knowledge could be 'a bad' as understood by knowledge economics, which according to Varian (2010, p. 41) "*is a commodity that the consumer doesn't like*" unlike the knowledge provided by Gen AI, whether true or fabricated. The exception here would be jokes that often rely on fabricated information, yet there are 'liked'.

As far as consumer preference theory (Varian, 2013) is concerned, the theory works well with a bundle of several goods too, but it cannot be drawn with more than two at a time. Given no change in the consumer's overall budget, Figure 2 below depicts a situation where the price reduction of *FK* (from P_1 to P_2, see Figure 1) results in the change of consumer preferences in disfavor of *SK* thus increasing the quantity demanded of *FK* from Q_1 to Q_2.



Source: Own elaboration

Figure 2: Convex preferences between *SK* and *FK/GenAI*

3. Conclusion

Changing consumer preferences, or the changing trends and the nature of the knowledge market is far more complex than it has been examined here. It would be interesting to examine it for example in the context of such political agendas as the sustainability goals promoted by the United Nations, the geopolitical conflicts and the info-war, or historical and scientific lies as posted by regular social media users (Pennycook and Rand, 2021), prominent politicians and scientists (Richie, 2020). A suggestion for further study is to research the causes of increased fake knowledge supply both from the sociological, psychological, and economic perspectives. It could be instructive to understand if gender, level and type of education, income, ethnical background (for instance based on one's mother tongue), or even personality with inter alia Cloninger's Temperament and Character Inventory (TCI), and see whether these results would have any correlation with the inclinations towards fake-knowledge consumption. From the cognitive perspective, Pennycook and Rand (2021) suggest that the reason why people share fake news is largely driven by inattention rather than by purposeful sharing of misinformation. Social media users have become mere puppets in the greater info war. From the business perspective, one of the causes could lie not only in the income shift but in rent-seeking, unproductive, or determined destructive activities as posited by Baumol (1990) which in business ethics could be attributed to egoism (Kutrzeba, 2024) and/or ignorance - lack of careful reasoning and relevant knowledge (Pennycook and Rand, 2021). What is morally challenging, as some researchers maintain, is that egoism *"is not necessarily evil"* (Werhane, 2000, p. 193) in certain contexts, and as Smith (1776/2007, p. 16) suggested, "*it is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own interest*". Nevertheless, Smith also noticed that even the egoism of merchants and manufacturers can lead to unethical actions; he (ibidem) observed that it lies in their interest to restrict the competition which is contrary to the public interest. The distribution of obvious lies to the public, whether intentionally or mistakenly is depriving and deteriorating trust. Hence mistakes and fake knowledge offered by public figures must be perceived as degenerative, and those provided by Gen AI, as morally legitimate - as long as the applications are programmed to serve the science.

4. Limitations and Future Directions

A huge although relentlessly undermined problem in the sciences in general is the demarcation problem of the phenomena researched. Especially from the knowledge management perspective, the definition of truth, or the concepts concerning what is fake or what is true is one of the most difficult parts for rigorous and critically constructive minds to settle. As long as the economic and psychological mechanisms behind the change in consumer preferences are quantitatively measurable, the qualitative part shall always remain disputable. This is due to the paradigmatic nature of science, especially when the social sciences are concerned.

Further research into how income disparities and technological advancements influence the demand for different types of knowledge is needed. The tension between the convenience of GenAI-generated content and the value of scientifically produced knowledge will most probably escalate. Hence, raising awareness, skills, and competencies in the use of technological marvels will be on demand - both for the integrity of the scientific community, the morality of public institutions and consequently for the sake of the general population's well-being.

Ethics Declaration: This study was conducted by all applicable ethical guidelines.

AI Statement: AI tools were used in writing the abstract for the article. The author confirms that generative artificial intelligence was not used in the writing of the manuscript or the creation of graphs or their corresponding captions.

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Entrepreneurial Orientation and Knowledge Integration: The Case of Mature Companies

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Abstract: The dynamically changing environment of companies, in addition to the continuous collection and analysis of information, forces adaptation to the internal and external conditions of the business environment. Adaptation of companies and maintaining a competitive advantage is possible thanks to appropriate actions of the organization, including knowledge management, which consists of a number of elements and actions. It can be indicated that the knowledge resources of the organization are the most important source allowing for gaining a competitive advantage, and knowledge management (KM) is an important element of the entire process of managing the organization. One of the areas in the process of managing the organization's knowledge is knowledge integration (KI). According to the literature review, KI is an important element influencing the company's results, the ability to collect and process the organization's characteristic information resources, and is of key importance, among others, for the innovativeness of companies. The literature review indicates that many organizational behaviors correlate with KM, including entrepreneurial orientation (EO). The EO concept describes strategic behaviors of enterprises expressed by the desire to implement innovations, take risks, and take proactive actions more intensively than competitors. The paper is based on a review of international literature and the results of own research on a group of mature companies. The aim of the article is to identify dimensions of EO that affect KI in organizations. The actual research was preceded by a pilot study. During the study, an original questionnaire was used. The study involved 280 randomly selected Polish enterprises. The analysis conducted using descriptive statistics and linear regression indicated the relationship between dimensions of EO and KI in the organization. In addition, it enabled the identification of EO dimensions, which dimensions influence the level of KI in the organization. The conducted study has limitations, but it also constitutes a contribution to science. The novelty of the article is the indication of dimensions of EO that correlate most strongly with the level of KI in the organization.

Keywords: Entrepreneurship, Entrepreneurial orientation, Knowledge management, Knowledge integration, Mature enterprises, Poland

1. Introduction

There are many studies in the international literature on the relationship between entrepreneurial behaviors, including EO and KM. This prompted the authors to undertake both literature and empirical research in the area of the relationship between EO dimensions and specific activities in the field of KM, i.e., KI. EO has a significant impact on KM in companies because it shapes the way an organization makes decisions, uses its resources, and responds to changing market conditions (Cherbib, 2024; Zhou, 2011). EO is associated with high flexibility and the ability to quickly adapt to changing market conditions (Purkayastha and Gupta, 2022). In the context of KM, EO influences how a company collects, shares, processes, and uses knowledge to gain competitive advantage and achieve strategic goals. Entrepreneurial-oriented companies treat knowledge as a key resource that can provide them with a competitive advantage (Lattacher et al., 2021). Therefore, they invest in the development of KM systems and processes, including KI, which help them better use intellectual resources, as well as respond faster to business changes.

It can be indicated that EO in companies creates conditions for dynamic development and effective use of knowledge (Wiklund & Shepherd, 2003). Entrepreneurs in such organizations are more willing to invest in mechanisms that enable the collection, exchange, and integration of knowledge in everyday activities, which directly affects the company's success on the market. KI in companies is not only a matter of information management but also a key element supporting, among others, innovativeness, operational efficiency, and the ability to adapt to a changing market (Caridi-Zahav, Carmeli & Arazy, 2016). In mature companies that are going through change processes, KI is important for employees and managers to effectively manage this change. The flow of information about the goals, strategies, and change processes facilitates adaptation and minimizes resistance to new solutions. Through proper KI, organizations can better use their intellectual resources, which translates into long-term success and competitiveness.

The aim of the paper is to identify dimensions of EO that affect knowledge integration in organizations. The results of the research on a group of Polish mature enterprises allowed for an analysis using descriptive statistics and nonparametric statistics, adequate to the purpose of the study. The paper contributes to science by identifying dimensions of EO that positively affect activities in the area of KI in mature enterprises.

2. Literature Review

2.1 Entrepreneurial Orientation

Entrepreneurship understood as the pursuit of a goal by a company in a competitive market is one of the organizational features (Stevenson & Jarillo, 1990) that determine success in a changing business environment. One of the most common conceptualizations of entrepreneurship at the organizational level is entrepreneurial orientation. EO is a key concept that reflects the strategic attitude of a company towards entrepreneurial activities, as shown by its processes, practices, and business activities in a competitive environment (Jogaratnam, 2017). The concept of EO developed by Miller (1983) and refined by Covin and Slevin (1989) was initially perceived as a construct reflecting a firm's propensity for innovation, proactivity, and openness to risk taking. Over time, these dimensions were enriched by two more, namely autonomy and aggressive competitiveness (Lumpkin & Dess, 1996). These dimensions reflect the willingness, propensity, or ability of a company to engage in entrepreneurial behavior and the type of decision-making that leads to strategic renewal (Kusa, Suder, & Duda, 2024). Accordingly, EO shows how a company is organized to best utilize its capabilities (Zhao et al., 2011). Furthermore, EO reflects a firm's willingness to undertake entrepreneurial activities, effectively respond to current needs, and anticipate future market needs (Hughes et al., 2018). It turns out that EO can be a source of value creation in an organization only when companies acquire, develop and use their strategic resources, developing a competitive advantage at the same time (Cherbib, 2024). Since EO is associated with both acquiring new resources and improving existing ones, it is necessary to implement simultaneous activities in both the areas of search and development (Lee & Kreiser, 2018). Success depends on the skills and competencies of team members who drive goal achievement and knowledge building (Borodulin, 2024).

Existing literature identifies EO and its implementation as the main strategies used to overcome the negative effects of the crisis. It emphasizes the key role of a firm's EO in operational and strategic performance in a turbulent and uncertain environment (Morgan & Anokhin, 2020). It turns out that EO activities allow overcoming uncertain and difficult business conditions and ensuring survival and success (Cegarra-Navarro et al., 2019). Therefore, companies implementing EO should monitor and analyze the business environment in order to detect new opportunities, new markets, and increase their resources (Kollmann et al., 2021). Moreover, companies that are simultaneously engaged in activities within the dimensions of EO are usually perceived as dynamic and flexible because they make proper use of new opportunities that emerge in the competitive market (Purkayastha & Gupta, 2022).

Entrepreneurship research (Kamble et al., 2023) has shown that start-ups cannot develop this type of EO because they lack strategic resources. Mature companies often have limited growth opportunities in the current market (Klepper, 1997), but through their experience and strategic resources they try to mitigate the traps of organizational maturity. This happens through increased competition or entering new markets (Zhou, 2011). One of the areas influencing the growth of organizational competitiveness in the case of this group of companies is proper KM, including activities in the area of KI in the organization.

2.2 Knowledge Integration in Enterprise Management

The high level of competition in current markets, the variability and unpredictability of the business environment create conditions for the management of companies. This is the pressure that companies must overcome in order to compete and develop. The organizational behavior of companies, including flexibility, agility in learning and KM, allows companies to adapt to changing organizational conditions (Lyu et al. 2020).

Knowledge as a strategic resource of an organization is a source of lasting differentiation and thus competitive advantage. KM in a company (Wiklund & Shepherd, 2003) combines dynamic capabilities and possibilities, information and technological practices. Thanks to this, a company can more precisely predict the direction and potential of changes in the business environment. Moreover, a company can determine the adequacy of its actions in the current environment, both in the area of strategic and tactical actions.

Knowledge is difficult to measure or audit, and companies, as Di Vaio et al. (2021) point out, must effectively manage it to fully leverage the skills and experience inherent in organizational systems and structures and to combine and share the knowledge held by company employees. It is a process that helps organizations find, select, organize, disseminate, and transfer the key information and knowledge necessary to conduct business. As indicated by Omerzel and Gulev (2011), the method of action, speed of action and effectiveness of knowledge use in management are conditions for maintaining competitive advantage. It also turns out that the inability and inability to act in the area of KM determines obstacles in achieving and creating competitiveness of the company, as well as in the development of the company.

KM is defined as the ability to manage information, including collecting knowledge from internal and external sources, transforming it into new strategies or ideas, and implementing and preserving it (de Bem Machado et al., 2022). KM encompasses many activities, companies, among others, generate available knowledge from the business environment, systematically collect knowledge and optimally use it to achieve a competitive advantage, disseminate it among employees, enrich knowledge through its integration and dissemination (Brzostek, 2015). A number of processes are involved in collecting, sharing, transferring, or transforming knowledge, and then applying it in the organizational activities of the company. Knowledge creation is a key advantage of the KM approach, due to the fact that companies in contemporary market conditions must anticipate markets, be flexible and adapt to rapid market changes, and overcome development problems within the adopted competitive strategy (Galli & Lopez, 2018). The literature review confirms that KM can help achieve these goals (Chen et al., 2022).

The key to acquiring new opportunities lies not only in the effectiveness of individual knowledge management processes but also in the way knowledge is integrated (Shaw and Williams, 2025). KI is the ability to manage and use existing, but also newly acquired knowledge in enterprises (Caridi-Zahav, Carmeli & Arazy, 2016). KI allows enterprises to acquire new knowledge, share and use new and existing knowledge, and these activities are a prerequisite for achieving a market advantage (Eslami, Lakemond & Brusoni, 2018). KI includes the use of expertise to implement new initiatives, the integration of external knowledge with the company's existing knowledge, the integration and application of external knowledge in new projects, a shared understanding of roles and responsibilities in jointly carrying out a task, a shared understanding of the processes required to complete a task, and a shared interpretation of organizational rules (Caridi-Zahav, Carmeli & Arazy, 2016; Lyu et al., 2022). Organizational success requires the integration of systems, operations, people, customers, partners, and management. It is positively related to the ability to manage knowledge, which generates competitive advantage (Latilla et al., 2018).

The above arguments and observation of the business environment of companies allowed the formulation of the following research hypothesis: H1. Mature companies with a higher level of entrepreneurial orientation achieve a higher level of knowledge integration.

3. Methodology

The aim of this article is to identify dimensions of EO that influence KI in organizations. The results presented in this paper are part of a larger study.

The actual research was carried out in stages and was preceded by pilot research. The pilot study involved 20 purposefully selected mature companies operating in southern Poland. Companies that have been operating on the market for over 5 years were selected for the study due to their development and organizational processes occurring during their operations. After the initial formal analysis and elimination of incorrectly completed survey questionnaires, 280 randomly selected production and trade companies participated in the actual study. Among the respondents according to the size of employment (classification in accordance with EU guidelines), 35.0% were microenterprises, 26.4% small enterprises, 17.5% medium-sized enterprises and 21.1% large enterprises.

The review of international literature and the results of the pilot study enabled the construction of an original research tool for quantitative research, a survey questionnaire. The survey questionnaire consisted of a metric and closed questions relating to selected aspects of management in the organization, including EO and activities in the area of KI in the enterprise. A direct method of data collection was used.

The research questions identified the level of EO in each of the five dimensions (Lumpkin & Dess, 1996), i.e., organizational autonomy (EO1), proactiveness (EO2), innovativeness (EO3), competitive aggressiveness (EO4), and risk taking (EO5). The level of KI was identified based on six subvariables, and the final KI variable is their average. The Carlile (2004) scale was used to assess KI, which refers to the communication pattern of company employees in order to understand individual roles, a common interpretation of company rules and processes required to complete a task. In addition, the Caridi-Zahav, Carmeli and Arazy (2016) and Lyu et al. (2022) KI assessment scale was used. Due to the social nature of management sciences, the managerial approach was used as indicated by Sheng, Zhou and Li (2011) and Peng and Luo (2000). The survey responses were on a 5-point Likert scale. The scale was constructed in such a way that 1 means "strongly disagree" and 5 means "strongly agree".

4. Results

The first stage, before the analysis of the study results, was the evaluation of the research tool. For this purpose, internal consistency analysis was used using Cronbach's alpha coefficient (Tavakol & Dennick, 2011; Taber, 2018). The reliability tests performed showed that the scales constructed in the research tool meet the criteria presented by George and Mallery (2016). It turned out that all subscales for the EO scale achieved satisfactory reliability ($\alpha > 0.70$), and all subscales for the KI scale achieved good ($\alpha > 0.80$) or excellent reliability ($\alpha > 0.90$) (Table 1).

Table 1: Reliability

Variable	Cronbach's α
EO	0.777
EO1	0.755
EO2	0.743
EO3	0.703
EO4	0.742
EO5	0.738
KI	0.913
KI1	0.902
KI2	0.899
KI3	0.898
KI4	0.892
KI5	0.894
KI6	0.899

The research showed that the average level of KI in the surveyed companies was 4.057 on a 5-point Likert scale and this level deviates from the average value by +/- 0.703 points. In turn, the level of EO in general was 3.733 on a 5-point scale and this level deviates from the average value by +/- 0.813 points. The highest level of EO in the surveyed companies was indicated in the proactivity dimension at the level of 3.996; however, no significant differences were found between the distinguished dimensions.

In the next stage of the study, it was checked whether the individual dimensions of EO were related to KI activities. It was examined whether there was a linear relationship between the variables, for this purpose the Kendall tau-b correlation coefficient was used. Further data analysis showed that initially the correlations between the variables were identifying. It turned out that the relationships between the variables are statistically significant for the level of $p < 0.05$. The value of the index ranged from $r = 0.281$ to $r = 0.546$ (Table 2), which indicates a moderate to strong positive character. It can be concluded that the prepared regression analysis is correct.

Table 2: Descriptive statistics and correlation analysis (n = 280; p < 0.05)

	M	SD	EO1	EO2	EO3	EO4	EO5	KI
EO1	3.907	0.987	1.000					
EO2	3.996	0.993	0.417	1.000				
EO3	3.825	1.024	0.509	0.546	1.000			
EO4	3.514	1.270	0.281	0.337	0.469	1.000		
EO5	3.421	1.273	0.339	0.347	0.431	0.522	1.000	
KI	4.057	0.703	0.378	0.443	0.467	0.360	0.334	1.000

The impact of the four distinguished dimensions of EO on the implantation of KI in the surveyed companies was assessed using linear regression analysis. The KI level was included as a dependent variable in the regression. The multivariate linear regression analysis was conducted using the stepwise method, which allows for examining the significance of the next variable introduced, as well as examining a different ordering of variables

at each step (Montgomery, Peck & Vining, 2012). Table 3 presents the modeling results after entering all variables. The model ultimately left four variables: EO1, EO2, EO3, EO4, which are statistically significant ($p < 0.05$). The fit of the model to the data was assessed by the R^2 coefficient, which was 0.3036, so it can be indicated that the four variables that entered the model at $p < 0.05$ explain it by 30.36%.

Table 3: Modelling result, final model

n = 280	b*	SD with b*	b	SD with b	T (274)	p
Intercept			2.199	0.178	12.349	0.000
EO1	0.130	0.060	0.093	0.043	2.159	0.031
EO2	0.218	0.062	0.154	0.044	3.517	0.000
EO3	0.196	0.069	0.135	0.047	2.843	0.004
EO4	0.124	0.062	0.069	0.035	1.988	0.047
EO5	0.065	0.062	0.036	0.034	1.045	0.296
Multiple R = 0.55100224; R^2 = 0.30360346; Adjusted R2 = 0.29089550; F(5.274) = 23.891; p < 0.0000; Standard error of estimation = 0.59220						

5. Discussion

Research on a group of mature companies has shown a positive relationship between the level of EO in the following dimensions: organizational autonomy, proactivity, innovativeness and competitive aggressiveness and the level of activities in the area of KM, including KI. The formulated hypothesis H1 was confirmed.

International research confirms the assumptions made in this paper that knowledge is necessary for the development of entrepreneurial attitudes and orientation (Bouguera et al., 2023). Moreover, knowledge is a key factor that positively moderates the entrepreneurship process (Lattacher et al., 2021). The entrepreneurship process is important and exposed to seek opportunities, and knowledge allows organizations to identify and exploit those opportunities that strengthen the entrepreneurship process (Hughes et al., 2022). On the other hand, EO, as a key concept for entrepreneurship (Jogaratnam, 2017), promotes the use of market opportunities, taking action, and responding to market behaviors (Zhao et al., 2011; Hughes et al., 2018). In order for a company to develop and fully utilize its resources by creating value in the organization, it is necessary to acquire new knowledge or manage existing knowledge (Cherbib, 2024). KM, including the process of integrating knowledge and related mechanisms and practices, not only improves market competitiveness but also creates new space for entrepreneurial opportunities and activities (Paul et al., 2023). KM includes activities related to knowledge generation, knowledge storage, and knowledge use and sharing (Mao et al., 2016). Reus, Ranft and Adams (2009) assumed that knowledge is a key competitive advantage, i.e. the more effective actions in the area of KM the company undertakes, the greater the benefits for the company will be. Since the entrepreneurial approach supports actions in the area of knowledge management, it can be indicated that it leads to the improvement of the management of the company as a whole and supports the development of its entrepreneurial process. It can therefore be assumed that the entrepreneurial approach results in the development of processes in the organization that focus on actions in the area of acquiring necessary information and knowledge and actions in the area of KM.

6. Limitations and Future Research Directions

The research conducted by the authors is not free from limitations. Research limitations may affect the analysis and interpretation of research results. They may also affect future research directions. Among the limitations, the size of the group that operated in a given region of the country should be mentioned first and foremost. The selection of a broader research group and a nationwide or international study would allow for generalization of the results. In addition, the sectoral division of enterprises could allow for conducting analyses in several ways in the future, which may have a positive impact on the conclusions drawn. It is worth mentioning that the authors also plan to expand their research in the area of analyzing the conditions for the growth of entrepreneurial orientation, including in the aspect of digitalization, dynamic organizational capabilities, and knowledge management.

7. Conclusion and Implication

To sum up the research results, it should be emphasized that there is a bilateral relationship between the level of EO and the level of activities in the area of KI. Strengthening activities in the area of entrepreneurship at the organizational level, i.e. EO in the dimension of organizational autonomy, proactivity, innovation, and aggressive competitiveness, has a positive impact on the level of activities in the area of KM, including KI. In this context, it can be indicated that the authors have expanded the current state of knowledge regarding the relationship between EO and KI. The research results indicated which dimensions of EO positively influence the level of KI, causing implications for management practice. It turned out that EO positively influences:

- using specialist knowledge to implement new initiatives,
- integrating external knowledge with existing company knowledge,
- integrating and applying external knowledge in new projects,
- shared understanding of roles and responsibilities in jointly implementing a task,
- shared understanding of the processes required to complete a task,
- shared interpretation of organizational principles.

These are aspects, the strengthening of which, as indicated by the review of international literature, improves the functioning of enterprises in the currently changing business environment. The advantages of building a knowledge-based organization are now unquestionable, and entrepreneurs should adopt entrepreneurial attitudes, including processes, practices and business activities, in order to create the right combinations of company resources and use the acquired and integrated knowledge in a competitive market environment.

AI declaration: I confirm that no AI tools were used to the creation of this paper.

Ethics declaration: I declare that ethical clearance was not required for the research.

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The Dharma of Knowledge: Bridging Ancient Indian Practices and Contemporary Thought

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Abstract: The present study aims to explore the foundations of knowledge management and sharing as seen in Ancient Indian culture. In a world that is making significant strides towards digitisation, knowledge management serves as an essential tool for efficiency, innovation and cultural continuity. Contemporary systems rely on technological infrastructure, but ancient civilisations developed sophisticated practices to ensure knowledge sharing and management. The study will delve into classical texts such as the Vedas and Brahmanas – which provide spiritual wisdom; Arthashastra – which offers administrative and economic knowledge; Manusmriti – which served as a benchmark for legal codifications, and other related texts. These works, while mainly religious and political, provide profound insights into the generation, transmission, and regulation of knowledge in Ancient Indian society. The study will involve thematic and textual analysis to understand the pedagogical frameworks, oral teachings, institutions such as Gurukulas, and the duties and information mentioned in the relevant texts; the research will uncover practices and principles of knowledge management and sharing. Drawing from these historical insights, the end goal of the study is to create and propose a model that can be incorporated into contemporary education systems to bridge ancient epistemological paradigms with contemporary organisational needs. This model can serve as a foundation for an enhanced knowledge management system, inspire the younger generations to understand the value of ancient wisdom and lead to further innovation in interdisciplinary studies by offering a culturally grounded yet universally relevant framework for knowledge management in the 21st century. Ultimately, this study aims to deepen our understanding of how oral traditions in ancient India successfully preserved and transmitted knowledge across generations long before the widespread use of script and writing.

Keywords: Knowledge management, Ancient Indian texts, Oral traditions, Gurukula system, Epistemology

1. Research Methodology

The study has adopted a qualitative and interpretive analysis of primary sources from ancient Indian literature, namely the Rigveda, Arthashastra, and Manusmritti. The textual and thematic analysis of these texts focuses on identifying implicit and explicit references to the creation, preservation, transmission and application of knowledge in ancient India. The method used is textual discourse, where ancient verses and principles were interpreted through a modern light that incorporates contemporary knowledge management frameworks. These texts were chosen because they lay the foundations of knowledge in terms of cultural significance, temporal breadth, and thematic richness in matters of education, governance and epistemology for matters such as education, epistemology and governance. Attention was paid specifically to how oral traditions, social structures, and ethical frameworks functioned as early knowledge systems when compared to modern frameworks. Each text was studied contextually, with insights that were brought through secondary literature to enable further understanding and establish a solid context.

2. Introduction

Knowledge as a concept is a very broad and complex notion. The Cambridge English Dictionary defines knowledge as the understanding of or information about a subject you get through experience or study, either known by one person or people (Cambridge Dictionary, 2019). Knowledge has existed ever since our ancestors gained consciousness and the ability to process thought. One can relate it with innovation; for instance, the Homo Habilis developed the thought process to develop the hand-axe using stone, eventually building upon it to arrive at spears, arrows, swords and other weapons along with farming tools by the time the species evolved into Homo Sapien Sapiens. When one talks about knowledge in an epistemic and intellectual way, some might argue that it started in ancient Greece with the advent of Socrates in the 5th century BCE.

Modern knowledge frameworks are built on this, although in academia, it emerged as a discipline in the 1990s, with foundational contributions from scholars such as Ikujiro Nonaka and Hirotaka Takeuchi. They presented the SECI model – Socialisation, Externalisation, Combination, and Internalisation. The model described how tacit and explicit knowledge was created and maintained whilst enabling sharing within organisations. These frameworks focused heavily on the role of individuals, institutions, and structures in shaping the flow of knowledge. While most of the research in this domain is rooted in the corporate or business world, this paper seeks to bring light to how knowledge management systems, especially one from Ancient India, can improve modern education systems.

Ancient India is often considered to be a hub of knowledge and wisdom. Even if the colonial notion had been that India was never rich in history and knowledge, ancient texts challenged this notion. The presence of texts such as the Vedas, Brahmanas, Upanishads, Arthashastra, Manusmriti, and the Samhitas proves the fact that knowledge as an intellectual notion and knowledge management systems (KMS) existed way before the era of kings and polity.

In the contemporary world, knowledge management is usually related to business, wherein various management systems are used to find sustainable ways to help promote a firm's progress. It is defined as identifying, organising, storing and disseminating information within an organisation (IBM, 2021). Based on this, Alavi and Leidner point out that the objective of KMS is to support the creation, transfer, and application of knowledge in organisations (Alavi and Leidner, 2001). However, this study aims to shift the orientation of this notion towards education, especially in India. By learning from age-old texts, the hope is to understand the current scenario of the education system in contemporary India.

According to a press release by the Ministry of Finance, posted on the 22nd of July 2024, about 4.33 crore students were enrolled in higher education in the Financial Year of 2022 (Government of India, 2017). The Ministry noted an increase of 26.5% since the Financial Year 2015. Similarly, a report published on the UNIFIED DISTRICT INFORMATION SYSTEM FOR EDUCATION PLUS (UDISE+) 2023-2024 by the Ministry of Education declared in its findings that within the Indian school Education system, there are nearly 14.72 lakh schools, more than 98 lakh teachers and almost 24.8 Crore students from pre-primary to higher secondary level from varied socio-economic backgrounds (GOVERNMENT OF INDIA, MINISTRY OF EDUCATION and DEPARTMENT OF SCHOOL EDUCATION & LITERACY, 2024). The report also highlighted the dropout rates of 1.9%, 5.2%, and 14.1%, respectively, at primary, upper, and secondary levels. The Ministry claimed that increasing the cost-effectiveness of public spending on education requires spending on pedagogy and governance. Officials suggested introducing supervisory positions to monitor teaching quality, scrutinising teacher performance, and hiring local volunteers to ensure 'teaching at the right level.' The argument was based on the fact that textbook knowledge would not be enough since children would still lack curricular standards. However, as of now, the claim remains a claim and nothing else. The New Education Policy of 2020 has helped improve the educational sector by a large margin, but inefficiencies remain. Although solving all of the problems within the system may take time, which the Government also agrees with by setting up a deadline of solving the issues by 2030, significant strides can be made by incorporating the knowledge management systems of ancient India into the contemporary education system.

3. Analysis of Literary Texts

3.1 Vedic Literature

India has always been a hub of insightful texts that have provided information that transcends time to this day. The Vedas are a perfect example of this statement. The term *Veda* itself means wisdom. The texts have laid the foundations for religious, spiritual and philosophical insights, comprising four: Rigveda, Samaveda, Yajurveda, and Atharvaveda. However, the main text is always considered the Rigveda since all the other texts are built upon its hymns. These hymns not only include practices that promote religion, but they also include guidance towards environmental preservation and maintenance, education and knowledge management. It can be understood that Ancient Indian society focused on education to build a person's character whilst providing them with holistic knowledge of the world. Knowledge in India is termed as *vidya*, and the Vedic society believed that if education did not raise the spirituality and humanity within a person, it could not be considered as *vidya*, even if the person gained intelligence (Banerjee and Mahato, 2022).

“Vedic system of education in ancient India, more than three thousand years ago, designed the educational curriculum of the then Indian society in such a way where learning and application of the 'Apara Vidya' (worldly knowledge) was firmly based upon the philosophy of 'Para Vidya' (knowledge of self), or for the sake of our simple understanding, which we may call Dharma ‘or spirituality (Banerjee and Mahato, 2022).” The Rigveda provides us with knowledge that spreads over every field, but if one were to focus on its educational aspects, the text would be one of the most important in Ancient India. The educators were well-versed in the knowledge of the Vedas, and they understood the importance of external factors affecting a student’s education. “The ultimate aim of the ancient Hindu education system was to produce a person morally correct, spiritually inclined, socially responsible, respectful to tradition and holy spirits or gods, environmentally conscious, and a family person (Nath Ganguly, 2020).” The most interesting fact is that all the knowledge that was transmitted was done orally; the system of oral education in India was called *Gurupāramparya*, which means the uninterrupted ideal succession of pupils and teachers, by which knowledge is conserved and transmitted (Kokić and Tonći Kokić,

2024). This method showcases a knowledge transfer mechanism that is fundamental in creating an effective knowledge management system, ensuring continuity and integrity. In his paper, Ganguly (Nath Ganguly, 2020) quotes Max Muller, "How then were these ancient hymns and the Brahmanas, and it may be, the Sutras too, preserved? Entirely by memory, but by memory kept under the strictest discipline." This disciplined memorisation of knowledge can be interpreted as an early form of knowledge validation and quality control, which are key in maintaining accurate knowledge banks. This gives us insight into how knowledge management systems work, not by constantly bombarding with facts, but by maintaining discipline through a teacher's conduct and how he would treat his students. This gives us an insight into how the knowledge management systems worked in Vedic society. Here, ethical considerations regulated the spread of knowledge while preserving its value and, most importantly, its relevance. In contemporary India, it is often seen that teachers see themselves as superior to students and usually resort to belittling them and, in some cases, resorting to physical violence. Within the Vedic literature, this was not the case; teachers were supposed to instruct the students in a way that would benefit them. Punishment will be vocal and mild to start with. Only when the conduct was severely wrong to them will the student be punished with a split bamboo for the sound effect or a rope to hit the student on the fleshy parts. Never be the child hit on the face, stomach, and perineum with such contraptions (Nath Ganguly, 2020).

Analysing particular verses of the Rigveda, "Allied by worship, let him give man knowledge: by an extended cord they lead him onward (Griffith, 1896)." The verse provokes collecting reverence, enabling the transmission of wisdom through a structured and continuous lineage, which can be interpreted as a metaphor for oral systems that sustained Vedic rituals. Furthermore, the text also states, "Bring forth your gifts to his refulgent splendour, your hymn as purest offering to Agni, to him who goes as messenger with knowledge between all songs of men and Gods in heaven (Griffith, 1896)." The verse symbolises the role of intermediaries in conveying knowledge and safeguarding it. This transmission of knowledge, however, does not come without ethical conditions and warns us about hollow participation in spreading knowledge. It states, "Worship, thyself, O God, the Gods in heaven: what, void of knowledge, shall the fool avail thee (Griffith, 1896)?" The Rigveda also provides insight into how concealment of knowledge and dishonesty are enemies of learning and spreading knowledge; it states, "Guile follows close the untruthful men: no secrets may be hidden from your knowledge. (Griffith, 1896)" Conclusively, the Rigveda talks about knowledge as a divine gift and not only says that one who has an understanding of the origin of knowledge will be free of ignorance and will distribute this divine gift with purpose; the verses state, "She who hath knowledge Of the first day's nature is born refulgent white from out the darkness; As she who in her parents' house is growing old, I pray to thee as Bhaga from the seat of all. Grant knowledge, mete it out and bring it here: give us the share wherewith thou makest people glad (Griffith, 1896)." The symbolic language in these hymns highlights the role of knowledge intermediaries who act as keepers of sacred knowledge, safeguarding its transmission and ensuring its spread while maintaining its ethical boundaries, an essential feature of knowledge management frameworks. Overall, the Rigveda presents knowledge as a divine gift, underscoring the necessity of purposeful, ethical, and sustainable knowledge management practices to support societal evolution and prevent stagnation.

3.2 Arthashastra

The Arthashastra is regarded as one of the most influential books on polity and statecraft in Ancient India. Authored by Kautilya, the book covers all aspects of statecraft, from a king's duties to how a state should function. Kautilya emphasises the education a king should receive and how to implement it. Within Book 1 of the Arthashastra, Chapter 2, titled "*Determination of the place of Anvikshiki",* talks about the sciences a king should be versed in and the place of *Anvikshiki* (the science of inquiry). Kautilya states that *Anvikshiki* comprises the Philosophy of *Sankhya* (interpreted as Practical Knowledge), *Yoga* (interpreted as activity without attachment), and *Lokayata* (interpreted as direct perception). In light of all the other sciences that are present, Kautilya argues that *Anvishaki* is the most important since it keeps the mind steady and firm in all situations and bestows excellence of foresight, speech and action (Kauṭalya, 2010). Ami Ganatra points out that Chanakya's emphasis on philosophy is based on the fact that the Sanskrit word for philosophy is *Darshan,* which translates to 'seeing' or 'perceiving', therefore asking for a king to have the correct perception (Ganatra, 2016). Having the proper perception and not being biased leads to better decision-making. This is an essential skill to learn, not just for a king but also for an ordinary man. In the contemporary world, textbooks are no longer thought-provoking and just contain information without building a student's thinking ability. By incorporating the principles of *Anvikshiki* into modern education, students will develop a new way of understanding things that will promote innovation and critical thinking, leading to faster and more accurate decision-making, which they can apply in the academic world and the professional world, especially in business organisations.

Similarly, in Chapter 8, titled "*Creation of Ministers*" of Book 1, Kautilya talks about appointing the king's ministers. He agrees with *Báhudantî*'s son that a man with only theoretical knowledge and no practical political experience will commit blunders; he adds that a man's ability is inferred from his capacity shown in work and by differences in the working capacity (Kauṭalya, 2010). Although Kautilya here highlights the importance of the practical knowledge of a king in terms of choosing his ministers, this perspective highlights a crucial tenet of knowledge management, i.e., practical knowledge is of utmost importance since a student who has learned through experience will be much more valuable than a student who has learned theoretically. This distinction aligns with the basic principle of modern knowledge management: the difference between explicit knowledge (theoretical) and tacit knowledge (experiential). Kautilya's emphasis on evaluating a minister based on his performance reflects that tacit knowledge was recognised systematically before the fundamentals of modern knowledge management were written down. By prioritising practical competence, he advocated for a holistic approach to knowledge management beyond formal learning, which modern education systems should implement.

The most crucial knowledge management system in the Arthashastra is the management of spies and the espionage system that the king oversees. The Arthashastra requires the king to set up various departments of spies to keep a check on the activities happening inside his kingdom and to ensure that there is no misinformation being spread by cross-checking the information he receives. In Chapter 13, Kautilya highlights that to protect the state from internal and external factors, a wise king would guard factions among his people, friendly or hostile, powerful or powerless, against the intrigue of foreign kings (Kauṭalya, 2010). Kautilya highlights that all the information a king receives should be written down, which we can see Ashoka of the Mauryan Dynasty built upon by inscribing his edicts and ordering his ministers and officials to write down every order issued by the king. This reflects an early recognition and institutionalisation of the central concepts of modern knowledge management systems, i.e., the need for systematic information verification and internal knowledge audits.

By analysing the aspects of the Arthashastra highlighted above, it can be inferred that Kautilya never limited the learning of a king only to the theoretical aspects. He emphasised understanding every aspect of life, including philosophy, sciences, history and polity. Leaving out any information on the concerned disciplines will only spread chaos since the king would be misinformed and not knowledgeable enough to tackle any situation that arises. Historians date the book to c.3rd century BCE; it is one of the most relevant and essential texts on statecraft and polity, which can help modern-day knowledge management systems in the education sector and inspire innovation.

3.3 Manusmriti

The Manusmriti, often referred to as the Laws of Manu, is one of the most essential and ancient texts in Hindu jurisprudence, believed to have been composed around 200 BCE to 200 CE. Attributed to the sage Manu, the text provides a comprehensive code of ethics, duties, and societal laws that govern human behaviour, social order, and governance. It covers various topics, from personal conduct and family life to legal matters and the administration of justice. While its core focus is on dharma (righteousness) and the social roles of individuals within the varna (caste) system, the Manusmriti also offers insights into ancient Indian views on nature, sustainability, and social responsibility. Though revered and criticised over the centuries, the Manusmriti remains foundational in studying ancient Indian law, culture, and ethics.

While the Manusmriti does not exactly refer to knowledge management systems, it provides insight into the dissemination of knowledge; the text supports several Knowledge Management principles. One such principle is hierarchical transmission: knowledge, especially sacred knowledge like the Veda, is meant to be transmitted through specific social channels, typically from teacher to worthy disciple. The text talks about hierarchical transmission of knowledge and textual adaptation, aligning with the concept of tacit knowledge transfer. The Manusmriti also reflects textual adaptation and epistemic flexibility since the society went from orally transmitting knowledge to textual dissemination. As Lariviere notes, "Not only was the adaptation of textual tradition to the changing needs of society implicit in the development of the *dharmashastra,* but it was also explicitly recognised within the tradition (Lariviere, 2009)" This can also be interpreted as - the *dharmashastra* tradition of disseminating knowledge was not rigid or fixed but instead it evolved with society. The same should be applied to contemporary education systems, but we see cases where schools and universities use outdated curricula to educate and provide knowledge. The text explicitly mentions the need for scrutiny and promotes critical engagement with knowledge. It states, "A learned man, after fully scrutinising all this with the eye of knowledge, should, by the authority of the revealed texts, be intent on (the performance of) his duties (Bühler,

2024)." Not only did the text provide insight into how a knowledgeable man behaves, but it clearly stated that the knowledge one spreads should not be spread to a person who does not pay heed to its importance. It states, "Even in times of dire distress, a teacher of the Veda should rather die with his knowledge than sow it in barren soil (Bühler, 2024)." The Manusmriti may not have been designed as a text discussing knowledge management systems. Still, it talked about knowledge as one of the most sacred parts of human existence. It highlighted the importance of societal evolution and the need for a dynamic system to ensure that society would continue to spread knowledge systematically and truthfully. When a society refuses to focus on innovations, systems are bound to suffer, leading to inconsistencies.

4. Systems of Gurukulas

The ancient Indian education system was built on offering knowledge through Gurukulas and universities like Nalanda University for higher education. "These systems focused on a person's overall development, including their spiritual, moral, and intellectual growth. Today, the education system is more structured, focusing on academic achievements, skills, and standardised exams (Kumar, 2024)." Within the gurukula system, a student was placed under the direct supervision of his Guru and resided under the Guru's roof; this was known as the *antevasin* (Nath, 2023). This means that the student would spend his time at the Guru's house, and under this system, serving the teacher and his family was a priority for the pupil. Over time, this system evolved, and more buildings were added to the Gurukula. For a student, a guru was a spiritual father (Nath, 2023). The system fostered a personal relationship that was built on compassion but, at the same time, discipline. A Guru would guide his student on a better path academically and help him grow mentally, physically and spiritually. This holistic approach towards a student's overall development helped him maintain the knowledge he received. It also helped transmit it through harmonious channels where personal bias did not come into play, and knowledge management systems worked smoothly. Based on a case study by Edwina Pio (2005), one finds that the Guruguru–shishya process was instrumental in knowledge sharing and production and was a crucial move in the overall organisational viability. This can be looked at wherein an organisation (here the education system) which sees itself as a flexible network of independent, adaptive relationships between a teacher and student, rather than a rigid one where superiority plays a role, is more likely to adapt and innovate a student to reach his full potential (Brown and Duguid, 2000). Overall, considering a student's spirituality and value systems growth can significantly enhance knowledge management and educational outcomes. By blending in traditional wisdom through ancient techniques, one can ensure that knowledge is acquired, internalised, preserved, and passed on through meaningful and relevant channels.

5. Discussion

Ancient Indian literature is found to have a multi-dimensional approach to knowledge management that spans ethics, pedagogy, ritual, and governance. The Rigveda indicates ordered oral transmission and ethical sharing, resonating with present knowledge, integrity and stewardship issues. The Arthashastra illustrates the value of both tacit and explicit knowledge—performance-based assessment and practical prudence in leadership, pre-empting the tacit/explicit dichotomy in contemporary KM theory. The Manusmriti illustrates hierarchical yet adaptive knowledge structures, where knowledge must be transmitted purposively and ethically, in harmony with present-day controversies regarding access, legitimacy, and development of knowledge systems. These revelations collectively suggest that knowledge in ancient India was not just divine but purposefully managed intergenerationally through socially embedded routines. In contemporary parlance, they present a template of decentralised, morally rooted, and person-centred knowledge management suited for educational reform and intercultural KM theory.

6. Conclusion

Taking into account the nature and structure of texts like the Rigveda, Arthashastra and Manusmriti and pairing them with the pedagogical framework of the Gurukula system, it is viable to conclude that contemporary education systems need to focus on not only academic growth but the growth of a student as a human being. A future-oriented education system should be implemented where a student will learn how to regulate their values, spirituality and mental health. This holistic framework will lead to a knowledge transfer network where both tacit knowledge and practical knowledge are in play.

Including the study of ancient Indian texts such as the Vedas in the educational system will promote this holistic framework since the texts are well-versed in environmental jurisprudence and governance to ethics, value systems, and knowledge stewardship. Although very complicated, the authority in charge can use simplified translations of these texts while teaching the students in Sanskrit for a better understanding. The best example

is the state of Uttarakhand, where the state government mandated that Sanskrit be a mandatory subject from the 3rd to the 8th grade. This decision not only lives up to the potential of the New Education Policy of 2020 but also ensures that students can understand texts such as the Vedas.

Ultimately, reintegrating the knowledge and wisdom found in ancient Indian texts into the contemporary education system will not only help us preserve the rich cultural and epistemic heritage that our ancestors left us with but also build a resilient and adaptable society that leans towards knowledge. To end and quote the Upanishads, "Those who follow the path of *avidya* (ignorance) fall into darkness, those who follow the path of *vidya* (knowledge) fall into greater darkness (Radhakrishnan, 2018).” A simple reminder of the fact that knowledge should not be isolated from values. It is the mixture of *vidya* and values that should guide the future of education and knowledge management.

Ethics Declaration: The author affirms that this research paper is an original work and has been prepared in accordance with academic standards and ethical guidelines. All sources have been acknowledged and cited appropriately. No part of this paper has been plagiarised or copied from unauthorised sources. The interpretations and conclusions drawn are based on the author's independent analysis and synthesis of the subject matter.

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A Resource-Based View Framework for Knowledge Risk Management in SMEs

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Abstract: Small and Medium Enterprises (SMEs) face a significant challenge of knowledge loss due to their inability to implement Knowledge Risk Management (KRM) strategies effectively, which ultimately negatively affects their competitiveness and sustainability. The modern nature of work causes an over-reliance on technology to perform remote work, conduct organisational collaboration and exchange knowledge assets, which poses risks associated with knowledge exposure and loss for SMEs. Given that SMEs are resource constrained, they put little effort into risk management strategies that can potentially save them from losing their most critical knowledge. This study proposes a Resource-Based View framework (RBV) for SMEs to leverage internal resources and capabilities to mitigate the risks related to knowledge loss. A systematic literature review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) to analyse academic publications from the past ten years (2014–2024) in order to identify key trends, challenges and strategies related to KRM, RBV and SMEs. Thematic analysis was applied to analyse the selected articles, with three themes emerging, namely the role of intellectual capital in mitigating knowledge risks; technological interventions for knowledge protection; and organizational culture's impact on knowledge-sharing and security. SMEs struggle with managing intellectual capital, implementing technological interventions for knowledge retention, protection and sharing due to limited resources. Their approach to knowledge-sharing is unstructured and formal processes are less frequently implemented. However, organizations that integrate KRM effectively demonstrate greater resilience, sustainability and competitive advantage. The results underscore the need for SMEs to develop structured KRM frameworks aligned with their resource capabilities. This research bridges the gap between RBV and KRM, providing insights for SME managers to manage knowledge loss risks and enhance long-term sustainability. Future research should explore empirical case studies to validate the findings and proposed framework of this paper.

Key words: Resource-Based view, Knowledge risk management, SMEs, Systematic literature review

1. Introduction and Background

Knowledge plays a crucial role in the modern economy, often referred to as the "knowledge economy" (Oliveira and Matos, 2023). Unlike traditional economies that relied heavily on natural resources and physical labour, today's economies are driven by information, expertise and innovation. Knowledge allows businesses and industries to improve productivity, develop cutting-edge technologies and maintain a competitive advantage in a rapidly changing global market. It is a key driver of entrepreneurship and social mobility, enhancing the visibility of small and medium enterprises (SMEs) in global economies (Garzoni et al, 2020). SMEs are an important sector of the world economies, accounting for over 90% of employment creation and innovation (Al-Karkhi, 2024; Mugano, 2024). They are privately-owned organisations defined in terms of the number of permanently employed staff and the amount of revenue generated annually. In South Africa, a privately-owned organisation with a staff complement of not more than 500 and an annual turnover revenue of not more than 20 million rands is categorised under the SME sector (SEDA, 2019). However, the literature indicates that SMEs face significant risks of knowledge loss due to increased human resource mobility, compounded by underdeveloped tacit knowledge management (Adesina and Ocholla, 2024; Durst et al, 2023).

Furthermore, challenges such as limited access to finance are the biggest hurdles limiting the growth potential of SMEs in developing countries in Africa (Mugano, 2024). Despite these challenges, SMEs have significant opportunities for growth in the current digital economy. The culture of innovation and risk taking allows SMEs to rapidly adopt digital technology like e-commerce, artificial intelligence and smart systems to enhance their competitiveness (Raihan, 2024). According to Matchaba-Hove et al (2015), organisations that are quick to innovate and adopt digital technologies are more likely to gain a sustainable competitive advantage. Nowadays, the integration of digital technology is increasingly becoming a cornerstone of modern SME operations (Raihan, 2024). Indeed, SMEs have a flexible management mindset which serves as a strength for adopting new technologies with little bureaucracy.

Moreover, SMEs rely on knowledge for innovation, competitiveness and sustainability, which they use to optimize operations, make informed decisions and develop unique value propositions. Understanding industry trends, customer preferences and technological advancements helps them differentiate themselves. In

addition, knowledge of business management, financial planning and regulatory requirements helps them navigate challenges and expand (Ogujiuba et al, 2023). However, managing knowledge-related risks like loss, leakage and obsolescence remains a critical challenge for SMEs (Adesina and Ocholla, 2024). The increasing complexity of today's knowledge-intensive processes, reliance on digital technologies, remote work and inter-organizational collaborations exposes SMEs to various risks associated with knowledge leakage, cyber threats and intellectual property loss, leading to ineffective knowledge-sharing practices (Mamorobela, 2023).

Effective Knowledge Risk Management (KRM) is essential to mitigating these risks and ensuring that SMEs leverage their knowledge resources optimally (Massingham, 2010). Despite high knowledge loss vulnerabilities in SMEs, KRM is relatively underdeveloped. KRM is a process that involves identifying, analysing and responding to risks related to the creation, application and retention of organizational knowledge (Durst et al, 2020). The field of KRM emerged as a catalyst to apply knowledge management tools and techniques to the management of risks related to organisations' intellectual property (El Khatib et al, 2022a; El Khatib et al, 2022b). The lack of formalized risk management frameworks in SMEs leads to a reactive approach, exposing them to economic downturns, cybersecurity threats, supply chain disruptions and unforeseen crises. This lack of preparedness often results in business failures, stunted growth and inability to secure financing from risk-aware investors (Mamorobela, 2023). Hence, this paper explores the development of a resource-based view framework for SMEs to mitigate knowledge loss risks.

2. Research Problem

Despite the growing recognition of risk management as a critical business function, there is limited research on the barriers that SMEs face in adopting formalized risk management frameworks (Crovini et al, 2021). Arnaudova et al (2025) aver that existing risk management models tend to be tailored to larger enterprises dealing with finance, insurance and utilities, which comply in accordance with their specific industry regulations. Evidently, there is a significant gap in the literature to understand the levels of KRM in SMEs (La Torre and La Torre, 2020). As a result, knowledge as a strategic resource receives little attention and the mismanagement of risks associated with knowledge loss puts SMEs at a competitive disadvantage.

Due to the challenges highlighted, this paper asks the research question: *how can a resource-based view framework that provides guidelines for SMEs to address the risks related to knowledge loss be developed?* By adopting proactive risk management practices that focus on knowledge as a key intellectual property, SMEs can improve their resilience, enhance decision-making and secure their competitive advantage in an increasingly uncertain business environment. Most studies focus on knowledge management practices in SMEs with little evidence on mechanisms for SMEs to address knowledge-related risks (Arnaudova et al, 2025). A view of knowledge from the competitive resource perspective may expose SMEs to more opportunities for leveraging knowledge for their sustainability and putting more effort into knowledge protection mechanisms (Grimaldi et al, 2021). This paper proposes a resource-based view (RBV) framework for KRM in SMEs, aiming to leverage internal resources and capabilities to mitigate the risks related to knowledge loss.

3. Research Methodology

This study followed a ten-year systematic literature review (SLR) process between 2014 and 2024 using PRISMA to enquire about KRM from the RBV perspective in an attempt to develop a framework for leveraging internal resources and capabilities to mitigate the risks related to knowledge loss in SMEs. As stated in Snyder (2019), the SLR process is a qualitative method used to gather, compile, assess and identify gaps in research over time. It includes approaches like meta-analyses, mixed method reviews, scoping reviews, targeted literature reviews, rapid reviews and umbrella reviews.

PRISMA is a guideline used for reporting all types of SLRs to ensure consistency and transparency in the manner that the review process is reported (Hansen et al, 2022). The guidelines of PRISMA in this paper helped ensure that research bias was minimised by determining the inclusion and exclusion criteria for the selection of relevant literature sources; coding and analysis of selected literature sources; and the discussion and reporting of the findings from the sources included in the review. Being a qualitative study, the review of literature in this paper was informed by the research problem and questions. A review protocol was developed to find relevant sources aligned to the research topic, problem and question. Massaro et al (2015) emphasise the importance of preparing a review protocol that guides the search process and provides a basis for the inclusion and exclusion criteria of literature sources. Setting up a research protocol for this paper was helpful to the researchers because the protocol served as a tool for a rigorous and transparent process of making decisions about the literature sources selected in the study. The PRISMA process includes the identification of

the review protocol; searching for articles through various databases; determining the eligibility criteria for article selection; and defining the inclusion/exclusion criteria of articles (Hansen et al, 2022).

The initial search was conducted on Scopus, Web of Science and Google Scholar, which are popularly used in social sciences research to provide the most accurate bibliometrics of highly cited scholars in the field (Falagas et al, 2008). Each database has its own query for defining a combination of strings and Boolean operators for the search. The query used on Web of Science was: TI=(Resource-based view AND Knowledge risk Management AND SME) OR TI=(RBV AND KRM AND SME) OR TI=(Resource-based view AND Knowledge risk) OR TI=(Resource-based view AND Knowledge risk Management AND Small and Medium Enterprises) OR AB=(Resource-based view AND Knowledge risk Management AND SME) OR AB=(RBV AND KRM AND SME) OR AB=(Resource-based view AND Knowledge risk) OR AB=(Resource-based view AND Knowledge risk Management AND Small and Medium Enterprises) AND AK=(Knowledge Risk Management). As at January 2025, the Web of Science database returned 21 articles. The query used on Scopus was: TITLE-ABS-KEY ("Resource-based view") AND TITLE-ABS-KEY ("SME") AND TITLE-ABS-KEY ("Knowledge management") AND PUBYEAR > 2014 AND PUBYEAR < 2024 AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "English"), which returned 2 articles as at January 2025. The search on Google scholar included all articles published between 2014 and 2024 with a search query: ("SME" AND "Knowledge Risk Management" AND "Resource-based view"). The search returned 95 articles as at January 2025.

The total number of articles from the initial search across all three databases was 118. Only peer-reviewed articles written in English were considered in the review because the authors did not have the financial resources to hire a language translator or bilingual team members. Ms Excel was used to check for duplicate articles. There were 23 duplicate articles between Google Scholar, Web of Science and Scopus. In essence, all articles found on Scopus and Web of Science were also duplicated in Google Scholar. The removal of duplicate articles brough the total number of articles down to 95. The titles, abstracts and keywords of all remaining articles were read to determine their relevance to the study objectives.

4. Data Analysis

The resultant 95 articles were categorised according to the keywords of the study title and the subject under investigation, namely: "knowledge risk management", "knowledge risk management and resource-based view", "resource-based view and SME", "knowledge risk management and SMEs", and "knowledge risk management and resource-based view and SMEs".

After reading all the articles and categorising them, a further 63 articles were found to be unrelated to the categories and were excluded from the list, leaving 32 articles that were read in full and were found to be highly relevant. A total of 14 articles were found to be only addressing "knowledge risk management" issues. Four articles were related to "knowledge risk management and resource-based view"; four articles address issues around "resource-based view and SME"; nine articles were about "knowledge risk management and SMEs"; and only one article was found to be about "knowledge risk management and resource-based view and SMEs".

Thematic analysis was applied following the guidance of Archer et al (2017). The process included steps such as text familiarisation, coding, revision, theme creation and lastly a revision of the final themes. To familiarise themselves with the text, the researchers read all 32 articles in order to understand their research objectives, methodologies and results. Coding involved the creation of tables on Ms Excel to capture articles under different categories based on their objectives and the subject under investigation. Important segments of the articles were noted as codes that were stored on a separate Excel sheet for further analysis. The list of all codes was then revised to ensure their relevance to the study and to ensure that none of the important code segments were missing from the analysis. The codes addressing similar ideas in relation to the research objectives were grouped together to formulate the initial set of themes. The themes were named accordingly to reflect the proposed RBV framework for KRM in SMEs. The process of naming themes was very rigorous to ensure that all generated themes capture specific aspects of the data with no overlap between themes. Finally, the themes were revised and some refinements were done where necessary to combine the themes with similar ideas, discarding those not sharing the central ideas of the research. The final set of themes were then used to propose a conceptual RBV framework for KRM in SMEs, shown in Figure 1.

5. Results and Discussions

The results of the thematic analysis revealed three themes that are pertinent to the development of the RBV framework for KRM in SMEs, namely, the role of intellectual capital in mitigating knowledge risks; technological interventions for knowledge protection; and organizational culture's impact on knowledge-sharing and security. These are discussed in the following sections.

5.1 The Role of Intellectual Capital in Mitigating Knowledge Risks

Intellectual capital serves as a dynamic capability that SMEs can use to manage knowledge risks and improve sustainability (El Hanchi and Kerzazi, 2020). The effective use of intellectual capital enables organisations to safeguard their knowledge assets and enhance resilience. Intellectual capital encompasses human capital, structural capital and relational capital as crucial factors for mitigating the risks associated with knowledge loss, leakage and obsolescence (Tsang, 2017). Human capital is the most important component of intellectual capital, which ensures that critical knowledge is retained within the organisation. Human capital uses knowledge-sharing approaches like mentorships and cross-functional teams to prevent the risk of losing organisational knowledge when employees leave (Phaladi, 2024). Human capital reflects on constructs like skills, expertise and the experiences of staff (Akinsola et al, 2023; Khatib and Abbas, 2023; Mutai, 2023; Chakabva et al, 2021; El Hanchi and Kerzazi, 2020; La Torre and La Torre, 2020; Shujahat et al, 2020; Chan et al, 2016). By investing in human capital through education and training, SMEs can build resilience against the risk of knowledge loss.

Structural capital is another important component of intellectual capital that focuses on the formalisation and documentation of knowledge (Alam et al, 2024; Alam et al, 2023). It uses mechanisms such as standard operating procedures, knowledge repositories and workflows to ensure that essential knowledge is retained within organisations. Structural capital also ensures that effective knowledge management systems are in place to enable the smooth access and distribution of knowledge that prevent knowledge silos (Zeiringer, 2023). Structural capital includes constructs like processes, databases and intellectual property (Magni, et al, 2022; Chakabva et al, 2021; Tsang, 2017; Brustbauer, 2016; Chan et al, 2016; Durst and Leyer, 2014; Abidin, 2014). SMEs need to pay particular attention to structural capital assets in order to enhance knowledge security, retention and adaptability to mitigate knowledge loss risks.

Relational capital is the third component of intellectual capital, which refers to the external relationships between organisations and third-party organisations, customers, suppliers and stakeholders (Lima Rua et al, 2023; Magni, et al, 2022). It focuses on knowledge exchange and collaborations to provide access to new knowledge and foster innovation. Relational capital includes constructs like external networks, customer relationships and partnerships (Tohãnean et al, 2020; Ali et al, 2019; Multaharju et al, 2017; Chan et al, 2016; Cerrudo et al, 2014) to allow organisations to share best practices, co-develop solutions and stay up-to-date with changes in the industrial revolution. To manage knowledge risks, SMEs can leverage relational capital by building strong trust-based relationships with employees, industry partners, research institutions and professional networks to validate, refine and protect knowledge.

5.2 Technological Interventions for Knowledge Protection

In the contemporary milieu, technology plays a crucial role in protecting unauthorised access to knowledge assets within organisations (Zeiringer, 2023). Technological interventions like knowledge management systems (KMS), cybersecurity and digital collaboration tools allow organisations to safeguard knowledge assets and maintain long-term sustainability. KMS platforms provide organisations with the ability to create, store, organise, distribute and retrieve knowledge quickly to reduce the risk associated with knowledge loss when employees leave the organisation (Alam et al, 2024; Alam et al, 2023; Chan et al, 2016; Abidin, 2014). Cybersecurity is another important technological intervention that SMEs can use for the protection of knowledge assets (Zeiringer, 2023). Cybersecurity measures like encryption, access control and multi-factor authentication are there to ensure data security so that SMEs can mitigate knowledge-related risks. Additionally, technology interventions like advanced digital collaboration tools are there to offer communication platforms that are more secure, with version controls and audit trails for SMEs to enhance the level of KRM (Yuwono and Rachmawati, 2024; Magni, et al, 2022). Therefore, by leveraging technological interventions, SMEs can improve knowledge retention, security and adaptability to safeguard their knowledge assets, enhance innovation, and ensure long-term resilience in a dynamic business environment.

5.3 Organisational Culture's Impact on Knowledge-Sharing and Security

The impact of organisational culture on knowledge-sharing and security also emerged as a theme of discussion. According to Hamzah et al (2022), culture that promotes knowledge-sharing has the potential to reduce the risk of knowledge loss. Constructs like security awareness and compliance, trust and open communication and incentives for knowledge-sharing are pertinent to influence KRM in SMEs. Trust and open communication foster collaboration, innovation and learning by creating an environment where employees constantly seek new knowledge, which ultimately mitigates the risk of knowledge obsolescence (Multaharju et al, 2017; Ali et al, 2019). A culture of openness is important to facilitate the efficient capture and transfer of critical knowledge by the KMS. Indeed, organisations that encourage employees to share expertise through mentorships, collaboration, cross-functional teams and open communication channels can potentially reduce the risk of knowledge loss. Additionally, the culture of security awareness and compliance ensures that employees understand the importance of safeguarding critical knowledge in the organisation, as well as adherence to best-practices around data and information security (Tsang, 2017; Chan et al, 2016). SMEs need to train employees to recognise the risks of unintentional knowledge leaks to better protect their intellectual assets. Incentives for knowledge-sharing are also important to ensure that employees are not hesitant to share valuable expertise due to concerns about job security (Magni, et al, 2022; Hamzah et al, 2022; Multaharju et al, 2017). Incentives for knowledge-sharing encourage employees to continuously update and refine knowledge as they participate in training programs and engage in innovative initiatives. Therefore, by strategically designing structures for incentives, SMEs can enhance knowledge-retention; keep updated knowledge; and ensure that sharing practices align with security measures to support long-term KRM.

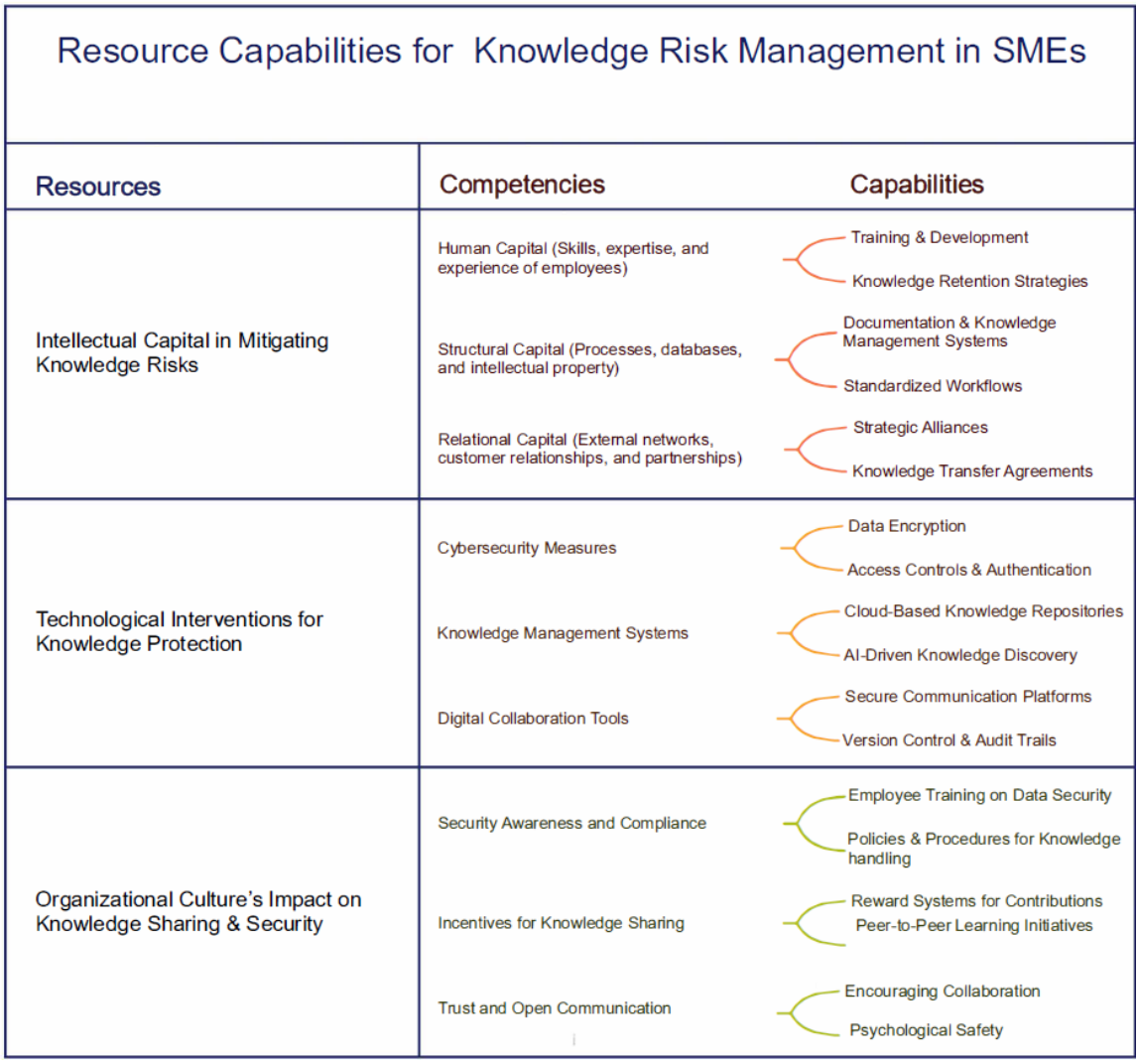


Figure 1: Proposed research framework

6. Conclusion

This study was triggered by the research gaps highlighting that SMEs put little effort into knowledge risk management strategies that can potentially save them from losing their most critical knowledge. The study reviewed academic literature in KRM for a period of 10 years since 2014 to 2024 using PRISMA to uncover trends, challenges and strategies related to KRM in SMEs. Not too many studies exist in this area, especially in the context of SMEs. It was discovered that KRM is an emergent area that is mostly explored in large organisations dealing with finance, insurance and utilities; to comply with their specific industry regulations. The PRISMA process resulted in 32 relevant articles that were thematically analysed. Three themes, namely the role of intellectual capital in mitigating knowledge risks; technological interventions for knowledge protection; and organizational culture's impact on knowledge-sharing and security, emerged from the analysis and were used to propose an RBV framework for KRM in SMEs. The study contributes to both theoretical and practical discussions by bridging the gap between RBV and KRM, offering insights for SME managers to proactively manage knowledge risks so that they can enhance the long-term sustainability of their SMEs. Given that the study is only limited to the literature search using the PRISMA methodology, future research should explore empirical case studies to validate the findings of this paper.

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Improving Project Goal Setting Through AI-Driven Knowledge Management Tools

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Abstract: This paper investigates how artificial intelligence (AI)-driven knowledge management (KM) tools might better shape project goal setting. The paper focuses on their capacity to surface relevant organisational knowledge at the earliest and most strategic phase of project planning. While knowledge management (KM) has long been considered as a lever for improving project outcomes, its integration into the goal-setting process remains underdeveloped, particularly in connection with AI-enabled technologies such as large language models (LLMs), natural language processing (NLP), and robotic process automation (RPA). We argue that project goals are not set in isolation. We consider that these are shaped by what an organisation knows, remembers, or forgets. In this context, our author's team strongly believes that AI-enhanced KM tools might have the potential to highly influence what goals are proposed, prioritised, and formalised. The paper adopts a case study approach, analysing five organisations across manufacturing, insurance, IT, and infrastructure sectors. The selected cases vary in their use of KM systems and AI capabilities, allowing us to compare both traditional and advanced configurations. Using the SECI model (Socialisation, Externalisation, Combination, and Internalisation) just as an useful interpretive framework, we trace how knowledge is captured, transformed, and embedded into planning processes. Our comparative analysis shows that AI enhances the speed, scale, and contextual relevance of knowledge flows, particularly during the Combination and Internalisation phases. The paper also highlights that successful implementation also highly depends on cultural readiness and correspondingly on the capability to properly integrate into the existing planning routines. Findings indicate that AI-KM tools may contribute to improving the planning quality by surfacing overlooked insights, reducing scope drift, and correspondingly by aligning goals with past performance data. However, we consider that these tools cannot replace human judgement or communication and soft skills, mostly concerning negotiation. The core competences and mostly soft skills have an important impact that lies in enabling better-informed conversations between partners involved within negotiations. We conclude that AI-driven KM, when effectively embedded, might turn organisational memory into a usable asset that might be helpful within the strategic decision-making process. We consider that our research might contribute to both knowledge management and project management literature by reasserting the importance of goal setting as a knowledge-intensive process, one that AI might support, but not in an automatic way.

Keywords: Knowledge management (KM), Project goal setting, Large language models (LLMs), AI-enhanced planning

1. Introduction

Projects often begin with assumptions rather than informed goals. Teams rely on prior habits, inherited templates, or gut feeling even in data-rich environments. As a result, mistakes are repeated, resources are misallocated, and strategic alignment is more assumed than achieved. We've seen this not because organisations lack experience, but because that experience rarely translates cleanly into an usable knowledge.

This is where knowledge management (KM) is supposed to help but often it doesn't. KM tools have promised structured learning and better decisions for decades (Nonaka and Takeuchi, 1995; Alavi and Leidner, 2001).

Their impact on how goals are formulated in projects remains quite limited. Knowledge is recorded, not absorbed. What could guide future planning ends up as archived and even forgotten.

The new generation of AI-enabled KM tools, including large language models (LLMs) and robotic process automation (RPA), reopens discussions on how to leverage past project insights for better planning (Chugh and Grandhi, 2021; Dwivedi et al., 2021). These tools offer not only storage but also insightful feedback during project goal setting, influencing negotiations and team commitments.

Despite extensive literature on KM systems and AI integration, the empirical exploration of their impact on project goals is limited. This paper employs a case-based approach to investigate how organizations utilize AI-KM tools in defining project goals, examining their effect on knowledge retrieval, filtering, and application. We

also explore what may be overlooked: missed signals, persistent assumptions, and whether these tools foster better goals or quicker consensus.

Our contribution is mostly a practical looking for a clearer understanding of how knowledge, structured by AI, enters the strategic phase of project planning. It covers also a theoretical background by facilitating the reconnecting of KM with the foundational act of goal setting, where so many projects succeed or fail before they even begin.

2. Literature Review

Project goal setting is usually placed on the intersection between decision-making, organisational memory, and strategic alignment. However, we consider it underexplored in KM and artificial intelligence. This section reviews key concepts and prior research to highlight issues such as: how knowledge flows might impact planning, how AI-enhanced KM tools are transforming this dynamic, and where existing literature lacks focus on the goal-setting phase.

2.1 Definitions and Conceptual Framing

This paper brings together several interlinked but often separately treated concepts. For clarity, we define them as follows.

Data refers to raw, structured or unstructured information that has not yet been contextualised or interpreted (Davenport and Prusak, 1998). It becomes actionable only when processed through organisational routines or transformed into knowledge.

Knowledge management (KM), as defined by Alavi and Leidner (2001), includes the systems and processes used in order to better capture, store, and apply knowledge to improve performance. Following Nonaka and Takeuchi's (1995) SECI model, we treat knowledge as both tacit and explicit, and its flow as central to organisational learning.

KM tools include systems that support knowledge sharing and application, ranging from document management platforms to more recent AI-enhanced systems. We are primarily interested in tools that influence strategic processes, not just storage.

AI-driven KM refers to KM tools that incorporate artificial intelligence (AI), particularly large language models (LLMs), robotic process automation (RPA), and natural language processing (NLP) in order to better support knowledge interpretation, summarisation, and contextual delivery (Chugh and Grandhi, 2021; Dwivedi et al., 2021).

Project goal setting is defined within this paper as the process by which intended outcomes, scope, and performance measures for a project are established. We considered this as a strategic activity shaped by memory, available knowledge, and planning norms, not as a procedural checklist (Locke and Latham, 2002).

Strategic alignment refers to the degree to which project goals reflect organisational intent, capacity, and existing knowledge. We consider that KM tools are relevant only if they make this alignment more likely and visible (Lee and Choi, 2003).

2.2 Project Goal Setting

Effective project goals guide action, allocate resources, and shape expectations. Despite this, we strongly believe that poor goal setting remains a primary cause of project failure (PMI, 2021). Classical work on goal setting highlights specificity and difficulty as predictors of performance (Locke and Latham, 2002) but says little about how knowledge might help to implement those goals in practice.

Many organisations repeat planning errors due to inadequate knowledge integration (GPR Journals, 2022). While lessons are often documented but rarely consulted when new goals are set. Knowledge flows into implementation, not into the decision-making that precedes it. This disconnect persists even in organisations with formal KM systems.

A growing body of research suggests that goal setting benefits when historical project data and prior experience are made accessible and contextualised, mostly at the planning stage. However, few studies examine how this happens, or fails to happen, in real-time planning contexts.

2.3 Knowledge Management in Planning Contexts

KM systems were developed in order to address knowledge fragmentation, yet their contribution to planning remains uneven. Most traditional systems act as passive repositories. Information is stored but not transformed into insight (Alavi and Leidner, 2001; Jennex and Olfman, 2005). Poor search functionality, low contextual awareness, and limited integration with project management tools might limit their strategic value.

Cultural challenges also play an important role. Many teams treat KM as post-project documentation rather than pre-project support. As a result, knowledge is captured too late and reused too little. While the SECI model provides a robust conceptual framework for understanding knowledge creation and flow, it relies on consistent routines of reflection and sharing, which many organisations lack (Nonaka and Takeuchi, 1995).

Recent work calls for KM systems that support real-time decision-making and planning, rather than merely archiving past actions (Sanchez and Palacios, 2002). We consider that this shift from storage to flow is a prerequisite for any impact on project goal setting.

2.4 AI in Knowledge Management Systems

AI-enhanced KM tools respond to the limitations of traditional systems. LLMs, NLP tools, and RPA offer capabilities such as semantic search, automated summarisation, and contextual recommendation (Syed, Bandara, and French, 2020; Chugh and Grandhi, 2021). These tools might surface relevant knowledge at the point of need rather than requiring manual extraction.

Within the project planning process, this translates into smarter templates, dynamic risk identification, and scenario forecasting. Case studies show that AI-KM systems might enable more informed planning conversations and reduce reliance on untested assumptions (Egbedion, 2023; Wilson and Daugherty, 2018).

Still, we believe that the impact of these tools highly depends on how they are integrated. Without alignment to decision-making routines, even the most advanced systems remain unused. AI's value lies in automation and its ability to shape attention, helping teams see patterns and contradictions that might otherwise go unnoticed.

2.5 Where the Gaps Remain

Despite the technological promise, empirical work connecting AI-driven KM to project goal setting remains limited. Most studies focus on process improvement or post-hoc analysis, rather than on how knowledge tools affect early-stage planning.

This leaves several unanswered questions. How do AI-generated insights influence the selection of goals? What routines support or block the integration of these tools into planning? And under what conditions does knowledge, structured by AI, improve strategic alignment?

These are the questions this paper mainly addresses. By focusing on project goal setting, we aim to clarify what AI-KM tools might do and what they might also change.

3. Methodology

This paper adopts a case study methodology to examine how AI-enhanced KM tools are applied in formulating project goals. We aim to explore how these technologies influence decision-making, strategic alignment, and knowledge reuse in real organisational settings. A case study approach allows for in-depth analysis of how tools function in practice, not just how they are designed or theorised (Yin, 2023).

3.1 Case Selection Criteria

Cases were selected according to the following criteria:

- *Relevance*: Each case involves the documented use of KM tools, three explicitly incorporating AI capabilities, to support project planning and goal definition.
- *Diversity*: The cases span sectors including manufacturing, insurance, IT services, and infrastructure, offering a varied empirical base for cross-case comparison.
- *Data availability*: All cases are supported by peer-reviewed literature, organisational reports, or documented project records that allow for rigorous analysis.
- *Documented outcomes*: Each case includes measurable impacts on goal clarity, planning accuracy, or project alignment.

Five cases were included in our paper:

- *Irizar* (Sanchez and Palacios, 2002): A manufacturing firm with a deeply embedded KM culture, but no use of AI, used here as a contrast baseline.
- *Aetna* (Wilson and Daugherty, 2018): An insurance provider integrating AI-supported decision tools into planning processes.
- *Egbedion* (2023): An IT sector case examining AI-supported scheduling, planning, and milestone forecasting.
- *Siemens Mobility* (2023): A European infrastructure firm using LLM-based KM systems to generate strategic goal-setting inputs at the project design stage.
- *Morshed* (2024): A synthesis of 65 projects across industries demonstrating recurring patterns in AI-KM integration and planning performance.

3.2 Analytical Framework

In order to better structure our analysis, we applied the SECI model (Nonaka and Takeuchi, 1995), which frames knowledge creation as a continuous process across four interlinked phases: Socialisation, Externalisation, Combination, and Internalisation. We consider this model is beneficial for identifying where and how knowledge enters decision processes, and how it is absorbed or ignored in organisational settings.

While the SECI model was not designed with AI in mind, we consider its mechanisms remain applicable to systems that structure, extract, and contextualise knowledge, even when those systems are algorithmically driven. Our analysis considers not only the technical functions of AI-KM tools but also how they enable or constrain each phase of knowledge transformation in relation to goal setting.

3.3 Cross-Case Synthesis

For each of the four deep-dive cases (Irizar, Aetna, Egbedion, Siemens), we coded the role of AI-KM tools in relation to three dimensions:

- *Knowledge accessibility*: How and when relevant past knowledge was surfaced.
- *Planning behaviour:* Whether the tools influenced project goals' scope, precision, or realism.
- *Strategic alignment*: The degree to which goal-setting outputs reflected organisational intent and known constraints.

The fifth case (Morshed, 2024) was analysed as a meta-synthesis, not for narrative depth, but to validate broader trends observed across the more granular cases. Its inclusion strengthens the generalisability of our findings while maintaining clarity about the distinct function it plays within the paper.

We believe that this combined design enables both theoretical insight and practical relevance: it shows not only what is possible with AI-enhanced KM, but how specific tools and organisational routines mediate that potential in practice.

4. Case Study Analysis

We analysed five cases across distinct organisational contexts to examine how AI-driven KM tools influence project goal setting in practice. Each case highlights different configurations of KM systems, AI capabilities, and planning behaviours. Together, they offer insight into what these tools enable and where their limits remain.

4.1 Irizar: Knowledge Culture Without AI

Irizar, a Spanish bus manufacturer, has long been recognised for its commitment to organisational learning and internal knowledge sharing (Sanchez and Palacios, 2002). While the company did not deploy AI-enhanced KM tools during the studied period, its structured approach to knowledge exchange provides a useful baseline against which AI-integrated systems might be compared.

It maintained a mature KM system without AI. The company relied on internal workshops, codified planning guides, and cross-functional collaboration to circulate knowledge. These practices supported all four SECI dimensions and contributed to improved planning accuracy and faster time-to-market. However, success depended on sustained cultural investment and manual processes.

This case illustrates the limits of traditional KM. Irizar's effectiveness came from deliberate organisational routines, not from automation. The case underscores the potential value of AI tools for organisations lacking the time or capacity to maintain such deeply embedded knowledge systems.

4.2 Aetna: Integrating AI into Planning Routines

Aetna, a prominent U.S.-based health insurer, enhanced its claims processing and planning operations by implementing AI-supported systems. According to Wilson and Daugherty (2018), the company created a hybrid model where human experts collaborated with AI. This setup allowed AI to perform repetitive tasks such as pattern recognition and data analysis, while human teams concentrated on judgment, negotiation, and handling exceptions. The integration of AI tools also extended into planning routines, especially for resource allocation and process goal setting, where AI analysed historical claims data and proposed optimal task flows that informed departmental objectives.

The engagement of AI-enabled knowledge management (KM) tools at Aetna encompassed all four SECI dimensions. Socialisation occurred during team review sessions of AI-generated outputs, while externalisation involved translating claims protocols into structured rules for system learning. Combination was illustrated by merging human and machine insights within planning frameworks, and internalisation was evident as staff adjusted their routines in response to AI feedback loops. These processes led to a significant 25% reduction in processing time and a 20% boost in customer satisfaction, while clarifying the establishment and justification of planning goals (Wilson and Daugherty, 2018).

Aetna's experience underscores the significance of human integration within AI systems. The added value stemmed not from replacing expert judgment but from structuring knowledge to enrich planning discussions. This hybrid model indicates that AI's true advantage lies in enhancing the visibility and usability of organisational knowledge at goal-setting stage.

4.3 Egbedion: AI in IT Project Scheduling

Egbedion (2023) presents an empirical study on the role of AI-driven KM tools in medium-sized IT firms managing multiple projects with tight deadlines and shifting requirements. In this context, the planning phase often faced issues like goal misalignment and inefficient resource use. To address these challenges, the firms implemented AI-enabled platforms that utilised natural language processing, machine learning, and historical project data for early-stage scheduling and goal definition, generating real-time planning recommendations by analysing archived project reports and team feedback.

Implementing AI tools resulted in measurable improvements, with a 23% increase in scheduling accuracy and a 31% reduction in resource waste over three cycles. These gains were attributed not only to automation, but also to the way the tools transformed planning dialogues. Project leads received contextualised insights, which helped them refine project scope and objectives, leading to informed decision-making based on historical data rather than assumptions.

The SECI framework was evident in the case study, highlighting socialisation through digital platforms, externalisation of undocumented knowledge, combination of predictions with human inputs, and internalisation of data-driven adjustments in team routines. A key takeaway from Egbedion's findings is that AI transformed planning practices from assumption-driven to evidence-informed, creating a feedback loop that framed goal setting as a dynamic, iterative process instead of a static commitment.

4.4 Siemens Mobility: LLMs for Strategic Goal Definition

Siemens Mobility, a division of Siemens AG specialising in railway infrastructure and intelligent transport systems, offers one of the clearest recent examples of AI-enhanced KM applied directly to project goal setting. Beginning in 2022, as part of its digital transformation agenda and supported by Horizon Europe's *Shift2Rail* programme, the company integrated a KM system powered by large language models (LLMs) and advanced semantic indexing. The goal was to improve planning alignment and risk forecasting within complex infrastructure projects spanning multiple national contexts.

The system utilizes a repository of project reports, technical documents, engineering logs, and stakeholder feedback. It employs natural language processing to identify recurring issues like permitting delays, procurement inconsistencies, and timeline slippage. Importantly, it synthesizes this data into strategic planning templates, aiding project leads in setting initial goals and recognizing early constraints.

Siemens Mobility's approach uniquely integrates knowledge management (KM) outputs into goal formulation. The AI system not only suggests deadlines and budget ranges, but also highlights discrepancies between proposed scopes and past realities, allowing teams to adjust objectives early to avoid unrealistic commitments.

In SECI terms, Socialisation occurs through shared dashboards informed by AI knowledge. Externalisation is seen in summaries structured into reusable artefacts. Combination merges live data with historical insights, while Internalisation occurs as teams view AI insights as essential planning tools.

According to Siemens' internal reviews (Siemens, 2023), the AI-KM platform has led to a 28% reduction in planning rework and better alignment between national goals and local plans. The system has been expanded across more business units.

This case illustrates the scalability of AI-driven KM in multi-stakeholder project environments and reinforces the claim that effective AI-KM tools not only enhance planning accuracy but also transform the nature of goal formulation in complex organisations.

4.5 Morshed: Cross-Industry Validation of AI-KM Integration

Morshed (2024) presents a macro-level synthesis of AI-enhanced knowledge management (KM) tools across 65 projects, published in the International Journal of Project Analytics. The study aggregates data from over 40 organizations in sectors like healthcare and IT. While lacking the detail of a traditional case study, it effectively highlights the impact of AI-KM systems on project planning and delivery.

Projects ranged from €100,000 to €5 million with teams of 10 to 50. AI tools included LLM-based knowledge summarization, predictive analytics, and structured feedback systems, utilized for early project goal definition, often enhancing manual processes.

Key findings reveal:

- 34% increase in on-time delivery using AI-informed goal-setting.
- 28% reduction in rework due to precise early-stage planning.
- Positive correlation between AI-KM usage and strategic alignment in projects (Morshed, 2024).

Although lacking detailed SECI process narratives, the report emphasizes common features: automated lesson extraction, integration of historical knowledge, and alerts for deviations from successful parameters. Morshed argues that AI-KM represents a major shift in knowledge integration during goal-setting, validated across various organizational types. This synthesis is used to confirm whether patterns from primary cases are observable in broader applications, enhancing the credibility of our findings within a wider empirical context.

Table 1: Summary of the Case Studies used within the paper

Case	Sector	AI in KM	Key KM Features	Planning Impact
Irizar	Manufacturing	No	Workshops, codified practices, internal sharing routines	Improved planning cycles, knowledge reuse (manual)
Aetna	Insurance	Yes	AI-assisted planning inputs, claims optimisation	Faster decision-making, clearer goals
Egbedion	IT	Yes	AI-powered scheduling and resourcing	Improved accuracy, reduced waste
Siemens Mobility	Infrastructure	Yes	LLM-based knowledge prompts, semantic analysis	Better alignment, reduced rework
Morshed	Cross-industry	Yes	Meta-analysis of AI-KM integration	Validated patterns: improved delivery, fewer revisions

5. Discussion

Across the five cases analysed, one pattern holds: the integration of KM tools, particularly those enhanced by AI, consistently improves the clarity, realism, and adaptability of project goal setting. We consider that this improvement is not simply a matter of better data, but of better access to relevant knowledge at the moment strategic decisions are made.

The most notable contrast emerges between *Irizar*, which operates a mature but non-automated KM system, and the AI-enabled cases. At Irizar, goal setting was supported by shared routines, internal workshops, and codified planning practices. The system worked because the organisation invested heavily in social learning. However, it was labour-intensive and required sustained cultural effort. In contrast, *Aetna*, *Egbedion*, and

Siemens Mobility demonstrate that AI-enhanced KM tools can scale, automate, and accelerate many of the same knowledge flows, with measurable impacts on forecasting accuracy, planning alignment, and project efficiency.

We believe that what distinguishes the AI-enabled cases is not the elimination of human judgement, but the restructuring of what information is surfaced during goal-setting deliberations. Teams were not just faster, they were *better informed*, because AI systems drew attention to patterns that might otherwise remain invisible. *Siemens*, for example, used LLM-generated summaries to identify permitting delays in infrastructure projects. These insights were directly embedded in goal-setting templates, influencing both scope and timeline decisions before plans were formalised.

We strongly believe that SECI model provides a useful lens for interpreting these dynamics, though it requires extension. In all cases, we observed that AI tools did not create knowledge on their own. Instead, they facilitated the movement of knowledge across SECI phases, particularly *Combination* and *Internalisation*. For example, in *Egbedion*, predictive dashboards helped teams connect fragmented insights into coherent planning outputs. In *Aetna*, AI-supported review sessions encouraged internalisation by helping staff adjust routines based on system-generated insights. However, AI tools were less effective in *Socialisation*, where tacit knowledge still required human interaction, and in *Externalisation*, where the transformation of lived experience into usable inputs often lagged behind system capabilities.

These findings support two claims. First, *AI does not replace KM*; it activates it. The same SECI logic applies, but with added reach and speed. Second, the effectiveness of AI-KM tools depends not only on algorithmic sophistication, but on whether organisations treat them as embedded components of planning, not as separate analytics tools.

The *Morshed* synthesis reinforces this conclusion. Despite its scale, the reported gains were aligned with those seen in the individual cases: fewer delays, clearer objectives, and better alignment. These gains were contingent on the ability of AI systems to structure historical knowledge into formats that informed current planning, more than just store or visualise it.

One important limitation we noticed is the absence of detailed user-level narratives in most studies. While outcomes are well-documented, the lived experience of interacting with AI-KM systems during planning remains underexplored. Future research could benefit from ethnographic or longitudinal methods to observe how teams adapt to, resist, or reshape these systems over time.

In summary, we consider that the integration of AI-driven KM tools appears to shift project goal setting from a reactive to a proactive activity. It makes organisational memory actionable. And it does so not by automating decision-making, but by ensuring that decisions are anchored in what the organisation has already learned, yet too often forgotten.

6. Conclusions and Intended Further Future Research

We began this paper with a question: do AI-enhanced KM tools make project goals more grounded, more coherent, and more useful? The answer, based on five cases across industries and planning cultures, is yes, but we consider we have to take into account specific conditions.

AI does not properly set goals. But it changes how goals are formed. It brings forgotten knowledge back into view, challenges assumptions early, and makes risk patterns harder to ignore. In environments where planning happens under pressure, this matters.

Our analysis showed that the most effective uses of AI-driven KM tools weren't just technical up-grades, they were shifts in planning behaviour. Project leads worked differently because the systems gave them access to prior outcomes, structured insight, and in some cases, hard-to-ignore contradictions. At Siemens, this meant redefining scope before committing to impossible timelines. At Egbedion, it meant adjusting schedules based on past resourcing failures. In both cases, goals improved because memory was made active.

The SECI model helped frame what changed. AI supported Combination and Internalisation in particular, connecting fragments and embedding insights into routines. But we consider that Socialisation and Externalisation, the more human parts of KM, still required conversation, pushback, and interpretation. We strongly believe that no tool is capable to replace that. While SECI remains a useful lens, it was not originally designed for algorithmic contexts. We consider that future applications of SECI in AI-enhanced systems may

benefit from reinterpretation of how tacit knowledge is surfaced and transformed when machines, not just humans, are involved in early-stage knowledge structuring.

One important limitation of this paper lies in the temporal spread of the case data. The cases span more than two decades, from early KM cultures to current AI-enhanced environments. This variation provides breadth but also introduces inconsistencies in context. Thus we believe that future research might focus on the examination of longitudinal adoption within a single organisation or compare AI-KM transitions over time in order to better isolate what changes are truly due to the technology itself.

One of our clearest takeaways is that good AI-KM integration does not guarantee better goals. It only improves the odds, when embedded in planning routines, accepted by teams, and treated as a planning partner, not a compliance tool. Irizar showed what disciplined, non-AI KM can do. The rest showed how AI can extend those gains, faster, and at scale.

This paper is just a starting point. We worked with documented outcomes and surface-level descriptions. What we could not access were the planning rooms themselves, the back-and-forth, the edits, the hesitation. We strongly believe that future research should go there. Thus we consider fir further research we have to identify how teams actually use these tools in real time. How they trust or resist their outputs. How goals shift mid-process, not just in retrospect.

If AI is considered as having an important potential in order to contribute to the improvement of planning, than we believe further research have to focus more on where planning happens. Otherwise, we risk evaluating tools instead of decisions.

Ethics Declaration: This research was conducted using secondary data sources and publicly available case studies. No human participants were involved, and no personal or sensitive data was collected or analysed. All sources are cited in accordance with academic standards. The authors declare that there are no conflicts of interest.

AI Declaration: Artificial intelligence tools were used to support the drafting and editing of this manuscript. The tools assisted in structuring the content, synthesising literature, and improving clarity. All ideas, interpretations, and conclusions result from authors analysis and have been critically reviewed before inclusion.

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Knowledge-Sharing Behaviour Within a Non-Profit Organisation: A Reflexive Thematic Analysis

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Abstract: Despite their heterogeneous compositions, non-profit organisations (NPO) are inherently knowledge-centric, necessitating continued exploration into the influential constructs that shape knowledge-sharing (KS) behaviour among employees. This study offers an in-depth examination of KS behaviour within a community-based service provider in Dublin, Ireland. Using a novel approach to Reflexive Thematic Analysis (RTA), data collection consisted of seventeen semi-structured interviews across multiple locations. Findings show that four overarching themes explain how and why knowledge is shared in this organisational context. The four themes developed through rigorous RTA offer the organisation a greater understanding of its employees' KS behaviours. Practical recommendations are provided to inform organisational policy and improve staff performance in the service of those in its care. Additionally, the novel approach to RTA, the showcasing of axial connections, and the integration of theoretical models represent scholarly advancements in the fields of organisational psychology and motivational theory. By offering a deeper understanding of human interaction within knowledge-intensive work environments, this research informs organisational policy to foster a knowledge-sharing culture. It highlights the importance of supporting employee autonomy, enhancing competence and cultivating stronger workplace relatedness. These developments contribute to creating a psychologically safe environment capable of withstanding increasing social and structural demands.

Keywords: Knowledge-sharing, Qualitative research, Reflexive thematic analysis, Theoretical contributions

1. Introduction

Knowledge management (KM) comprises three fundamental processes: knowledge acquisition, knowledge sharing, and applying that knowledge (Suchitra and Gopinath, 2020). It is a set of activities that permit the organisation to create, use, and share knowledge by integrating people, technologies, processes, and strategy (Andreeva and Kianto, 2012; Swain and Lightfoot, 2016). There is no denying the proliferation of academic research in recent decades on the management of knowledge (Serenko and Bontis, 2004; Serenko and Dumay, 2015b, 2015a, 2017), and, in particular, the interest in KS (Serenko and Bontis, 2016; Ahmad and Karim, 2019). While studies show considerable interest in the public and private sectors (Oliveira and Pinheiro, 2021), there is a need for increased examination of how and why knowledge is shared within a NPO (Bloice and Burnett, 2016). Literature also confirms that numerous factors influence KS behaviour, all of which are dependent upon the context of the research (Issac and Thomas, 2019).

Nonaka and Takeuchi (1995) state that "the one sure source of competitive advantage is knowledge" (Dinh Tho, 2017, 1240). This is considered critical for success, regardless of whether it is a for-profit organisation or a not-for-profit organisation, since both require knowledge-centric approaches to function effectively (Vakharia *et al.*, 2018). The understanding of knowledge and its meaning has undergone numerous ratifications from Socrates to Polanyi (Anand and Walsh, 2016; Oliveira *et al.*, 2022). This paper honours Polanyi (2009) view that knowledge comprises both tacit and explicit dimensions. Polanyi distinguishes between "knowing what" and "knowing how," referring to the practicalities of human experience and the theoretical aspects (Polanyi, 2009, p. 7). This view of knowledge continues in contemporary literature (Nguyen, Siri and Malik, 2022; Hadjimichael, Pyrko and Tsoukas, 2024), showcasing that personal knowledge resides in the minds of the individual (Ferger and Rechberg, 2024). Employees cannot be mandated to share knowledge, but they are ore willing if enabled to do so (Tseng, 2017; Zhang, Song and Song, 2020).

The organisation is an "autopoietic system" in which the various independent employees or groups of employees develop and evolve, leading to the creation of new knowledge (Nonaka, Toyama and Konno, 2000, p. 26; Vakharia *et al.*, 2018). These systems function collectively by facilitating the exchange of knowledge, thereby generating new levels of knowing (Nonaka, Toyama and Konno, 2000; Polanyi, 2009). It is based on the reciprocal processes between knower and receiver (Endres and Rhoad, 2016; Zaremohzzabieh and Rasdi, 2025), involving the sharing of experiences and the exchange of best practices (Chou, 2005). The reciprocal interactions among employees are contingent upon multifaceted constructs, with no single construct emerging as the predominant facilitator or inhibitor of KS (Farooq, 2018; Masood *et al.*, 2023).

2. Literature Review

While extant literature examines KS from a plethora of sectors, there is still limited research towards the KS behaviour of employees within NPOs (Bloice and Burnett, 2016; Zbuchea *et al.*, 2020; Le and Tuamsuk, 2023). Historically, non-profit organisations have been viewed as somewhat underdeveloped in their approach to KM processes, such as examining what enables and/or hinders KS. Additionally, stakeholders within non-profit organisations are more interested in the soft "touchy-feely" returns on investment (Sibghal and Raj Kumar, 2016, p. 227). NPOs are entities characterised by a degree of institutionalisation and autonomy and operate without pursuing personal gain. They are distinct from both the public and private sectors due to their voluntary nature in assisting the local community and broader societal needs (Yi, Qiu and Li, 2025). NPOs are considered knowledge-centric despite their heterogeneous compositions (Vakharia *et al.*, 2018; Mahasuar, 2023). Research suggests that stakeholders tend to rally under a single cause, such as saving or improving the lives of someone or something, or the cause to "fight homelessness", "end hunger", or "support children and adults with intellectual disabilities" (Rangan, 2019, p. 1). Furthermore, prior research indicates that NPOs tend to depend on external knowledge rather than leveraging the internal knowledge available within the organisation to enhance operational procedures (Sibghal and Raj Kumar, 2016). Contemporary research explores constructs such as authentic leadership and its effects on KS behaviour (Sharif *et al.*, 2023), or the mechanics of KM within NPOs (Mahasuar, 2023). For example, Zbuchea et al. (2020) explore the influence of the human dimension on the adoption and utilisation of knowledge transfer in NPOs. Although the study does not explicitly define what constitutes the human dimension, it emphasises the importance of KS intentions and behaviour with the NPO. In another study, employees of a Malaysian voluntary organisation highlight the importance of KS in relationships and accountability in improving organisational performance (Mohd Noor, Ah and Idris, 2017). Other research suggests that access to knowledge, the perceived value of knowledge, and the intrinsic motivation to assist colleagues enhance the KS culture within an NPO in Thailand (Le and Tuamsuk, 2023).

3. Research Methodology (1000 Words)

This research follows the guidelines of Reflexive Thematic Analysis (RTA) outlined by Braun and Clarke (2006, 2021a, 2021c). It maintains that "reflexivity focuses on the role the researcher has in knowledge production" (Cassell, Cunliffe and Grandy, 2018, p. 371), particularly in generating themes related to knowledge sharing within a community-based service provider. The philosophical lens underpinning the analysis is acknowledged, with the research employing RTA through Heidegger's philosophy, positioning the researcher's Dasein (being-there) at the forefront (Heidegger, 2010). This aligns with the need to place the researcher "front and centre" in the interpretive process (Heidegger, 2010; Braun and Clarke, 2021b, p. 9). RTA supports a fusion of horizons, recognising that "meaning emerges at the *intersection* of data and the researcher's contextual and theoretical" positioning (Braun and Clarke, 2021d, p. 210). Addressing Braun and Clarke's (2021c) methodological concerns, this research introduces the 'coding family of RTA' to enhance rigour and trustworthiness in Phase 2 of the systematic data coding process, as shown in Figure 1. This coding family builds on Saldaña (2016), integrating the researcher's reflexive coding approach.

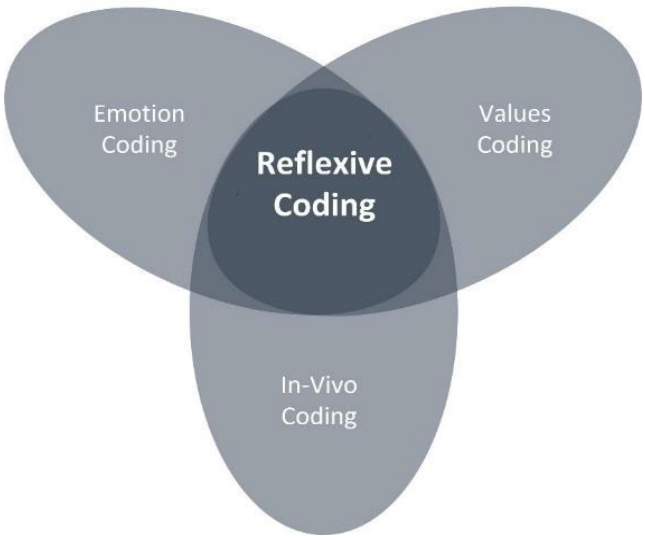


Figure 1: The coding family of RTA

Figure 2 represents emotion and value coding in practice, with Figure 3: In-vivo coding in practice illustrating the analytical process that leads to the creation of the interpretative and reflexive codes. Images are segments taken from data. Notably, the emotion code titles are based on works by Susanto et al. (2020) and Keltner and Cowen (2021). Both Interpretive reflexive coding examples, circled below, illustrate a central idea or scheme pertinent to the participant. This aligns with Braun and Clarke's ideal "to be reflexive, be be reflexive!" (Braun and Clarke, 2022, p. 3). It is the analytical process of becoming immersed in data. Requiring deep reflective questioning of the researcher's 'self', while imagining and questioning "taken for granted thinking" (Braun and Clarke, 2021c, p. 332). This study incorporated manual coding by way of the creation of an Excel workbook. The notebook is akin to a painter's canvas, where the interpretative artistic style is viewed as a craft (Saldaña, 2011).

Interview data	Emotion Coding	Values coding	Interpretive reflexive coding	Axial connection
It's probably in a way opportunistic because something will crop up…lot of…when did you send that? Where did you send the referral to?	**Eager**	**Opportunity to help others**	Wanting to give as much assistance as possible	Organisational commitment

Figure 2: Emotion and values coding in practice

Interview data	Emotion Coding	In-vivo coding	Interpretive reflexive coding	Axial connection
It actually felt nice. I felt **honoured and privileged** that they asked me	Pride	**Honoured and privileged**	Having a sense of belonging	Professional Identity

Figure 3: In-vivo coding in practice

The above data samples illustrate the evolution of two of what this research refers to as 'the twelve axial connections'. Axial connections are defined as dynamic, influential constructs that influence employees' KS behaviour. In line with Bronfenbrenner and Morris(2006)s bio-ecological theory (BT), the axial connections are also shaped by participants' interactions.

4. Findings and Discussion

This research presents the four themes that influence employees' KS behaviours with this community-based service provider through a novel approach to RTA. The non-profit sector is increasingly being determined by increased regulatory demands, which are stifling the willingness to KS. There is no denying that organisational challenges, such as a lack of cross-disciplinary understanding, are causing a divide between the professionals within the NPO. This, combined with a reluctance to build meaningful relationships, impacts employee development, reducing employee competence due to a lack of KS behaviour. Autonomy is reduced by increased regulatory demands and a lack of competence, leading to a fear of asking or offering knowledge.

Table 1: The four themes of influence illustrate how each theme tells a story where "the title alone, clearly conveys that this is a shared meaning with a central organising concept theme" (Braun and Clarke, 2021c, p.p. 341-341). Additionally, a description of each theme is accompanied by a representative quote.

Table 1: The four themes of influence

Theme	Description	Representative quote
Increased regulatory demands prevent meaningful employee connection	Employees are concentrating on the demands of the regulator instead of the needs of one another	I don't think these bureaucrats at the top realise that on the ground, those demands are huge
A misplaced sense of hierarchy limits interdisciplinary cooperation	The individual demands require individual focus, regardless of others' opinions	My old job was continuously sharing information, sharing thoughts, and collaboratively working, while here it's a little bit more individualised
Employee's desire to return to the way things were	A sense that things were easier in the past, with a greater sense of camaraderie	A resistance to change can be something…why are we bringing this in when everything else worked previously?
A lack of psychological safety impedes the willingness to share knowledge	Employees no longer feel a sense of personal security	I know there's huge emotional impact to social work and it involves a good bit of trust between us.

The model below Figure 4: Causes of KS reduction, illustrates the slow decrease of KS over time, most of which has gone unnoticed by practitioners. The model illustrates the paradigm shift within the organisation from the employees' perspective. Point A represents the heightened level of KS from the perspective of the way things were (Theme 3). Point B represents the present state of affairs within this community-based service provider.

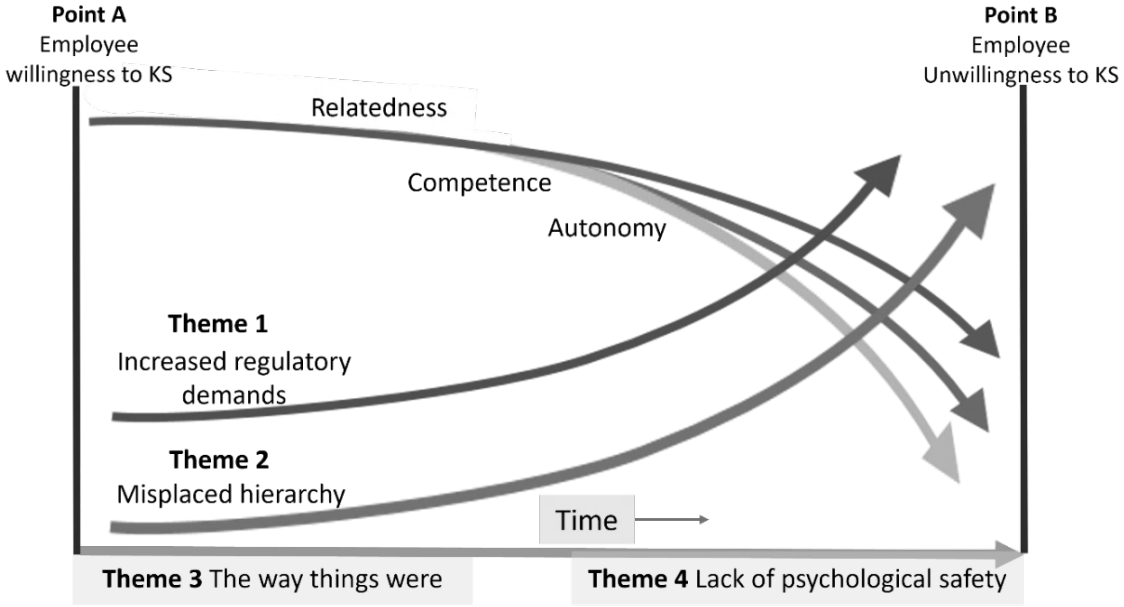


Figure 4: Causes of KS reduction

4.1 Theme 1: Increased Regulatory Demands Prevent Meaningful Employee Connection

Increased regulatory demands demonstrate that KS is negatively affected due to the limited interconnectedness of employees, resulting in reduced competence and autonomous behaviour. Participant 1, for example, expresses the cautionary rhetoric that "first protocol would be to link in with my supervisor." This adherence is essential since employees must "double check that that guidance…was the most appropriate and up to date" (Participant 4). Participant 4 maintains that there is a need to be "15 steps ahead" of the regulator. This adds pressure onto staff members who must consider "what needs to be done and what doesn't need to be done and what needs to be done every month" (Participant 13). This results in knowledge that is formal and produced under the governance of regulatory bodies (Rathi, Given and Forcier, 2016). While having a guided approach to care, there is a sense that the organisation has forgotten that "it's a human service" (Participant 11). In response to a question concerning *offering* knowledge, Participant 6's response, "yeah, that's a tricky one" implies the controlling nature of the regulator. This question is insightful, as it reveals that all participants, bar one, encountered difficulties in the concept of 'offering' knowledge. This suggests a reluctance to share knowledge.

The presence of strict regulations, while accommodating the explicit dimension, constrained employees' intrinsic motivation to share. This situation adversely affects several constructs that facilitate and reinforce a KS culture, such as staff cohesion and strong interpersonal relationships (Kim and Lee, 2012; Rathi, Given and Forcier, 2014; Imam and Zaheer, 2021).

4.2 Theme 2: A Misplaced Sense of Hierarchy Limits Interdisciplinary Cooperation

Undoubtedly, the participants have a passion and drive towards their avocation to support service users "from cradle to grave" (Participant 3). However, over time, participants have developed a need to maintain a hierarchical status within the organisation. Hierarchical mindsets negatively impact the connections among employees, limiting the reciprocal exchange of tacit 'knowing' (Oliveira *et al.*, 2022; Ul-Durar *et al.*, 2023). Akhavan et al., (2013) argue that a hierarchical culture, whether intentional or not, inhibits the natural inclination of human beings to share their knowledge. It is asserted that these mindsets have become fixed over time. Due to the need to stay "very much in [your] lane" (Participant 12) or not wanting to "give the wrong answer" (Participant 1) since "it could be some sort of disciplinary thing that you would come into if you don't share the right information with the right people" (Participant 17). This maintains an outdated "hierarchical decision-making" approach to KS (Lettieri, Borga and Savoldelli, 2004; Rhodes and Keogan, 2005). There are elements of traditional hierarchical behaviour that limit intrapersonal KS behaviour. One participant points out that some employees "might use a lot of…like big words, a lot of language that's not accessible to everyone." This results in "other disciplines" not knowing or wanting to ask for advice (Participant 5). The presence of hierarchy indicates that the organisation does not "have that culture of sharing…[but] maybe... in-house, in your team…in your discipline, there might be a little" (Participant 5). Another participant highlights that "clinicians will focus on their therapeutic work…frontline staff will focus on their key working [and] service managers focus on everything. Uh, you know, it depends on your scope of work, where your focus lies." Borders are drawn between what can be shared and what should be shared. This results in a disconnect between employees and limits knowledge creation through the intersection of knowing. Over time, the tacit learning outcomes of the employees are reduced. That is, as one "dominion is established over a lesser power and the latter operates as a function of the greater power, an order of rank…is bound to produce the appearance of an order of means and ends" (Nietzsche, 1968, p.p. 299, 300). However, this order of means and ends does not support KS from all areas of tacit and explicit existence within this service provider.

4.3 Theme 3: Employee's Desire to Return to the way Things Were

This theme represents how participants would reflect (emotion code) how, in the past, staff would work together in a more congenial manner, welcoming ideas and suggestions from peers. Recounting that "it's interesting how you forget your past experience and it's only when you're talking about it and going God" (Participant 9). Participant 9 also expressed that "there is a richness or an opportunity that is missing" from the organisation due to the lack of direct human interaction. That "we don't have that culture of sharing" (Participant 5) since "there's a whole lot of new policies and new procedures, new everything" (Participant 7). This sense of acceptance and nostalgia (both emotional codes) illustrates the participants' need and desire to return to the way things were in some capacity. Participants recall the way things were while going out to care for an individual as part of a two-person team, they "just loved it (laugh)…[they] found it really supportive (Participant 2). Data indicates that there are "a lot of experienced people…you feel we should have gone back to basics" (Participant 6) concerning connection with other staff members and communicating thoughts and experiences. Participant 16 provides an insightful understanding of why participants KS in that they "give an example of my previous experience of why this has worked well in the past." Participants expressed the longing for times when they were able and supported each other in the "past coming up the stairs from the canteen, you'd say, oh God, you know what? I just wanted to talk to you" (Participant 2).

4.4 Theme 4: A Lack of Psychological Safety Impedes the Willingness to Share Knowledge

The lack of psychological safety encapsulates the overall sentiment of participants. This theme is determined to be a psychological need that participants require to realise their KS potential. It is proposed that this 'need' is an additional construct to self-determination theory, which previously demonstrated how its constructs influence the behaviour of employees concerning KS (Sedighi *et al.*, 2018; Cai, Li and Shi, 2024). Employees within this service provider 'want' to share what is known to them "organically without being asked" (Participant 4). Participants "know not to overstep [their] boundaries" (Participant 15) and to take care not to "put your head above the parapet" (Participant 5). Psychological safety elicits employees to work together and share what is known through "trusting each other and respecting each other" (Participant 6). Participant 5 states, "for me offering [knowledge], I have to feel like it's in a safe space with people I know and trust." This implies the need

for psychological safety despite the participant having a strong sense of identity and knowledge around social care and its requirements. To have "a sense of security" (Deci and Ryan, 2000, p.235) elicits the growth of meaningful relationships that can increase KS behaviour. In certain instances, employees "have to feel like it's in a safe space" before sharing their knowledge (Participant 5). A lack of psychological safety is evident throughout the organisation, as employees do not feel safe sharing their knowledge with others, resulting in a disconnect. This disconnect generates a forced positionality, reducing autonomy and compromising staff's sense of competence. Employees aim to work in an environment where they are comfortable expressing new ideas and do not fear asking questions or seeking feedback from their peers (Edmondson, 2004).

5. Conclusion

This research indicates that the knowledge shared within NPOs has undergone a paradigm shift. What was once the sharing of knowingness from the tacit dimension is now primarily information being shared through the explicit dimension. To redress this, there is a continued need to reduce the number of rules (Sandhu, Jain and Ahmad, 2011). To provide an environment where employees can explore new ways of 'doing' by expressing their experiential ways of 'doing'. By loosening the chains of the regulator, employees can develop a greater sense of autonomy through constructive interaction, reducing the fear of repercussions or having a sense of 'them and us' within this community-based service provider. Employees can create a future where staff have a greater sense of belonging and happiness while working in an already strained sector. Ultimately, this is the fusion of multiple 'Dasein' horizons towards a sense of togetherness that is supported in the care for one another (Heidegger, 2010).

Ethical Approval: Ethical approval for this study was obtained from TU Dublin, Research Ethics Committee, ensuring that all procedures complied with established ethical standards

Informed Consent: Informed consent was obtained from all participants, who were fully briefed on the purpose, procedures, risks, and their right to withdraw from the study at any time without penalty.

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AI Adoption in Open Innovation Partnerships: Trends, Challenges, and Strategic Implications

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Abstract: Artificial intelligence (AI) is transforming innovation partnerships and clusters across diverse sectors, yet its adoption remains uneven, with numerous challenges hindering effective implementation. This study examines the adoption patterns of various AI technologies among open innovation partnerships, analyzing the motivations, challenges, and success metrics associated with AI integration. Drawing on open innovation paradigms, and emerging research on AI in collaborative contexts, we investigate how partnerships navigate the complex tensions between automation and augmentation when implementing AI across organizational boundaries. Our analysis of survey data from 45 European innovation partnerships across multiple industries reveals significant sectoral variations in AI readiness and implementation approaches. We identify four distinct adoption patterns—AI Leaders, Specialized Adopters, Early Experimenters, and Non-Adopters—each characterized by specific implementation approaches, technology preferences, barrier profiles, and ethical considerations. Knowledge gaps emerge as the most significant implementation barrier, showing a negative correlation with adoption levels, while efficiency improvement and innovation enhancement serve as primary adoption drivers. The findings highlight the transformative potential of AI in accelerating collaborative innovation processes and the role of partnership characteristics in shaping implementation strategies. By categorizing and evaluating different patterns of AI utilization, this study provides a comprehensive framework for partnerships to strategically devise and execute AI initiatives aligned with their innovation objectives. The research offers valuable insights for partnership coordinators and policymakers seeking to design effective strategies for fostering AI-driven innovation ecosystems and addressing sector-specific implementation barriers.

Keywords: Artificial intelligence, Innovation partnerships, Technology adoption, Cluster analysis, Collaborative innovation

1. Introduction

The integration of artificial intelligence (AI) into organizational processes has emerged as a critical driver of innovation and competitive advantage across industries. While substantial research has examined AI adoption within individual organizations, considerably less attention has been given to how AI technologies are implemented within collaborative innovation environments such as innovation partnerships. These multi-stakeholder collaborations, which bring together diverse organizations including industry partners, research institutions, and public sector entities, present unique challenges and opportunities for AI implementation that differ from single-organization contexts. Innovation partnerships have become increasingly important mechanisms for addressing complex societal and economic challenges, fostering knowledge exchange, and accelerating technological development (Carayannis, 2020). The European Commission has recognized their significance, investing substantially in collaborative innovation initiatives through programs such as Horizon Europe and various Digital Innovation Hub networks (European Commission, 2023). As these partnerships evolve, they face growing pressure to leverage emerging technologies, particularly AI, to enhance their innovation capabilities.

AI technologies offer considerable potential to transform collaborative innovation processes by facilitating more effective knowledge sharing across organizational boundaries, enabling data-driven decision-making, and identifying non-obvious patterns in complex innovation ecosystems. Recent research has suggested that AI can be leveraged in open innovation contexts by aligning innovation stages with AI management functions to foster productive collaborations (Broekhuizen et al., 2023). However, implementing these technologies in multi-organizational settings introduces additional complexity related to governance, knowledge asymmetries, trust dynamics, and resource allocation (Wang & Ramiller, 2019). The adoption of AI in collaborative contexts also challenges organizational power structures across partner organizations (Holm et al., 2023).

Despite the growing importance of this intersection between AI and collaborative innovation, research examining AI adoption in partnership contexts remains fragmented. Previous studies have primarily focused on single-organization adoption drivers (Davenport, 2018) or broader economic implications (Agrawal et al., 2019), with limited attention paid to how innovation partnerships navigate the specific challenges of implementing AI across organizational boundaries.

To address this research gap, this study examines AI adoption within innovation multi-partner partnerships, focusing specifically on current implementation levels, technological applications, motivating factors, and implementation challenges. Drawing on data from 45 innovation partnerships across multiple sectors, we

employ rigorous analysis to identify patterns of AI adoption and implementation approaches. The study addresses three primary research questions (R1.) How do innovation partnerships currently implement AI technologies, and what factors influence their adoption levels? (R2.) What challenges do partnerships face in implementing AI technologies, and how do these vary across different partnership contexts? (R3.) What distinct patterns of AI adoption emerge across the innovation partnership landscape?

By investigating these questions, this research makes several contributions to the literature. First, it provides empirical evidence on the current state of AI adoption within innovation partnerships, addressing a significant knowledge gap in the technology adoption literature. Second, it identifies sector-specific adoption patterns and challenges, offering insights for targeted policy interventions and support mechanisms. Third, through cluster analysis, it develops a typology of AI implementation approaches that moves beyond simplistic adoption/non-adoption dichotomies to capture the multifaceted nature of AI integration in collaborative contexts. The findings have important implications for partnership coordinators, policy makers, and organizations participating in innovation networks.

2. Theoretical Background

Research on organizational adoption of artificial intelligence has expanded considerably over the past decade, building upon earlier technology adoption frameworks while addressing the unique characteristics of AI technologies. Traditional technology adoption frameworks such as the Technology Acceptance Model (Davis, 1989), the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), and the Technology-Organization-Environment framework (Tornatzky & Fleischer, 1990) have provided the theoretical foundation for understanding organizational technology implementation. However, AI technologies introduce additional dimensions that extend beyond the parameters of traditional technology adoption models (Dwivedi et al., 2021).

The distinctive characteristics of AI—including learning capabilities, potential autonomy, and data dependency—create new adoption considerations (Davenport, 2018). Researchers have identified AI-specific adoption factors including algorithm aversion (Burton et al., 2020), explainability requirements (Miller, 2019), and ethics concerns (Floridi et al., 2018). Raisch and Krakowski (2021) further developed this understanding through the automation-augmentation paradox, proposing that organizations must navigate tensions between using AI for task automation versus human augmentation. Empirical studies have documented substantial variation in AI adoption across industries, with sectors such as financial services, healthcare, and technology demonstrating higher implementation rates than manufacturing, construction, and public administration (McKinsey, 2022). These sectoral differences reflect industry-specific factors including data availability, competitive dynamics, and workforce capabilities (Ransbotham et al., 2020). However, these studies have predominantly focused on individual organizations rather than collaborative networks (Jöhnk et al., 2021).

A parallel stream of literature has examined collaborative innovation networks and partnerships. These formalized collaborative arrangements have become increasingly prominent in innovation strategies (Carayannis, 2020), taking various forms including innovation clusters, competence centers, and public-private partnerships (Etzkowitz & Leydesdorff, 2000; Porter, 2000). The literature identifies several theoretical perspectives that help explain these arrangements: knowledge-based views emphasize partnerships as mechanisms for knowledge recombination across organizational boundaries (Kogut & Zander, 1992); network theories highlight the importance of social capital and trust (Powell et al., 1996); and open innovation paradigms position partnerships as responses to increasing innovation complexity (Chesbrough, 2003). Research has demonstrated that innovation partnerships face distinctive challenges compared to single-organization innovation efforts, including governance complexities (Keast et al., 2007), coordination costs (Gulati & Singh, 1998), and goal alignment difficulties (Das & Teng, 2000). These challenges increase with partnership size and diversity (van de Vrande et al., 2009). Despite growing interest in collaborative innovation, studies examining the intersection of AI adoption and innovation partnerships remain limited.

The literature specifically addressing AI implementation in collaborative contexts remains nascent. Trantopoulos et al. (2020) argue that AI adoption in collaborative contexts requires joint capability development across organizational boundaries. The transformative potential of AI in innovation management has been conceptualized by Haefner et al. (2021) and further developed by Tekic and Füller (2023) as a data-driven process that significantly affects all dimensions of the innovation process. The limited empirical studies in this area have primarily utilized case methodologies, with Weerasinghe et al. (2021) identifying challenges related to data sharing, trust, and differential capabilities among partners in manufacturing innovation clusters.

Several theoretical gaps emerge from this literature review. First, there is a limited understanding of how innovation partnership characteristics influence AI adoption approaches; Second, AI implementation barriers in collaborative contexts are underexplores, Third, there is limited insight into potential patterns of AI adoption across innovation partnerships.

Building on this literature, we propose an integrated theoretical framework that combines elements from both technology adoption and collaborative innovation perspectives. Our framework posits that AI adoption in innovation partnerships is influenced by four interrelated dimensions:

- Partnership characteristics: e.g. sector, size, and governance structure.
- Technology factors: e.g. general technology adoption considerations and AI-specific factors.
- Collaborative dynamics: e.g. trust levels, knowledge asymmetries, and goal alignment.
- Environmental factors: e.g. regulatory environments, competitive pressures, and policy support structures.

These dimensions operate at multiple levels—organizational, partnership, and ecosystem—creating a complex decision environment for AI implementation. Our research focuses primarily on the first two dimensions while acknowledging the broader theoretical context. Building on this framework, we hypothesize that: (1) AI adoption levels will vary significantly across partnership sectors, with technology-oriented partnerships demonstrating higher implementation. (2) Implementation challenges will differ based on partnership characteristics, with different-sized partnerships facing distinct barrier patterns. (3) Partnerships will exhibit identifiable patterns of AI adoption approaches that extend beyond simple adoption level differences. The remainder of this paper empirically examines these hypotheses using survey data from 45 innovation partnerships.

3. Research Design

This study employed a quantitative cross-sectional design to examine AI adoption patterns in innovation partnerships across multiple European sectors. Data were collected through a structured survey administered to partnership representatives between January-March 2024. The final sample comprised 45 distinct innovation partnerships (40.2% response rate) spanning technology/ICT, healthcare, energy, manufacturing, construction, transportation, aerospace, and other sectors.

The survey instrument included six sections covering: (1) Partnership Characteristics (role, sector, size); (2) AI Adoption Level (6-point Likert scale); (3) AI Technology Types (multiple-response); (4) Implementation Motivations; (5) Implementation Challenges (6-point Likert scale); and (6) AI Perceptions and Success Measurement. The instrument was piloted with domain experts and showed satisfactory reliability (Cronbach's α: 0.77-0.89).

This study examined eight AI technology categories: (1) data analytics, (2) machine learning, (3) natural language processing, (4) computer vision, (5) robotics/automation, (6) virtual assistants, (7) speech recognition, and (8) recommendation systems. Respondents received definitions of each to ensure consistent interpretation, covering both analytical and physical implementation technologies.

Data analysis proceeded in four phases using SPSS v27: (1) Descriptive statistics; (2) One-way ANOVA with post-hoc tests to identify significant differences across sectors, partnership sizes, and respondent roles ($p < 0.05$); (3) Correlation analysis examining relationships between adoption levels and organizational factors; and (4) Two-step cluster analysis to identify distinct AI adoption patterns, followed by discriminant analysis to validate the clustering solution and determine differentiating variables. Missing data (<3% overall) were handled using pairwise/listwise deletion as appropriate. Variables were examined for normality and transformed when necessary.

4. Results

Analysis of AI adoption across sectors revealed significant variability in implementation maturity. Aerospace and defense exhibited the highest adoption rate ($M = 3.50$, $SD = 0.71$), followed by technology/ICT ($M = 2.88$, $SD = 1.25$) and healthcare ($M = 2.75$, $SD = 0.96$), while agriculture ($M = 0.00$) and transportation ($M = 1.50$, $SD = 0.71$) demonstrated significantly lower rates (Table 1) . ANOVA confirmed statistically significant sectoral differences ($F(7, 37) = 3.842$, $p = 0.003$, $\eta^2 = 0.421$), with post-hoc analysis indicating significant contrasts between technology-oriented and traditional sectors. These findings suggest that sectors with established digital infrastructure and historically higher R&D investments are more advanced in their AI implementation journey.

The considerable standard deviation (1.63) across all sectors indicates that even within sectors, individual partnership characteristics significantly influence adoption rates.

Table 1: AI adoption level in open innovation partnerships (n=45), (scale 0-5)

Sector	Average adoption level	n
Aerospace/Defense	3.50	2
Technology/ICT	2.88	15
Healthcare	2.75	6
Energy	2.25	6
Construction/Real Estate	2.25	4
Manufacturing	2.00	5
Steel/Metallurgy	2.00	1
Other Services	2.00	2
Transportation/Logistics	1.50	2
Chemical	1.00	1
Agriculture	0.00	1

Source: Data from the study.

The survey data reveals a clear hierarchy in the types of AI technologies being implemented across innovation partnerships. Data analytics emerges as the most widely adopted technology, with 48.9% of partnerships reporting implementation. Machine learning applications follow at 40.0%, with natural language processing close behind at 37.8%. More specialized technologies such as robotics for automation and computer vision each show adoption rates of 28.9%. Virtual assistants (17.8%), speech recognition (15.6%), and recommendation systems (4.4%) demonstrate lower adoption rates, suggesting partnerships prioritize foundational analytical capabilities before moving to more specialized applications. Notably, 22.2% of surveyed partnerships report no current AI technology implementation, highlighting a substantial adoption gap in the innovation partnership ecosystem.

Implementation barriers analysis identified knowledge and skill gaps as the most significant obstacle (M = 2.73, SD = 1.81) on a 0-5 scale, followed by implementation costs (M = 2.58, SD = 1.59) and technical complexity (M = 2.49, SD = 1.45). Privacy and security concerns (M=2.33, SD =1.67), stakeholder resistance (M=2.31, SD =1.49), and scaling issues (M=2.29, SD =1.66) constitute moderately significant barriers. Regulatory and legal barriers (M=2.18, SD =1.62) and ethical considerations (M=1.84, SD =1.58) were rated as less challenging compared to technical and operational issues. The high standard deviation in challenge ratings (1.55 average across categories) indicates partnership-specific variations in perceived implementation barriers. Multi-factor analysis reveals that partnerships in regulated sectors (healthcare, finance) report higher regulatory barrier ratings, while partnerships with limited digital infrastructure emphasize cost and technical complexity challenges.

Correlation analysis revealed a significant negative association between knowledge gaps and adoption levels ($r = -0.42$, $p = 0.003$), while implementation complexity showed no significant correlation with adoption ($r = 0.09$, $p = 0.560$). indicating that partnerships successfully implementing AI are not deterred by complexity. Partnerships that viewed AI as a collaboration enhancer demonstrated higher adoption rates ($r = 0.36$, $p = 0.015$). Implementation costs show a weak negative correlation with adoption level ($r=-0.18$, $p=0.229$), though this relationship lacks statistical significance.

A positive correlation between recognizing AI's revolutionary potential and actual adoption ($r=0.31$, $p=0.039$) suggests that organizational perspective influences implementation decisions. No significant correlation between ethical concerns and adoption levels was found. Organization size significantly influenced AI implementation, with large partnerships (>25 members) showing higher adoption rates than smaller partnerships (<10 members).

Two-step cluster analysis identified four distinct implementation patterns with well-defined characteristics (silhouette measure: 0.6, indicating good cluster quality), as shown in Table 2. Dominant Technologies refers to the primary AI technologies implemented by partnerships in each cluster, with the average number of technologies adopted shown as numerical values. Primary Benefits indicates the main advantages partnerships

in each cluster report from their AI implementations. Main Challenges shows the most significant barriers reported by each cluster, with mean scores on a 0-5 scale presented as numerical values. Sectors and Partnership Size describe the typical organizational characteristics of partnerships in each cluster. For analytical purposes, sectors were further categorized into broader groups to facilitate comparison.

Table 2: Cluster analysis results: AI implementation patterns in open innovation partnerships, n=45

Characteristic	Cluster 1: AI Leaders (n=8)	Cluster 2: Specialized Adopters (n=11)	Cluster 3: Early Experimenters (n=15)	Cluster 4: Non-Adopters (n=11)
Adoption Level	4.38 (0.74)	2.82 (0.60)	1.53 (0.52)	0.18 (0.40)
Dominant Technologies	Multiple (4.9 avg)	Specialized (2.1 avg)	Basic analytics (1.3 avg)	None (0.1 avg)
Primary Benefits	Strategic advantages	Process optimization	Experimental learning	Potential assessment
Main Challenges	Regulatory (3.75)	Integration (3.64)	Knowledge gaps (4.27)	Cost barriers (4.36)
Sectors	Tech, Healthcare, Aerospace	Manufacturing, Energy	Mixed sectors	Traditional sectors e.g.Agriculture
Partnership Size	Primarily large	Medium to large	Mixed sizes	Primarily small

Note: Values are means with standard deviations in parentheses.

Cluster 1 - *AI Leaders* (17.8% of sample) comprises highly advanced partnerships with comprehensive AI implementation (M = 4.38, SD = 0.74) utilizing multiple technologies concurrently (average of 4.9 different technologies). These partnerships prioritize strategic advantages including innovation enhancement (4.63/5.0) and complex problem solving (4.50/5) but face regulatory compliance challenges (M = 3.75, SD = 1.04) rather than technical barriers. This cluster predominantly comprises technology and healthcare partnerships (75%) with larger organizational structures.

Cluster 2 - *Specialized Adopters* (24.4%) consists of partnerships with moderate adoption levels (M = 2.82, SD = 0.60) implementing 2-3 technologies with specific operational objectives. These partnerships report higher process optimization benefits (4.27/5.0) than innovation benefits (3.55/5.0) and face primary challenges related to system integration (M = 3.64, SD = 0.92). This cluster is characterized by medium to large partnerships in manufacturing and energy sectors.

Cluster 3- *Early Experimenters* (33.3%) represents early implementation stages (M = 1.53, SD = 0.52) with limited AI application, typically implementing basic analytical technologies. These partnerships report experimental learning benefits (3.87/5.0) and face significant knowledge barriers (M = 4.27, SD = 0.70). This cluster shows diverse sectoral composition, suggesting early-stage implementation occurs across industries.

Cluster 4 - *Non-Adopters* (24.4%) consists of partnerships with minimal or no AI implementation (M = 0.18, SD = 0.40), reporting cost barriers (M = 4.36, SD = 0.67) and knowledge gaps (M = 4.18, SD = 0.75) as primary obstacles. This cluster predominantly comprises smaller partnerships in traditional sectors with limited digital infrastructure.

Discriminant analysis validated the clustering solution, with three functions calculated, the first two accounting for 91.6% of variance. Number of AI technologies (.764), AI adoption level (.742), and knowledge gap barrier (-.623) demonstrated the strongest relationships with the primary discriminant function. The analysis correctly classified 91.1% of original cases, with robust classification accuracy (85.6%) under cross-validation.

Analysis of measurement readiness revealed substantial gaps between perceived importance and implementation capability. Impact on organizational goals was rated most important (M = 3.73, SD = 0.94) yet showed the largest preparedness gap (1.82 points). Stakeholder satisfaction (3.56 importance, 1.54 gap) and project implementation speed (3.42 importance, 1.62 gap) follow a similar pattern. Return on investment metrics demonstrate high importance (3.29) with a substantial preparedness gap (1.40). Innovation metrics show the lowest importance rating (2.89) and smallest readiness gap (1.02). The overall readiness to measure AI effectiveness (M = 1.84, SD = 1.43) indicates most partnerships lack robust evaluation frameworks, with only 6.7% of respondents rating their readiness at the high end of the scale (4-5/5.0).

Correlation analysis indicates a positive relationship between current adoption levels and measurement readiness (r=0.41, p=0.005), suggesting that implementation experience contributes to measurement capability development. Cross-tabulation analysis demonstrates that partnerships with dedicated digital transformation strategies report significantly higher readiness scores (2.76) than those without formal strategies (1.29), highlighting the importance of strategic planning in successful AI implementation. Only 6.7% of respondents rate their measurement readiness at the high end of the scale (4-5), highlighting a critical area for development as partnerships advance their AI initiatives.

5. Discussion

The findings of this study demonstrate that AI adoption in collaborative innovation contexts follows multifaceted patterns influenced by organizational characteristics, sectoral contexts, and strategic priorities. Our findings extend traditional technology adoption frameworks by illustrating how the multi-stakeholder nature of innovation partnerships introduces additional complexity to AI implementation processes. While previous research has predominantly applied technology adoption models to single-organization contexts (Dwivedi et al., 2021), our results demonstrate that partnership characteristics—including size, sector, and governance structure—significantly influence adoption approaches and barriers. This suggests the need for expanded theoretical models that explicitly incorporate inter-organizational dynamics when examining advanced technology adoption in collaborative settings.

The identified cluster typology (AI Leaders, Specialized Adopters, Early Experimenters, and Non-Adopters) advances theoretical understanding by moving beyond simplistic adoption/non-adoption dichotomies. This nuanced perspective aligns with recent calls in the literature for multidimensional conceptualizations of technology implementation (Jöhnk et al., 2021). The distinct profiles of each cluster—characterized by specific technology configurations, challenge patterns, and strategic orientations—suggest that AI adoption in partnerships follows different pathways rather than a universal stage-based progression. For example, regulatory barriers show moderate overall ratings but represent a higher challenge for AI Leaders, while knowledge gaps present a greater barrier for Early Experimenters than the overall average. These findings challenge linear diffusion models and support more complex theoretical approaches that acknowledge heterogeneous adoption trajectories.

Our analysis of sectoral differences contributes to contingency perspectives in technology adoption literature. The significant variation in adoption patterns across sectors indicates that contextual factors substantially shape both the potential value of AI technologies and the barriers to their implementation. This reinforces the importance of sector-specific frameworks rather than universal models of AI adoption, particularly in collaborative innovation settings where multiple sectoral logics may coexist within a single partnership.

The strong negative correlation between knowledge gaps and adoption levels provides empirical support for absorptive capacity theories in the context of AI implementation. This finding suggests that a partnership's ability to recognize, assimilate, and apply AI-related knowledge fundamentally shapes its implementation capabilities (Zahra & George, 2002). The inter-organizational nature of partnerships introduces additional complexity to absorptive capacity development, as knowledge must be integrated across organizational boundaries—a theoretical insight that warrants further investigation.

The identified gap between perceived importance of measurement and actual readiness contributes to the emerging literature on AI governance and evaluation. This disparity suggests that theoretical frameworks addressing AI implementation must extend beyond adoption decisions to incorporate robust evaluation mechanisms—an area currently underrepresented in both AI and innovation partnership literatures (Trantopoulos et al., 2020).

For partnership coordinators, our cluster analysis provides a diagnostic framework to assess their current AI implementation status and identify appropriate development pathways. By recognizing which cluster profile most closely resembles their current situation, coordinators can develop targeted strategies addressing their specific challenges. For example, partnerships in the Early Experimenters cluster should prioritize knowledge development initiatives and structured experimentation approaches, while those in the Specialized Adopters cluster may benefit from integration support and cross-functional implementation teams.

The significant knowledge gaps identified across clusters suggest that partnership managers should prioritize capability development initiatives. These might include establishing dedicated AI competence centers within partnerships, developing knowledge-sharing platforms across member organizations, creating joint training programs, or engaging external experts for knowledge transfer. The negative correlation between knowledge

barriers and adoption levels indicates that such initiatives may be particularly impactful in accelerating implementation.

For policymakers and funding agencies, our sectoral analysis reveals opportunities for targeted intervention programs addressing sector-specific adoption barriers. The significant adoption gaps between technology/healthcare sectors and traditional industries highlight the need for sector-specific support mechanisms rather than generic AI promotion policies. Additionally, the measurement readiness gap identified across all partnership types suggests an opportunity for policymakers to develop standardized evaluation frameworks and success metrics for collaborative AI initiatives.

The identified correlation between partnership size and adoption levels has implications for partnership design and funding allocation. Rather than assuming that smaller partnerships require less support for AI implementation, our findings suggest they may actually need more substantial assistance to overcome scale-related barriers. Policy initiatives might include targeted funding programs for smaller partnerships, facilitated access to shared AI infrastructure, or incentives for cross-partnership knowledge sharing.

6. Conclusions

This study examined AI adoption patterns within innovation partnerships across multiple sectors, identifying significant variations in implementation levels, approaches, motivators, and barriers. Through analysis of survey data from 45 innovation partnerships, we have revealed important insights addressing our three research questions.

Regarding implementation patterns (RQ1), our findings demonstrate that innovation partnerships primarily adopt foundational AI technologies such as data analytics and machine learning, with more specialized applications showing lower implementation rates. Significant sectoral differences exist, with technology-oriented and aerospace partnerships demonstrating higher adoption levels than those in traditional sectors. Partnership size emerged as another influential factor, with larger collaborations showing more advanced implementation, supporting the assertion that resource availability and knowledge diversity influence collaborative innovation outcomes. This sectoral variation aligns with patterns observed in broader organizational AI adoption studies (Ransbotham et al., 2020; McKinsey, 2022).

The analysis of implementation challenges (RQ2) identified knowledge and skill gaps as the most significant barriers to AI adoption, followed by implementation costs and technical complexity. These challenges vary based on partnership characteristics, with smaller partnerships emphasizing resource constraints while larger ones highlight governance and alignment challenges. The significant negative correlation between knowledge barriers and adoption levels suggests that building shared AI capabilities across organizational boundaries represents a critical success factor. These findings align with Broekhuizen et al.'s (2023) framework for AI in open innovation, which emphasizes knowledge management capabilities, and reflect the automation-augmentation tensions described by Raisch and Krakowski (2021).

Our cluster analysis (RQ3) revealed four distinct adoption profiles—AI Leaders, Specialized Adopters, Early Experimenters, and Non-Adopters—each characterized by specific implementation approaches, technology preferences, and challenge patterns. This typology confirms that partnerships exhibit identifiable patterns extending beyond simple adoption level differences. Each cluster demonstrates how AI adoption in collaborative contexts follows multifaceted trajectories influenced by organizational characteristics, sectoral contexts, and strategic priorities. These patterns demonstrate extends beyond the binary adoption frameworks criticized by Jöhnk et al. (2021) to provide a more nuanced understanding of how partnerships engage with AI technologies.

These findings contribute to both theory and practice. Theoretically, our work extends technology adoption frameworks by illuminating how partnership characteristics shape AI implementation in multi-stakeholder environments and demonstrates how AI as a data-driven process manifests differently across partnership types (Tekic and Füller's, 2023). Practically, our findings provide partnership coordinators with a diagnostic framework for assessing implementation status and developing targeted strategies.

Several limitations suggest directions for future research. The cross-sectional nature of our study prevents examination of adoption dynamics over time, suggesting value in longitudinal approaches. The moderate sample size limits statistical power, indicating a need for larger-scale studies. Future research should examine how partnerships transition between the identified cluster types, focusing on mechanisms enabling progression. Additional research into successful knowledge-sharing practices across organizational boundaries would address the most significant barrier identified in our study. Finally, developing standardized assessment frameworks for

AI implementation in collaborative contexts would help address the measurement readiness gap revealed in our analysis, supporting Keding's (2021) emphasis on evaluation mechanisms for collaborative AI initiatives.

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Battlefield or Coexistence? Customer Knowledge Creation in the Financial Management of a B2B SME

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Abstract: Firms often seek new knowledge from external sources like customers to enhance customer satisfaction. This requires the efficient management of customer knowledge, not only in the firm's marketing but also in other functions to provide enablers for overall customer experience. This paper addresses the question of "how is customer knowledge created in the financial management process of B2B SME?". The phenomenon is empirically explored using a case study research strategy that was carried out by the semi-structured interview research method and theory-guided analysis. The case SME sells and develops well-being service solutions in the B2B market in Finland. The business is characterised by credit sales and the subsequent accounts receivable, which initially puts customer understanding at the forefront to enable better decision-making in managing customer risks. The paper concludes that the creation of B2B financial knowledge in an SME seems to vary related to the characteristics of the O2C process resulting in diversified understanding of the financial position and customer behaviour of B2B customers. The SME's process of creation of B2B customer financial data varies due to the knowledge needs emerging in different phases of O2C processes. Whereas the routine process seems to rest on the use of a customer's explicit financial data gathered mainly from inside the company, an unexpected process, which is typically by face-to-face encounters with customers, increases a need for tacit knowledge embodied in employees. Based on the empirical findings, the study concludes that customer knowledge creation plays a critical role in the financial processes of a B2B SME. This further indicates that the management of customer knowledge and the finance of B2B firms match each other nicely, forming a coexistence rather than a battlefield.

Keywords: Customer knowledge management, Knowledge flows, Customer financial knowledge, Financial management, Order-to-cash, Case study, B2B SME

1. Introduction

This study is positioned in the domain of customer knowledge management (CKM hereafter), which posits that a firm needs new knowledge from external sources like customers to gain a competitive advantage (García-Murillo and Annabi, 2002). CKM is viewed as a combination of management practices, skills and dynamic capabilities related to the ongoing processes of understanding customers, to help firms to improve their customised products, services and marketing results (Chaithanapat and Rakthin, 2021).

In general, the extant scholarly work on CKM has mainly focused on exploring various customer knowledge processes between a firm and its customers and within the organisation. The processes such as generating, sharing and using customer knowledge; creation, storage and sharing of customer knowledge (Chaithanapat and Rakthin, 2021); gaining, sharing and disseminating customer knowledge (Gibbert, Leibold and Probst, 2002); and revealing, sorting and levelling of customer knowledge (García-Murillo and Annabi, 2002) have been observed. CKM model integrating business functions, business processes and knowledge aspects (Gebert et al. 2003) has also been developed.

All this literature implicitly regards customers as an individual user of the products and services of the firms, which is typically referred to as 'the user' in the B2B marketing literature (Leone et al, 2021; Paschen, Kietzmann and Kietzmann, 2019). Further, customer knowledge processes have been explored in, or related to, organisational marketing functions such as product and service development and sales. What seems to have been overlooked in the CKM domain is study of the process of the creation of B2B customer knowledge occurring in the financial management process of a firm.

To fill the knowledge gap, this research addresses the question of how customer knowledge is created in the financial management process of a B2B SME? Drawing from CKM, knowledge management and financial management literature and completed with an empirical case study on an SME, the paper provides new insights into B2B customer knowledge creation in SMEs in general, and particularly into financial management in such a setting.

The remainder of this paper proceeds as follows: first, a conceptual clarification of B2B customer knowledge creation in the context of financial management is presented. Then, the methodology, data gathering and analysis are described, followed by a presentation of the research findings of the empirical study. The paper ends with conclusions and implications before providing avenues for future research.

2. Theoretical Foundation

2.1 B2B Customer Financial Knowledge

CKM literature typically defines customer knowledge by integrating the dimensions of customer knowledge flows and customer knowledge content. 'Customer' means the individual customer in the CKM literature. Consequently, three categories of *customer knowledge flows* can be identified: knowledge about customers, knowledge for customers and knowledge from customers (Salomann et al, 2005; Gebert et al, 2003).

Knowledge about customers covers various knowledge regarding customers, such as their values, experiences and perceptions (Gebert et al, 2003); customers' pain points, needs and preferences which could better explain the reason behind their actions (García-Murillo and Annabi, 2002); and the needs, demands and behaviours of customers (Chaithanapat and Rakthin, 2021).

Knowledge for customers is the knowledge that firms share with their customers to satisfy the needs of the customers (Gebert et al, 2003; García-Murillo & Annabi, 2002), and to help them make quicker and better buying decisions (Chaithanapat and Rakthin, 2021). This knowledge domain includes information regarding the range, structures and processes of the products and services offered by the company, markets, suppliers and distributers (Salomann et al, 2005; Gebert et al, 2003; García-Murillo & Annabi, 2002), which customers already have but also lack, to fulfil the latent need for knowledge of the customer (Chaithanapat and Rakthin 2021).

Knowledge from customers refers to what the customers know, have experienced, needed and felt about the firms and their products or services (Gibbert, Leibold and Probst, 2002). This type of knowledge is usually found in customers' responses or feedback (Gebert et al, 2003) but can also be gathered from them through interaction with the firm's staff, implying a tacit dimension to customer knowledge (García-Murillo and Annabi, 2002; Nonaka, Reinmoeller and Senoo, 1998).

B2B customer financial knowledge can be categorised into (1) traditional knowledge and (2) non-traditional knowledge or alternative knowledge based on the knowledge timeliness. Traditional knowledge aims to provide information on the firm's financial position. Due to its regulated nature, it is usually well-structured numerical or text data captured in the firm's financial statements (Dumitru, 2023; Sun et al, 2024; Vasarhelyi, Kogan and Tuttle, 2015). Financial information containing company-specific financial performance information or market economic indicators can stem from public or proprietary sources (Arleo et al, 2023).

Non-traditional or alternative knowledge refers to the constantly evolving real-time commercial or credit knowledge gathered through business processes (Sun et al, 2024). Commercial data in terms of consumption data, gathered from buying or selling data record, is highly important as it often directly reflects a firm's revenue. This type of data covers the firm's financial transaction data, which includes orders and payments and their amounts, dates, types and payment results (Yue et al, 2021; Sun et al, 2024). Customer's transaction data involves, for example, invoicing and payment history, the monetary value of money spent, purchase type and quantity and their frequency or recency (Janssens et al, 2024; Mirkovic et al, 2022).

2.2 Inter-Organisational Creation of Customer Knowledge in the O2C Process

The organisational creation of knowledge refers to the capability of a company to create new knowledge, disseminate it throughout the organisation and embody it in products, services and systems. Knowledge creation is interaction, which is shaped by shifts between different modes of knowledge conversion, which links action (socialisation, internalisation) with reflection (externalisation, combination) (Nonaka and Takeuchi, 1995).

New knowledge can be created beyond organisational boundaries through interacting with outside constituents (Nonaka and Toyama, 2005), which makes the interactions more complex compared to a single firm (Corno, Reinmoeller and Nonaka, 1999). The three levels of interaction that a firm can use in interacting with its key partners include the processes of (1) using the explicit knowledge of key actors, (2) helping key-actors to externalise their tacit knowledge, and (3) externalising shared hidden knowledge (Corno, Reinmoeller and Nonaka, 1999).

The first level prescribes a three-step process of *using the explicit knowledge of key actors* (Corno, Reinmoeller and Nonaka, 1999). The interactions at this level require explicit knowledge, which needs to be verbalised and communicated by the partners (Nonaka, Reinmoeller and Senoo, 1998). The companies collect the explicit knowledge both inside and outside the organisation using multiple communication channels. The interaction is typically collective and virtual, which can be supported with documents, meetings, information technology and the division of labour and hierarchy (Nonaka and Toyama, 2005). The level is limited to market transactions and

exchanges between suppliers. Specific orders made by a central firm are part of this (Corno, Reinmoeller and Nonaka, 1999).

The second level of interaction refers *to helping key-actors to externalise their tacit knowledge* (Corno, Reinmoeller and Nonaka, 1999). The process includes three different steps. First, the co-actors try to understand the tacit knowledge of their partners. Then, the companies try to make this knowledge explicit by inducing externalisation by suppliers. Finally, they collect, integrate and use such knowledge (Nonaka, Reinmoeller and Senoo, 1998).

The third level is *externalising shared hidden knowledge*. This requires a deeper level of interaction and a high level of cooperation from the firm and partners. It takes four steps to engage partners in knowledge creation. First, companies need to share tacit knowledge with their partners by sharing experiences. Second, the tacit knowledge needs to be externalised inside the organisation. Third, companies then externalise the tacit knowledge for their partners by generating hypotheses based on such tacit knowledge and testing them against the knowledge held by suppliers. Finally, customers and companies engage in the combination mode of knowledge conversion and subsequently in internalisation, for example by using products and services (Nonaka, Reinmoeller and Senoo, 1998).

2.3 Order to Cash (O2C) Process

The Order to Cash financial management process (O2C) is approached from the viewpoint of credit risk management. The O2C process refers to the end-to-end process that aligns with a sales process, i.e. the process from receiving a customer order to receiving the payment for it (Doxey, 2021; Parravicini, 2015). The O2C process typically includes sub-processes of sales, ordering, invoicing, accounts receivable (AR) and collections, cash management and the application of customer payment to AR. The process is supported by master data management (MDM) and credit management (Dimon, 2013; Doxey, 2021; Parravicini, 2015). MDM includes both product and customer database management and related information (Parravicini, 2015). Figure 1 demonstrates the O2C process from a financial management point of view.

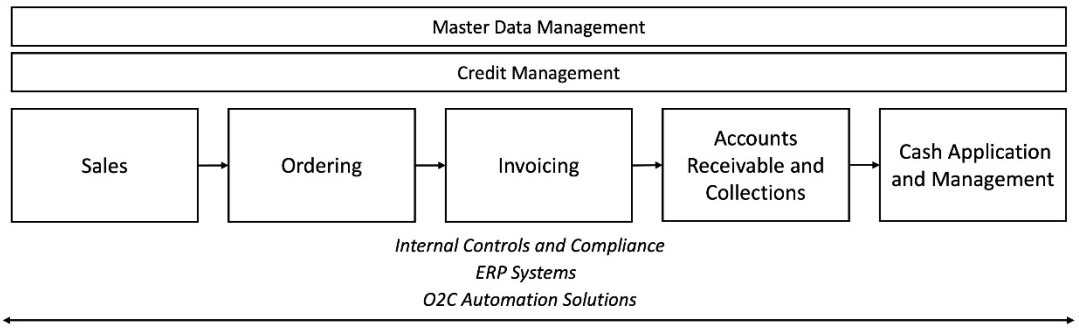


Figure 1: The Order to Cash (O2C) process (adopted from Doxey 2021; Parravicini 2015)

The O2C process starts from the sales process where the prospective buyer makes an actual purchase and the sale is closed (Doxey, 2021; Parravicini, 2015). The ordering phase means taking an order from the customer, fulfilling it and delivering the goods or services. After delivery, the customer is invoiced, and the phase of cash collection starts (Parravicini, 2015). When an invoice is created, it also creates an AR which is foundational in the O2C process from a financial management perspective. AR is created when a product or a service is sold on credit, the payment is received after product or service delivery (Doxey, 2021). A natural part of AR is the risk of non-payment (Štangová and Víghová, 2021) called credit risk.

Credit risk is managed by credit management, a function that enables the evaluation of the risk of credit sales related to unsuccessful payment collection. It is an ongoing support function extending from determining payment terms to performing credit analysis, recommending credit limits and periodic customer screening (Doxey, 2021). Efficient AR management is a key element in working capital management, minimising the time of receiving payment for the receivable and minimising the risk of bad debt (Yazdanfar and Öhman, 2014; Štangová and Víghová, 2021). The efficient AR management of credit sales is also an essential part of cash flow management and one of the driving factors of business profitability (Khalid, 2010). In practice, this means evaluating and approving credit decisions and also monitoring the customer's financial information and payment behaviour (Sihler et al, 2004). If payment is received on time, the AR is closed and so is the O2C cycle. After the

invoice has been due for payment but the payment is outstanding, the process continues to the collections phase until the receipt of payment or incurrence of bad debt (Doxey, 2021; Parravicini, 2015).

The O2C process is often enabled by automated data processing systems and solutions, with integrations into ERP systems and other internal or external systems such as credit systems (Doxey, 2021; Dimon, 2013). It is a transactional and granural process, the efficiency of which improves the O2C cycle time, in other words the monetary materialisation of a sale (Dimon, 2013). Consistent, high-quality data is the foundation and efficiency enabler of the O2C process. Effective MDM enabling consistent data curation and maintenance further enables the creation of clean ongoing data to the process data flows in the systems architecture. The more consistent the data, the better synchronised and seamless the flow between the systems is. Data discrepancies create unmatching records and might require manual interventions to the knowledge flow (Brown, 2022).

3. Research Methodology

The study adopted a qualitative research approach and was carried out by the case study research strategy. This strategy was selected because it provides in-depth answers to the 'how' questions in a real-life context and enables revealing the tacit knowledge and dynamics of the process in the researched case (Yin, 2003), which aligns with the aim and the research questions of the study.

The SME was selected as a case, which has been called for in the domain of customer knowledge management (Chaithanapat and Rakthin, 2021). The Finnish SME sells and develops well-being service solutions directly to the B2B credit sales customer without any intermediaries, which further offers solutions for end-users. The business is characterised by credit sales and the subsequent AR, which initially puts customer understanding at the forefront to enable better decision-making in managing customer risks.

The method employed for data collection was a semi-structured individual face-to-face interview. The interview was divided into themes including questions about the B2B customers' financial data, the different B2B customer financial knowledge creation practices and their role in the different phases of the O2C process. A total of nine key informants representing distinctive departments involved in the O2C process were interviewed. The informants were selected based on their operative role in the departments and O2C process and its sub-processes, creating expectations about their insights into the themes at hand. The interviewees presented the personnel from sales, product development, customer service and financial management. The interviews were conducted in March 2025 and lasted 67 minutes on average (Figure 2).

Dep	*Role in the O2C process*	*Interviewee role*	*Duration*
A	Invoicing, Collections, Credit Management, AR, Cash Management	Financial Management	85, 54, 74 mins
B	Ordering, Invoicing, MDM	Customer Service	72, 65, 91 mins
C	Sales, Ordering, Credit Management, MDM	Sales and Product Development	60, 28, 70 mins

Figure 2: Interviewees in the research setting

All interviews were recorded and transcribed. The theory-guided content analysis sought to collect evidence of B2B customer financial knowledge creation in the O2C process. Figure 3 illustrates the way of generating the results of the theory-guided content analysis.

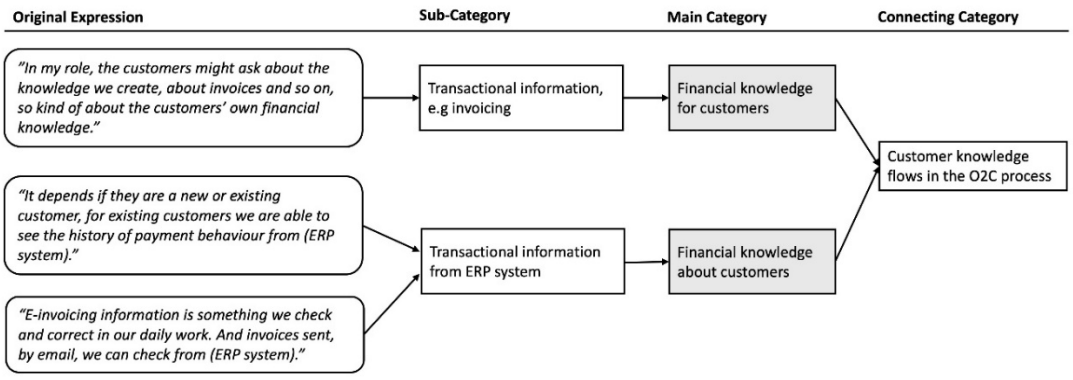


Figure 3: Illustration of the deployment of theory-guided content analysis

Following the logic of the analysis, the analysis was guided by the theoretical foundation. The main category (high-lighted in grey) represents the categories drawing on the theory. The sub-category was formed based on the original expressions.

4. Results

The findings indicate that, even though customer financial knowledge is created in the B2B SME using the explicit knowledge of key actors in managing customer risk, the creation of B2B customer financial knowledge is not so unambiguous. Specifically, the creation of customer financial knowledge seemed to vary according to the situation of the O2C process. Whereas the creation of customer financial knowledge using the explicit knowledge occurred in the routine O2C process, the extended customer knowledge creation process including collection of internal tacit knowledge was triggered by unexpected events in the process. Figure 4 illustrates the interplay between the phases of the O2C process, related IT architecture, the types of financial knowledge and the knowledge interactions.

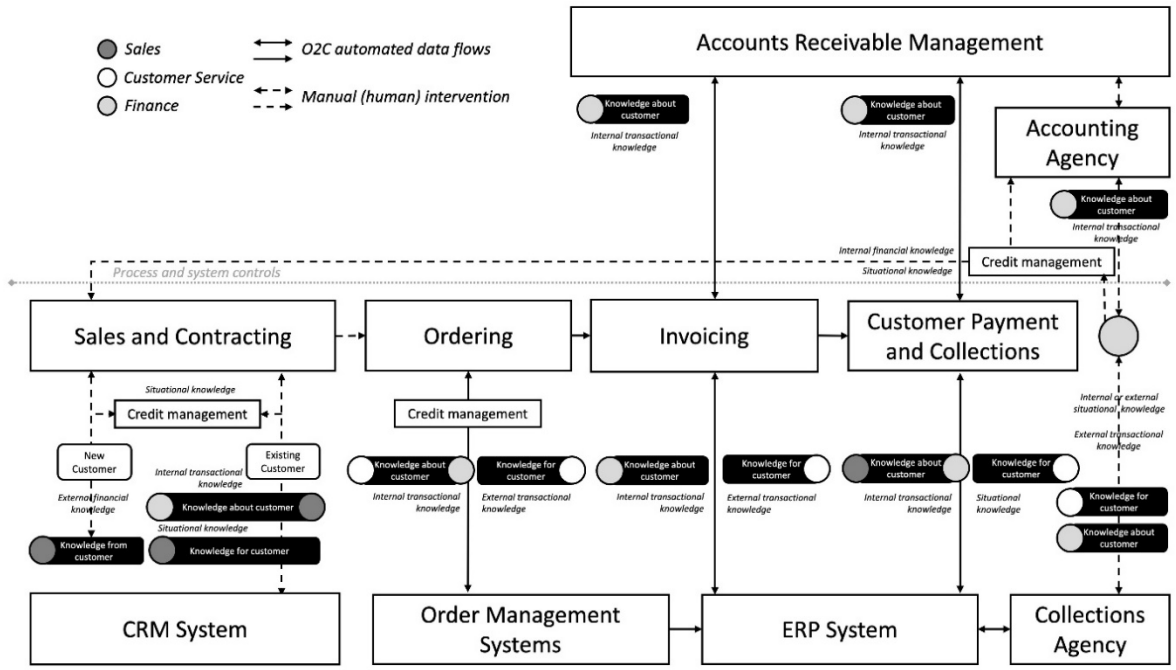


Figure 4: Creation of B2B customer financial knowledge in the O2C process of the SME (by authors)

Customer knowledge creation through using the explicit knowledge of key actors occurred in the routine end-to-end O2C process pertaining to all sub-processes including accounting and AR management. This kind of knowledge covered non-traditional financial data including transactional knowledge (customer orders, invoices, respective payments, sums and dates) and basic customer information (invoicing details). The company collected the explicit customer financial knowledge inside the company supported by automated data processing. Knowledge was also collected outside the company from the collection agency, which was integrated into the ERP system. The findings indicate that it is the financial knowledge about B2B customers that flows within the company, which is foundational to the sales and credit risk management. Interestingly, the internal transactional knowledge about customers was fed back to the B2B customer in terms of sales order confirmations, customer invoices or overdue invoices created by the order management or ERP systems. Hence, external financial knowledge for B2B customers also flows from the company to the customer.

The O2C cycle was closed by the automated customer payment process in which internal transactional knowledge about the customer was shared to AR. If a customer neglected its payment obligations, the automated system fed the knowledge to the collections agency. The notification of due payment from the collections agency refined the internal transactional knowledge to external transactional knowledge for the customer and reported it as situational knowledge to the customer, to the finance team and further as internal transactional knowledge to the accounting agency. This knowledge about the customer further triggered a need for a credit review in which situational knowledge of the customer was compared to internal financial knowledge and managerial accounting, being the total amount of AR and credit issued on an individual customer or customer base level.

The initial results further indicate that the process of creating B2B customer knowledge differs as the routine O2C process faces unexpected events. In this case, the situation seemed to change the need for the knowledge and subsequent process of customer knowledge. The role of tacit knowledge embedded in humans became the dominant aspect of B2B customer financial knowledge due to the manual interventions required for revising the process. Company internal human intervention was specifically required as the errors or deficiencies in customer master data or process controls of automated customer financial knowledge (e.g., pricing or invoicing information) were detected, otherwise resulting in effects on the customer or liquidity. This knowledge referred to the flows of financial knowledge about or for the customer. Also, customer inquiries (i.e., knowledge from customer) emerging in the customer service department triggered human intervention and the sharing of customer financial knowledge within the company, as well as sales process and credit management controls concerning knowledge from, about and for the customer. The customer financial knowledge created in this situation was used to reconsider the company's operative processes and risk management.

The manual interventions seemed to require seamless collaboration between several departments to avoid undesirable results in the creation of customer financial knowledge. This means that, without inter-departmental collaboration, a deficiency in process control or customer master data can trigger a chain reaction of biased customer financial knowledge and revenue across the automated system flows, influencing the correctness of internal knowledge about the customer and the knowledge shared for the customer in terms of invoices. Deficient knowledge shared for the customer often results in customer feedback or contact and investigation from multiple departments. Hence, the types of human interventions are closely interrelated.

The initial findings further show that the creation of B2B customer financial data in the O2C process of SMEs is dependent on the type of customer. As far as new customers are concerned, the sales, contracting and the credit checks of new customers are carried out in collaboration with the sales and finance departments. This process is characterised by situational knowledge in terms of the value of sales or the credit risk at the moment of evaluation. The new customer data concerns traditional financial data captured in the financial statements, which is collected directly from the customer to ensure up-to-date knowledge instead of the credit rating service provider possessing outdated data due to the retrospective nature of the knowledge. This helps in the better understanding of the financial situation of the customer. The decision on the credit check done by financial management is fed back to the customer by the sales department.

In contrast, the credit check of regular customers relies on the financial accounting information and key financial ratios collected from the credit rating service providers. The internal historical transactional knowledge that the company holds about the customers in its ERP, CRM, order management systems or external collections agency systems, and the basic customer information (company size and field of business) also play an important role. In continuous credit screening, credit limit acts as system-level credit management control in the ordering phase.

Further, the research findings indicate three main characteristics of high-quality customer knowledge in the financial management context: (1) the accuracy and timelines of knowledge, (2) the relevance and availability of knowledge, and (3) the understandability of customer financial knowledge. All these characteristics were viewed as knowledge aspects that indicate the usability of the B2B customer knowledge created in the financial processes of the SME.

5. Discussion and Conclusions

The paper started by stating that the creation of customer knowledge in the financial management of B2B firms is poorly understood in the CKM literature. By integrating the discussion on inter-organisational knowledge creation and financial management, the process of creating B2B customer financial knowledge in the context of the O2C process of SMEs was identified. As a conclusion of the empirical results, the creation of B2B financial knowledge of SMEs seem to vary related to the phases of the O2C process resulting in diversified understanding of the financial position and customer behaviour of B2B customers.

The empirical data revealed that SMEs' process of the creation of B2B customer financial data varies due to the knowledge needs emerging in different phases of O2C process. Whereas the routine-like process seems to rest on the use of a customer's explicit financial data gathered mainly from inside the company, an unexpected process increases a need for tacit financial knowledge embodied in employees. Specifically, the latter type of process of customer knowledge creation is triggered by face-to-face encounters with customers and requires intense inter-departmental collaboration including sales and finance in order for SME's to provide customer satisfaction, including the risk management perspective. SMEs seems to deepen customer understanding through unexpected occurrences in the O2C process although this may cause much work. Hence, it is not only

sales and marketing but also finance, which makes an SME a customer-oriented company resulting in the coexistence of functions.

This paper makes several contributions to the CKM literature. First, by providing the illustration of B2B customer knowledge creation for research into customer understanding, this study broadens the prevailing discussion not only on the type of customer knowledge processes but also on the type of customer as a knowledge source (Chaithanapat and Rakthin, 2021; Gibbert, Leibold and Probst, 2002; García-Murillo and Annabi, 2002). Second, the study enriches the discussion on the content of customer knowledge (Salomann et al, 2005; Gebert et al, 2003), by proposing content of financial knowledge concerning B2B customer's financial position and financial transaction for the study of CKM. Third, the paper further provides insights into managing customer knowledge in the context of the financial management, which supplements the prevailing view of CKM focusing solely on the sales and marketing context (for a review see Chaithanapat and Rakthin, 2021). Finally, the study enhances an understanding of CKM specifically in the context of SMEs, which has been called for (Chaithanapat and Rakthin, 2021).

The study also has several contributions to the management of SMEs. Understanding how to create B2B customer knowledge not only in sales and marketing but also in financial management is of key importance. To advance the creation of customer knowledge, SME management may design and activate inter-departmental collaboration specifically to increase the creation of tacit B2B customer knowledge and to open the knowledge silos. Also, the clear expectations and needs for creating tacit knowledge and the ownership of explicit MDM should be communicated to all company levels to ensure smooth customer and liquidity facing operative processes. In this way, SME management can foster information flows and information access inside the company.

The study suggests future research avenues on the creation of B2B customer financial data. More research should be conducted around various inter-organisational customer knowledge creation processes to increase understanding of the process. Further, more data should be gathered around the theme. Within this study, the emergence of only one process was limited. Another limitation was the qualitative research approach, which generated results only from one SME without providing more insights into the issue.

Ethics statement: Ethical clearance was not required for the research. The research followed ethical guidelines for the data collection with the semi-structured interviews as follows: the introduction letter (informing voluntariness and confidentiality; anonymity, privacy, and security of the data; and autonomy principle) and the interview guide (study purpose, interview process description, interview questions) were sent to the informants beforehand. Informed consent and the transcription were recorded. The interview data was anonymised, securely stored and deleted after use.

AI statement: No AI tools or technologies have been used to create this paper.

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Breaking Silos to Foster Knowledge Sharing in Universities: A Systems Thinking Perspective

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Abstract: Universities operate in an environment characterized by rapid change, globalization and other unpredictable complex factors. These institutions play a critical role in the socio-economic development of society. Knowledge has been identified as a strategic resource for private and public organizations to gain competitive advantage. Furthermore, universities are under pressure to respond to the needs of their diverse stakeholders. Hence, it is critical to create a conducive environment to foster Knowledge Sharing beyond functional boundaries in these institutions. However, functional silo mentality has been identified as a major factor that encumbers Knowledge Sharing in organizations, including universities of technology. The purpose of the study was to explore the applicability of the Systems Thinking concept in the context of fostering Knowledge Sharing in Universities of Technology. Previous research investigated this phenomenon from a different perspective, whilst this study provides a University of Technology context. The study adopted a qualitative research methodology underpinned by a constructivism philosophical worldview. Qualitative data was collected from the employees of two universities of technology through semi-structured interviews. Participants in the study were purposively selected. NVivo software was used for data analysis. The study provides theoretical perspectives and practical insights for applying Systems Thinking to foster Knowledge Sharing beyond functional boundaries in organizations and Universities of Technology. Overall, the results of the study indicated that participants were positive that adopting Systems Thinking would be a strategic choice to institutionalize Knowledge Sharing in universities of technology. One of the limitations of this study was that data was collected from only two selected public universities of technology. This provides an opportunity for future research to consider collecting data from more than two universities of technology to investigate this phenomenon.

Keywords: Knowledge sharing, Universities of technology, Systems thinking, Functional silos, Higher education

1. Introduction

Higher education institutions (HEIs) play a critical role in the socio-economic development of society (Menon and Suresh 2021). However, unpredictable and complex factors have an impact on the operations of the HEIs (Wang and Rashid 2022). Given the rapidly changing environment in which universities operate, it is therefore critical to continuously explore strategic options to gain competitiveness. Universities operate in a globalized environment, and they compete for funding, strategic partners and student enrollments, hence they have adopted corporate strategies to remain competitive (Parker 2024). This includes exploring the effective sharing of organizational knowledge. According to Mazorodze and Mkhize (2022), Knowledge Sharing is important for HEIs. Hence, this study investigates the applicability of Systems Thinking as a strategic approach to eradicating silo mentality and fostering Knowledge Sharing in universities of technology. Chowdhury (2023) defines Systems Thinking as the ability to understand the interrelationships between the interconnected and interacting elements of a system. These elements should work together to achieve a common goal. In the context of this study, interconnected elements are departments and faculties and other relevant structures in the university environment. Knowledge Sharing is generally a combination of exploiting and sharing existing knowledge to create new knowledge which must be applied to enhance organizational operations. According to Yoon and Park (2022), a Knowledge Sharing culture motivates employees to share and apply each other's knowledge to improve efficiency in organizations. Knowledge Sharing is part of Knowledge Management. However, the focus of this study is on Knowledge Sharing, not other aspects of Knowledge Management. This was informed by the objectives of this study.

Mahdi, Nassar and Almsafir (2019), describe knowledge as a strategic resource for organizations to gain a competitive advantage. Knowledge is divided into two categories, namely tacit and explicit (Karim 2023).This study focuses on Systems Thinking and Knowledge Sharing in universities of technology. Holistic understanding of organizational elements and their interactions is critical (Al-Kurdi, Eli-Haddadel and Eldabi 2020) as this understanding is key to fostering Knowledge Sharing in an organization. A holistic understanding of the university operations is critical as Stowell (2021) argues that an organization should be viewed as a system. Knowledge Sharing is one of the drivers for competitiveness and responsiveness (Annansingh, et al 2018). Interestingly, this study also highlights the importance of breaking down functional silos to facilitate Knowledge Sharing in universities of technology. Moreover, this study identifies the lack of an overarching and institutionalized philosophy to promote knowledge sharing in universities as a problem. This creates functional

silos and hinders Knowledge Sharing in universities. Bento, Tagliabue and Lorenzo (2020) attest that the lack of Systems Thinking creates functional silos in an organization. Furthermore, Rossouw and Goldman (2023) succinctly state that creating a collaborative environment in HEIs remains a challenge. Jones et al (2024) are also of the view that silo mentality hinders Knowledge Sharing and collaboration in an organization. According to Al-Kurdi (2023), few studies have been conducted to address Knowledge Sharing in universities. Lin, Eichelberger and Leong (2020) argue that to remain competitive in a rapidly changing environment, HEIs require new approaches.

2. Literature Review

In an environment characterized by disruptive and rapid change, the development of effective strategies is critical for HEIs to survive (Rossouw and Goldman 2023). Hence, Menon, Suresh and Raman (2022) emphasise that the ability of HEIs to adapt is critical to respond to the needs of the stakeholders and environmental changes. The development of operational strategies should foster the effective use of organizational resources including strategic resources like knowledge in HEIs.

2.1 Institutionalizing Systems Thinking to Promote Knowledge Sharing in Universities of Technology

Systems Thinking is regarded as a discipline founded on understanding the interrelationships and interactions of various system elements (Kordova, Frank and Miller 2018). This philosophy has received the attention of researchers, practitioners and leaders, mainly in the private sector context. Systems Thinking originates from General Systems Theory. As HEIs continue to explore effective strategies to gain competitiveness, effective Knowledge Sharing cannot be ignored. Factors that encumber Knowledge Sharing in universities, such as functional silos, need be eradicated. It is in this context that the study was conducted to explore the applicability of Systems Thinking as a solution to promoting Knowledge Sharing and eradicating silo mentality in universities. Systems Thinking serves as a catalyst to empower organizational members with the ability to appreciate the interconnectedness of various sections of the organization. In an organization where organizational members appreciate the interconnectedness of various departments, it becomes easier for them to work towards a common goal. Where people understand that they have a shared purpose, it becomes easier to share knowledge. In Systems Thinking, the organization is viewed as a system. Accordingly, Vemuri and Bellinger (2017) describe an organization as a family of individuals who are interrelated and interacting to achieve a common goal. In other words, a university is a system operating as part of a bigger system, namely the Higher Education sector. Rossouw and Goldman (2023) highlight a need to continuously evaluate processes and practices if HEIs are to remain relevant and competitive.

In a rapidly changing higher education environment, effective sharing of knowledge in universities is critical. Furthermore, an institutionalized and internalized philosophy to promote knowledge sharing is key to gaining competitive advantage. This study is informed by two theories, namely General Systems Theory and Social Exchange Theory. Tsai and Cheng (2012) attest that Social Exchange Theory covers Knowledge Sharing robustly. This argument is also highlighted in a study by Zahao and Detlor (2023), that Social Exchange Theory is considered relevant and useful to understand people's willingness to share knowledge. Systems Thinking on the other hand originates from General Systems Theory. According to Bashan and Kordova (2021), Ludwig Bertalanffy is regarded as a pioneer of Systems Thinking.

2.2 Applying Systems Thinking to Eradicate Silo Mentality in Universities of Technology

Nisula and Pekkola (2018) state that eradicating functional silos requires members of the organization to change their attitude and, to a certain extent, bring about change in the organizational structure. Systems Thinking is an alternative to the traditional reductionist approach where the focus is on individual elements of the system, instead of the system as a whole (Vemuri and Bellinger (2017). According to Bento, Tagliabue and Lorenzo (2020) organizational silos are a threat to cross-functional collaboration in organizations. Reductionist thinking promotes silos in an organization. Systems Thinking is the ability to appreciate interconnectedness, interdependency and interactions of a system's elements (Erzurumlu et al 2023). The ability to view the university from a systems perspective is critical to improve its operations. Similarly, using a Reductionist perspective to understand the university environment is not advisable because such an approach fails to understand complexity. Kordova, Frank and Miller (2018) state that the traditional approach informed by reductionism fails to deal with complex challenges. Understanding university operations from a holistic perspective is important. In the context of Knowledge Sharing, interrelationships, interactions and collaboration are critical to achieving organizational goals. Systems Thinking serves as a catalyst to view the organization holistically. Organizations exist to achieve their strategic goals, and the ability to adapt in a rapidly

changing environment is a key requisite (Abukalusa and Oosthuizen 2023). Benefits for Knowledge Sharing include among others increasing productivity, and organizational effectiveness (Alves and Pinheiro 2022).

2.3 Promoting Knowledge Sharing to Enhance Organizational Capabilities in Universities of Technology

De Witt and Koh (2020) describe knowledge as one of the most critical assets in an organization. Hence organizational knowledge is always regarded as a strategic resource to achieve organizational goals (Mosala-Bryant and Hoskins 2017). Continuously improving every aspect of the business holistically is critical to outperform and outsmart competitors. This applies to universities as well. Hence, Mosala-Bryant and Hoskins (2017) state that the effective sharing of knowledge becomes a contributing factor to improving organizational operations and achieving organizational goals. This requires a conducive environment in organizations. The effective sharing of knowledge is important for the organization to gain a competitive advantage. Al-Kurdi, Eli-Haddadel and Eldabi (2020) assert that organizations are realizing the importance of Knowledge Sharing. Organizational effectiveness relates to the effective use of organizational resources and capabilities to achieve its strategic goals (Xie and Lin 2023). In the context of this study, organizational knowledge needs to be shared effectively to enhance organizational effectiveness in universities of technology.

3. Research Methodology

A qualitative research approach was adopted to achieve the objectives of the study. Lim (2024) describes qualitative research as an indispensable approach to understanding complex and multifaceted social phenomena involving human experiences and perspectives. Hence, the qualitive research approach was appropriate to achieve the objectives of this study. According to Creswell and Creswell (2023), qualitative research is underpinned by a constructivism philosophical worldview. All participants were asked the same set of questions and leading questions were avoided. The researcher's personal views in this study did not influence the interpretation of the findings. Bangu, Provost and Carduff (2023) accentuate that qualitative research relies on non-statistical data. Participants in this study were employees of two selected public universities of technology. These were identified as the only universities of technology in a specific geographical area.

3.1 Sampling

A total of 15 participants were purposively selected for data collection purposes. Nyimbili and Nyimbili (2024) emphasize that the purposive sampling procedure ensures that a sample is selected without bias to increase the trustworthiness of the research findings. According to Adeoye-Olatunde and Olenik (2021), purposive sampling is a non-probability sampling method commonly used in qualitative research.

3.2 Data Collection

Data collection is a process of gathering specific types of data (Spickard 2017). Qualitative data was collected through semi-structured face-to-face interviews with 15 employees of the two selected Universities of Technology. This method of data collection allows the researcher to explore or probe pertinent ideas that may arise during the interview (Adeoye-Olatunde and Olenik 2021). Interviews were conducted in participants' individual offices. Participants allowed the researcher sufficient time to ask all the questions and probe further where it was necessary.

3.3 Data Analysis

Data analysis is the process that involves analyzing, interpreting and summarizing collected data to produce meaningful results (Tashakkori, Johnson and Teddlie 2021). NVivo was used to analyze data. This computer software package provides researchers with a user-friendly interface, simple data management features and extensive statistical functionalities (Tumiran 2023). The analysis of data assisted with the identification of themes which are presented and discussed later in this paper.

3.4 Profile of Participants

Participants were mostly in positions of authority and were operating at strategic levels in their institutions. Their input into the study was important as they understood the processes and practices in their institutions. Participants were asked to state their occupation at their respective institutions. Presented in Table 1 below is the profile of the participants.

Table 1 Profile of participants

Participant	Position
Participant 1	Deputy Dean
Participant 2	Associate Professor
Participant 3	Associate Professor
Participant 4	Director
Participant 5	Director: Special Projects
Participant 6	Director: Academic Development
Participant 7	Manager
Participant 8	Student Development Officer
Participant 9	Writing Centre Co-ordinator
Participant 10	HoD: HR (Academic Department)
Participant 11	HoD: Photography (Academic Department)
Participant 12	Quality Specialist
Participant 13	Deputy Dean: Faculty of Management Sciences
Participant 14	Health and Safety Officer
Participant 15	Assistant Registrar

The characteristics of the participants reflected diversity in terms of the functional roles in a university context.

4. Results and Discussion

To achieve the objectives of the study, data was collected using semi-structured face-to-face interviews. According to Lim (2024), when using qualitative research, researchers capture useful insights for policy formulation and solutions with an understanding of the relevant factors of a phenomenon. The findings of the study highlight the importance of institutionalizing Systems Thinking philosophy to promote Knowledge Sharing within and beyond functional boundaries in universities of technology. Participants indicated that applying Systems Thinking would create a conducive environment for cross-functional collaboration to facilitate Knowledge Sharing in universities of technology. Functional silos were identified as a major factor that encumbers Knowledge Sharing in universities. Bento, Tagliabue and Lorenzo (2020) mention that organizational silos hinder Knowledge Sharing.

In addition, the study reveals that Systems Thinking is applicable to universities and adopting Systems Thinking would be a strategic option to enhance Knowledge Sharing and eradicate functional silos in universities of technology. Overall, the study reveals a link between Systems Thinking, Knowledge Sharing and organizational effectiveness. Participants were of the view that through effective Knowledge Sharing , universities would enhance their organizational effectiveness. Stowell (2021) states that all systems must adapt to survive. In other words, the effective sharing of knowledge is key for the organization to gain a competitive advantage.

Based on the analysis of data, the following themes emerged:

Theme 1: Cross-Functional Collaboration and Knowledge Sharing in universities

According to Ishrat and Rahman (2020) organizational silos encumber cross-functional collaboration. Stowell (2021) argues that an organization should be viewed as a system. Participants stated that there was "*a silo mentality culture in universities*". Similarly, a study by Phaladi (2024) identifies silo mentality as one of the factors that hinder knowledge-based competitiveness in organizations. Such a culture hampers Knowledge Sharing in organizations as various departments focus on their own functional boundaries and ignore the broader strategic objectives of the organization, they are part of. The findings of the study resonate with the argument presented by Annansingh et al (2018), that Knowledge Sharing in HEIs is characterised by knowledge silos. Ishrat and Rahman (2020) highlight the importance of cross-functional collaboration to foster Knowledge Sharing in organizations.

One participant indicated that *"people were still operating in silos in his department"*. Explaining why departments and faculties were operating in silos, another participant was of the view that it was because departments and faculties did not want to "*lose their identities"*.

According to Mazorodze and Mkhize (2022), Knowledge Sharing is critical in HEIs. However, functional silos are still prevalent and as a result, there is no cross-functional collaboration. The overall findings confirm that there was silo-mentality in universities, particularly at the departmental and faculty levels. Erzurumlu et al (2023) point out that Systems Thinking is about the ability to appreciate how things are connected to each other in the whole entity and this key to promoting Knowledge Sharing.

In line with the responses from participants, Siriram (2020) argues that Systems Thinking was critical to stimulating a culture of looking at the organisation from multiple perspectives. Overall responses from the participants revealed that "*there was a lack of appreciating interrelationships among different divisions in the institution"*. Key to effective Knowledge Sharing is cross-functional collaboration in an organization. Consequently, cross-functional collaboration becomes key to enhancing organizational effectiveness. This facilitates Knowledge Sharing beyond functional boundaries to achieve organizational goals. It is however concerning, as pointed out by Kahn and Agnew (2017), that academic silos are prevalent in HEIs. Systems Thinking plays a role in creating a conducive environment that promotes cross-functional collaboration in the organization. This is critical to enhance organizational capabilities.

Theme 2: Systems Thinking and Knowledge Sharing in universities of technology

Universities are under pressure and should therefore operate as business organizations to remain competitive in a rapidly changing environment (Kok and Mc Donald 2017). It has been pointed out by Karim (2023) that knowledge continues to be a critical factor for HEIs to be competitive and sustainable. It was in this context that the current study was conducted. The purpose was to explore the applicability of Systems Thinking as a strategic option to promote knowledge sharing in the universities of technology. Participants indicated that *"adopting Systems Thinking would be a strategic decision to promote Knowledge Sharing in the university*".

Responses relating to opportunities for the application of Systems Thinking included:

"It will promote cross-functional collaboration". "There will also be flexibility in terms of operations and practices in the universities". One the participants mentioned the point that "*Systems Thinking will help the institution to operate efficiently to achieve its strategic goals.*"

Overall, participants were optimistic about the implementation of Systems Thinking philosophy in the universities.

Another comment was that "*Systems Thinking will promote a sense of shared purpose in universities".* Ishrat and Rahman (2020) stress that knowledge in an organization should be shared to improve organizational effectiveness. Systems Thinking is described by Ramovha (2022) as a concept that focuses on the holistic understanding of interactions and interrelationships of a system's elements. This happens to achieve a common goal.

Theme 3: Knowledge Sharing and Organizational Effectiveness

Knowledge is a strategic resource (De Witt and Koh 2020). Hence, it is critical to create a conducive environment where members share knowledge for the benefit of their organization. An organization is a system that is managed using policies and operational procedures to achieve a particular goal (Stowell 2021). Participants indicated that "*Knowledge Sharing was critical to gain competitiveness*"

According to Bento, Tagliabue and Lorenzo (2020), organizational silos encumber internal cooperation in an organization. Systems Thinking provides useful lens to appreciate the interconnectedness of a system's elements (Lin, Eichelberger and Leong 2020). Responses from the participants were positive. Another participant described Systems Thinking as a "*management approach that promotes multiple perspectives in dealing with complex challenges*". Furthermore, participants felt that:

> *"Systems Thinking will help to eradicate functional boundaries". "It will also help staff at every level of the institution to work towards a common goal".*

Overall, participants agreed that the implementation of Systems Thinking would help universities to deal with complex challenges using multiple perspectives. Rossouw and Goldman (2023) state that new ways of thinking were critical for HEIs to remain relevant. More importantly, Karim (2023) highlights the importance of creating

a conducive environment in HEIs for staff to share their knowledge. Mazorodze and Mkhize (2022) emphasise that HEIs are required to explore effective ways to promote Knowledge Sharing. Hence, Menon and Suresh (2021) argue that understanding interconnections in HEIs serves as a catalyst for agility.

5. Research Contribution

The aim of the study was to investigate the applicability and extent to which Systems Thinking fosters Knowledge Sharing and the eradication of functional silos in universities of technology. This study provides practitioners, researchers and policymakers with theoretical and practical insights to promote Knowledge Sharing through the application of a Systems Thinking philosophy in universities of technology. Additionally, the study highlights the importance of applying Systems Thinking to eradicate functional silos that encumber effective Knowledge Sharing in universities of technology. According to Al-Kurdi, Eli-Haddadel and Eldabi (2020), Knowledge Sharing is central to enhancing innovative capabilities in universities. This study is significant as Feiz, Soltani and Farsizadeh (2019) argue that few research studies have been conducted on Knowledge Sharing in universities. Therefore, this study is necessary to address that gap. Hence this study contributes to the existing body of knowledge by capturing Knowledge Sharing in the context of Systems Thinking in universities of technology. Lim (2024) highlights that the qualitative research approach provides crucial insights to develop theories and formulate policy and solutions that are effective and socially relevant.

6. Study Limitations and Future Research

This study has limitations which provide an opportunity for future research. Only two Universities of Technology participated in the study. Future research should consider investigating this phenomenon in more than two public universities of technology. Furthermore, the study focused on Knowledge Sharing and Systems Thinking in public university context not private universities.

7. Conclusion

The findings of this study highlight the lack of an institutionalized Systems Thinking philosophy in the universities of technology. In addition, the study reveals the prevalence of functional silos as one of the factors that encumbers Knowledge Sharing. This points to a lack of understanding that a university is a system with interconnected parts in the form of departments, faculties and other divisions that should work together to achieve the strategic goals of the institution. The study indicates that institutionalizing Systems Thinking in universities of technology will serve as an overarching philosophy to promote Knowledge Sharing within and beyond functional boundaries. More importantly, universities of technology are required to respond to the needs of their stakeholders. Participants felt that Systems Thinking would be a strategic choice to eradicate functional silos and promote Knowledge Sharing in universities which will enhance organizational effectiveness. Accordingly, Feiz, Soltani and Farsizadeh (2019) accentuate the point that Knowledge Sharing enhances creativity and innovation in organizations. Remaining relevant has been identified by Rossouw and Goldman (2023) as a critical factor for universities, as they continuously improve their operations to advance society. In this regard, Knowledge Sharing becomes critical. Jones et al (2021) aver that for universities to meet new challenges, they need to evolve. The adopted research approach in this study was appropriate to explore the applicability of Systems Thinking to promote Knowledge Sharing in universities of technology. Hence the study objectives were achieved. Lim (2024) describes qualitative research appropriate to understanding social phenomena, particularly in the context of organizations operating in a rapidly changing environment.

Ethical Requirements: This study was conducted in accordance with the rules and guidelines relating to research ethics of the institution. Participation in the study was voluntary, and confidentiality was ensured. Signing a consent form before participating in the study was one of the ethical requirements. Bougie and Sekaran (2020) state that ethical conduct in research applies to researchers, the participants who are the source of the required data and organizations that fund research.

AI Declaration: AI tools were not used to write this paper.

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Developing Phronesis in Business Education: A Student Perspective

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Abstract: This paper aims to discuss the results of the analysis of the feedback of business university students on the phronesis-focused course. The course is part of the MA programme at the Faculty of Business Administration, Prague University of Economics and Business. Its objective is to develop three intellectual virtues (dimensions of knowledge) defined by Aristotle – the episteme (theoretical knowledge), the techne (skills, practical knowledge) and the phronesis (practical wisdom, ability to use previous two in proper way and context). The course was developed to address one of the major arguments against business-oriented education – its over-orientation to theoretical knowledge. During the course, students work in teams that fulfil three types of assignments – presentation of theory, facilitation of discussion and case study preparation and implementation in the class. The teacher is the coach, helps teams with their work, and provides feedback. Episteme is developed via new theoretical knowledge of management. Techne is developed via training in different skills, like presentation skills, discussion skills, and skills to understand the professional text. Phronesis is developed through the interaction of students when preparing and implementing tasks. It becomes active as the ability to understand the colleague's point of view, discuss and harmonise one's own opinion with the ideas of others or understand the social climate in the class and adjust one's behaviour to it. As one of the course authors said, we do not want to teach students about management; we want to teach them management. The feedback of students was captured and analysed by the research based on three research questions: Q1 What do students like about the course? Q2 What do students dislike about the course? Q3 What do students think they learned in the course? The data were collected by the open-question questionnaire with three questions reflecting the research questions. The respondents were students from two classes of the course. The answers were analysed by thematic analysis. The research results show that respondents value the episteme they learn as it allows them to see and understand management holistically. They also like the originality of the course concept based on the cooperation of students and the teacher and the environment the course provides for skills and phronesis development. On the other hand, respondents disliked that the low quality of work of less motivated students influenced the whole class and found the course too demanding for preparation and attention. Even though limited, the research points at important aspects of phronesis-focused courses – they teach students a lot but are demanding and require a change of pedagogical paradigm. Students must be willing to take responsibility for their learning and development and learn even though this may threaten their identity and self-image.

Keywords: Knowledge, Skills, Phronesis, Tertiary business education

1. Introduction

The paper discusses the experience of business faculty students with the course targeted to phronesis development. The course is part of the MA programme at the Faculty of Business Administration, Prague University of Economics and Business. Its objective is to develop three intellectual virtues (dimensions of knowledge) defined by Aristotle – the episteme (theoretical knowledge), the techne (skills, practical knowledge) and the phronesis (practical wisdom, ability to use previous two in proper way and context). The course was developed to address one of the major arguments against business-oriented education – its over-orientation to theoretical knowledge. As one of the course authors said, we do not want to teach students about management; we want to teach them management.

The student experience was researched using a simple questionnaire with three questions about the course. The answers were analysed by thematic analysis. The results show that students are not used to such a format of the course, and even though they may find it valuable, they criticise it for being extremely demanding.

2. Background

2.1 Episteme, Techne and Phronesis in Business Education

The concept of episteme, techne and phronesis goes back to Aristotle (2004). Episteme represents objective (scientific) knowledge, techne practical knowledge. Phronesis (practical wisdom) integrates episteme and techne with values and moral guidance (Aristotle, 2004; Bachman et al., 2018; Kragulj et al., 2024). “Phronesis presents a relational mode of knowing that is founded on virtues and standards of excellence that are pursued on the way to perfection. In other words, phronesis is about the knowledge that defines the way we formulate our intentions and the course of action for achieving these intentions. Central to phronesis is practising as we search continuously to exercise practical/prudent judgements (or wisdom) when being purposeful in defining and pursuing particular objectives“ (Antonacopoulou, 2010, p. S7). “Practical wisdom strikes balances between

individual and common interests, short-term and long-term perspectives as well as between adapting to and shaping the environment“. (Roos, 2017, p.2). "Where the predictive capacity of scientific knowledge breaks down, practical wisdom steps in to guide decision making about what should occur in the future. And while practical wisdom may draw on cunning to achieve certain goals, it restricts it to focusing only on advantages that can be shared by all members of society" (Roos, 2017, p. 9).

Business education is traditionally based on episteme and, as such, puts major effort into theoretical education. If techne is developed, it concerns the application of theoretical concepts in simplified business situations, as students are not exposed to real-life problems (Gosling and Mintzberg, 2004; Kraguj et al., 2024). In business education, we systematically ignore phronesis (Antonacopoulou, 2010). The education where "knowledge is imparted from a professor to the students … only prepares students to become passive, un-thinking members of society“. They are trained to fit in rather than affect societal change (Kopf, Boje and Torres, 2010, p. 295). "Therefore Phronesis (practical wisdom), individual and collective, is an essential competence to be addressed in business education” (Rocha and Pinheiro, 2021, p.1).

There are attempts to integrate phronesis into business education. For example, Antonacopoulou (2010) describes the phronesis course whose objective was to “encourage participants to distil a more integrative analysis of the multifaceted nature of management and to critically reflect on their experiences of managing“ (Antonacopoulou, 2010, p. S12), Kraguj et al. (2024) prepared and tested the method WiseUpCube of phronesis development for business successors.

Focusing business education not only on episteme and techne becomes more and more important due to the conditions organisations operate because, as Roos (2017, p. 10) writes: “practical wisdom describes a form of human intelligence that is most relevant for, and appropriate to, ambiguous or uncertain circumstances in which the limits of scientific knowledge and cunning action are approached or surpassed; is a unique form of intelligence that is both effective and ethical; always involves a creative enactment of the common good" (Roos, 2017, p.10).

2.2 The Course

The course Management 2 is part of the MA programme at one of the leading European business-oriented faculties. The course “moves from theory-centered to more practice-oriented forms of learning, from socially isolated to more relational, and from self-interested to more community-oriented and project-based approaches” (Dierksmeier, 2020, p. 75-76) and provides the environment in which students develop all three types of knowledge defined by Aristotle (2004). The course was created to address one of the major arguments against business-oriented education – its over-orientation to theoretical knowledge. As one of the course authors said, we do not want to teach students about management; we want to teach them management, e.g. “by attempting to understand and solve problems, students gain phronesis rather than just techne“ (Kopf, Boje and Torres, 2010, p. 295).

Every week is dedicated to a different topic. Students work in fixed teams and fulfil three different assignments - presentation of theory, facilitation of discussion on obligatory pre-readings and case study. All teams do all three assignments during the term. The teacher does not lecture but supervises the process of knowledge development and sharing and provides team support. Students are examined individually at the end of the course.

The presentation of theory is the task where teams are assigned the topic. The team responsible reads literature provided by the teacher gains the knowledge, simplifies it and then presents it and teaches classmates. There is an obligatory consultancy with the teacher when the team responsible for the topic discusses their presentation with the teacher. It allows the teacher to give feedback and supervise the quality of presented knowledge.

Every week, the whole class has obligatory pre-readings (papers) allocated. One team is responsible for facilitating discussion on these pre-readings. They are supposed to briefly summarise the significant findings of the assigned papers and then support and facilitate the class discussions on the significant ideas of the paper author. They should lead their classmates to discuss the papers from opposite and conflicting standpoints.

The last assignment, the case study, usually starts with introducing an interesting company relevant to the topic. Then, the responsible team prepares a case study that allows the class to experience the topic.

Episteme, techne and phronesis are developed in all three assignments. As for episteme, every week's theory presentation provides students with basic theoretical knowledge of the given topic. Obligatory pre-readings

add the perspective of other authors. Case studies provide theoretical knowledge on different organisations with interesting management models.

When preparing individual assignments, students develop their techne – the ability to understand theoretical literature and distil relevant knowledge, skills to divide the work among team members, communication skills when discussing the topic and presenting it to classmates, etc.

Phronesis development is more hidden than episteme and techne development. Phronesis is developed via such tasks as building relationships with teammates, putting materials for presentation together and discussing them, simplifying presented knowledge for classmates, consultation with the teacher, working with risks, choosing the team member responsible for facilitation of discussion, team self-evaluation or redistribution of point the team got for assignment in dependence of performance of individual team members.

The final exam on theoretical knowledge is done individually, but the whole team must be present. When all students are examined, the teacher discusses the course outputs for the techne and episteme with the students and gives the team final feedback.

The course syllabus explains All assignments in detail (including their detailed grading). Students are given the syllabus during the first class at the latest (students of class B get the syllabus about two weeks ahead of the class), and the teacher dedicates the first class to thoroughly explaining the syllabus and answering questions.

3. Objective, Methodology, Limitations

This paper aims to discuss the results of the analysis of the feedback of business university students on the phronesis-focused course. The research had three research questions: Q1 What do students like about the course? Q2 What do students dislike about the course? Q3 What do students think they learned in the course?

The open-question questionnaire collected the data. We asked three questions reflecting on the research questions: What did I like about the course? What did I not like about the course? What is the course learning outcome for me? The respondents were students from two classes in the course. One class was taught in the local language and one in English.

As for respondents, most students in the local language class (class A, 38 respondents) are graduates of our the Faculty of Business Administration BA programme and already have good knowledge, especially of traditional approaches to management. Most of them come from our country or countries with similar cultural backgrounds. Some students in the English class (class B, 28 respondents) are graduates of English BA of the Faculty of Business Administration, and as students in the local language class, they have good management knowledge. But the number of students who are not graduates of our BA programme is much higher in class B. Students are from different parts of the world, and the cultural diversity is great. Respondents were asked to answer the questions in written form immediately after passing the final exam.

The answers were analysed by thematic analysis. Research questions guide the analysis (Clarke and Braun, 2017). We searched for patterns of meanings, which allowed us to identify codes. To capture the most important patterns and not lose the context, we did sentence-by-sentence in vivo coding (Willig, 2013; Glaser and Strauss, 2017) of respondent answers. When it was possible to classify the code into more categories, we classified it into the more context relevant. We used this approach because "These categories are analytic rather than descriptive. They interpret, rather than simply label, instances of phenomena" (Willig, 2013, p. 70). Further coding classified codes into higher-level categories (themes). We applied this coding style to all respondents' answers to achieve coding reliability. Knowing that the courses we used for the research provided a heterogeneous sample of respondents (from the perspective of culture and knowledge of management), we analysed students' answers in individual courses separately.

The validity of the coding was more challenging to achieve. Students officially evaluate the course before registering for another term, but unfortunately, most of these evaluations lacked detailed verbal explanations. Therefore, triangulation was not possible. Checking the research results with respondents was not done as motivating them for further cooperation is very difficult once the students finish the course. To eliminate the bias of the research, the researcher tried to focus strictly on each sentence and suppress personal explanations of its meaning. When the personal explanation was too strong, or the answers raised the emotional response of the researcher, the questionnaire was put aside, and the coding was done later.

The theoretical background of the research is formed by the papers collected using a keyword WOS search. We search two keywords, "phronesis" and "business education". The search led to 8 papers. These papers help us to find additional relevant literature on the topic.

Due to the data collection and analysis methods, the research has two important limits. Even though we tried to suppress the bias caused by the researcher, the researcher is the teacher of the course, which influences coding validity. The research covered the experience of two classes of one course; therefore, its results cannot be generalised.

4. Findings

The analysis of answers to the first question: "What did I like about the course?" identified the same themes in both classes (Table 1), except for theme attendance (we do not do attendance in English class as it is a hybrid one). Students liked the performance of class participants (classmates, the teacher); for example, student A16 wrote: "The teacher was open to different opinions", and student 19 noted that: "The class was very active, we helped each other". Students also liked the course content, course organisation, and activities. Student A3 wrote, "The course has a clear structure. Everything matches together at the end." Student B5 "The lecture structure where students have presentations, and a professor gives additional details when need is unusual". Student A37 liked that "theory was embedded in practical examples".

Both groups also evaluated the relationship of the course to practice and environment for skills and phronesis development. Student B10 wrote, "I liked how it needed cooperation, needed us to improve our public speaking and taught us what to expect in our future jobs" Student B10 "how it needed cooperation, needed us to improve our public speaking and taught us what to expect in our future jobs".

Table 1: Answers to first question

Both classes - Class A and Class B	
Examples of codes	Themes
teacher well facilitates discussions; excellent preparation of presentations; good group; good organisation of work; teacher explaining when students took something wrong;	Evaluation of participants
Examples of codes	Themes
first "serious" encounter with management studies, and I liked it; variability of views on management; Birkinshaw model; opportunity to learn various topics of management to deep; interesting content of the course;	Content – K about management and management tools
open discussions; cooperation; cooperation with my team; facilitation by students who led classes; interactivity; presentation of theory forced me to study all materials and understand everything better; students teach via presentations; possible to be creative; that we did presentations; improved our public speaking; it forces to search deeply for knowledge;	Environment for skills and phronesis development
original ideas; originality of the course; the original format of course; creative methods; the original structure of presentation where students have tasks and the teacher provides support when needed;	Originality
good course concept; organisation of the course; the way how teams are distributed; structure of the course gives complex framework; led by students; supervised by the teacher; structure of the course; demanding but at one moment, it all clicks to the big picture;	Concept of the course
games; creative and entertaining games; cases	Cases
discussions;	Discussions
presentations; presentations of theory by students;	Presentations
participation;	Attendance
exam in the group; pre-readings;	Exam, pre-readings
practical course that applies theory into practice; cases showed application of topic and discussions; practical examples; practical examples of companies; showing management in real life situations;	Relationship to practice

Analysis of answers to the second question: "What did I not like about the course?" identified similarities and differences (Table 2). Students of both classes did not like when their colleagues were not fully involved, which influenced the task performance quality. Student A2 wrote, "The fact that presentations of theory were done

only by students was very limiting. I was afraid to learn from them". Student A14 saw the same problem: "Not all students fully participated". Student B5 wrote, "Students were sometimes unable to present properly".

Students also complained that the course is too demanding for pre-class preparation, exercises are too long and demanding attention and covers too many topics. Student A8 noted, "Too long classes", student A12 ", Too much work", and student B21 "It was a bit time-consuming".

Students were also unhappy with the prereading exercise – student A23 concluded, "I failed to read all pre-readings". Student B4 wrote, "The discussion on pre-readings. No matter how well prepared you were, if the class did not read them or just did not want to participate, you had no chance to do it (facilitate the discussion) properly". Up to this, class A found the course too theoretical. Class B did not like that students taught the class; some thought the presented knowledge was not properly explained. Students also reported that they had problems extracting knowledge from the literature. For example, student B27 concluded, "I think having students doing theory was a bit more complicated as it was hard trying to understand theory and models by ourselves and then explaining it to our classmates". The last complaint concerns the hybrid form of class B.

Table 2: Answers to second question

Both classes - Class A and Class B	
Examples of codes	Themes
some presentations were not of the best quality; I would prefer the theoretical part presented by the teacher; presentations of theory done by students are not good – problem to evaluate the importance of topics; in some presentations, topics were not interconnected; presentations of colleagues limiting; some students are not able to present properly, which leads to lesser learning; some students did not try hard;	When colleagues were not fully involved, the quality of presentations was dubious
Examples of codes	Themes
for some a burden; lot of preparation; time demanding; time consuming; lot of moments of difficulty; time consuming;	Too much demand on preparation
Pre-readings; facilitation of discussions not good; lack of time for facilitation of discussion; discussion on pre-readings – the class did not read it, and this influenced your grade;	Pre-readings
audience attention-demanding; 3 hours of exercise too attention-demanding; challenging to stay focused for 3 hours;	Too long and attention-demanding
topics repetitive, too many concepts in one topic too many smaller topics in one class; too many different approaches;	Too many topics
no presentations from teacher; some approaches old; heterogeneous literature; I miss more company examples; I miss more tool examples;	Other
Only class A	
Examples of codes	Themes
too much theory; too abstract; too much focus on theory and definitions;	Too theoretical
Only class B	
Examples of codes	Themes
self-teaching approach; lectures by schoolmates; being taught by classmates – the teacher could do it better;	Students teach the class
not clear what was expected from presentations; assignments of topics need to be more specific to make clear what should be in presentations;	Not clear what to do
preparing the presentation may be distracting for online students; it was hybrid;	Hybrid form
hard to extract correct definitions from theory; hard to understand the theory and the model concepts and then present them;	Difficult to get knowledge from the literature

Analysis of answers to the third question: "What is the course learning outcome for me?" identified the same themes in both classes (except for theme other in answers of class B). Students reported that they acquired different types of knowledge, learned what management is, and developed certain skills, including phronesis (Table 3). For example, student A13 noted that "I learned that it is important to understand the topic holistically", student A15 learned "Holistic understanding of management tools", and A20 "Ability to think about different approaches to management". Student B6 wrote that he "learned many theories and to

articulate well the things I knew, and I managed to give them clear definitions which helped me understand things deeply". A17 improved "the reading and understanding of the professional text and critical thinking". B7 "learned how to work in a group in different circumstances, collaborate and analyse the information with critical thinking".

Table 3: Answers to third question

Both classes - Class A and Class B	
Examples of codes	Themes
completed my previous knowledge; well understandable theories; new knowledge; complex interdisciplinary learning about companies pioneers of MM; ethics; innovations; knowledge of MM; great case studies; different management styles; understand why some companies do what things; information gained; different theories;	Knowledge
we got foundations of management; better overview of management; deeper understanding of management; deeper understanding of management and management practices; I have overview of possibilities in management; understand management holistically; there is no single managerial approach;	What management is
improving skills to interconnect topics in presentation; possible to use methods in everyday life; raising self-confidence in presenting; ability to get knowledge from papers; increasing critical thinking;	Skills and phronesis
Only class B	
Examples of codes	Themes
learned a lot; I learned a lot;	Other

5. Discussion

The statement of Ross (2017, p. 11) who writes: "The need for practical wisdom, it is clear the key to a new model of business education must start from a holistic perspective to teach the next generation of leaders about the creation of value, redefining it as shared societal value, i.e., the common good" corresponds with the philosophy on which the course Management 2 was created. It is also related to the research results, where students mentioned that the course provided a significant amount of knowledge of different types and allowed them to understand management from different perspectives.

Answers to the second research question (What I did not like about the course) align with the findings of (Antonacopoulou, 2010). Our students reported that colleagues who were not fully involved in class tasks negatively influenced the class quality. Some students saw the class as too theoretical; some preferred the teacher to lecture. Antonacopoulou (2010, p. S18) identified the same problem: "A small proportion (11%) of managers did raise concerns about the course. They expressed indifference to the need to think critically. They found the course 'too abstract' and 'vague' to deal with. These students appeared to be less willing to take responsibility for their learning and development. Instead, they were more comfortable and keen to be instructed on how to learn and how to think. They were not ready or willing to engage in critique. It seems that for these students, this course was a threat to their identity and self-image, which they were very protective of and hence unwilling to challenge or indeed allow others to challenge". Antonacopoulou (2010, p. 19) follows: "it is also acknowledged that not all participants wish to develop themselves or be developed, nor do they all wish to support others in their development".

This unwillingness to cooperate and be "more reflective about their own lives, to learn to ask questions and deal with ambiguity and uncertainty in the answers" (Roos, 2017, p. 12) is the important limit of phronesis-focused courses. Such courses cause tension (Antonacopoulou, 2010) as students need to "question their practice" (Antonacopoulou, 2010, p. S11) and identity as "the exercise of phronesis is an aspect of who one wants to be" (Shotter and Tsoukas, 2014a, p. 239). As phronesis "needs to be learned in practice" (Shotter and Tsoukas, 2014a, p. 232), it requires "emotional involvement with it – to feel the diversity of emotions ordinarily encountered in the carrying out of work" (Shotter and Tsoukas, 2014b, p. 384) as "emotional involvement is a prerequisite for acquiring and developing expertise" (Dreyfus and Dreyfus, 2005, p. 784). Our research shows that not all students are willing (or capable) to do this.

6. Conclusions

"Practical wisdom comprises knowing how to strike balances between individual and collective interests, short-term and long-term perspectives as well as between adapting to and shaping the environment. These important balances must be played out every day, everywhere and in all kinds of situations" (Roos, 2017, p.8). This requires a change in business education (Mintzberg, 2004). "We can argue that management learning in the context of business schools could stand for the development/nurturing of phronesis, encouraging managers to think critically about the decisions they make. Moreover, it could stand for raising the importance of responsibility and accountability for the actions they take" (Antonacopoulou, 2010, S22).

Our research analyses the feedback of students of such phronesis-oriented course on management. Regardless of research limits, it is one of few attempts to capture students' experience of such courses. The results show that students value the episteme they learn but face problems with responsibilities the unusual course format requires. Still, business schools should change their curricula from episteme-oriented to phronesis-oriented.

As Ross (2017, p. 9) formulates it: "Of all contemporary human pursuits, leadership and management, precisely to the extent that they must deal with the uncertainty, ambiguity and unpredictability of the future stretch the limits of scientific certainty—including the certainty that we are heading towards unsustainability—and ultimately must call for alternative epistemological frameworks. Without denying the importance of methodological rigor and peer review, the on-going proliferation of practitioner-oriented, story-based 'straight-from-the-gut' kind of management books is evidence that, despite our bias towards science, people still seek precisely the practical wisdom identified by Aristotle as the most useful—and possibly most truthful--exemplars of intellectual thought".

Ethics declaration: The ethical clearance was not necessary for the research. Respondents to the research were asked to confirm that they agreed with publishing the anonymised results of the research.

AI declaration: Except for WOS search and language editing (Grammarly), AI was not used in any phase of this paper's development.

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Knowledge Management in the Tech Sector: A Rapid Review of Benefits, Challenges, and Metrics

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Abstract: Knowledge Management (KM) plays a fundamental role in technology-based organizations by enabling them to effectively manage and utilize their knowledge resources in dynamic and fast-evolving environments. While KM has been extensively explored across various industries, its application within technology-driven sectors requires further examination due to the unique challenges these organizations face, such as rapid technological advancements, knowledge silos, information overload, and high employee turnover. Knowledge is a key driver of innovation, decision-making, and competitive advantage, so a deeper understanding of how KM operates in these contexts is essential. This study conducts a rapid literature review to investigate the benefits, challenges, and evaluation metrics associated with Knowledge Management in technology-based organizations. The findings reveal that well-implemented KM strategies enhance innovation capacity, operational efficiency, and more effective decision-making processes. However, despite its advantages, Knowledge Management implementation is often hindered by cultural barriers, reluctance to share knowledge, and difficulties aligning KM initiatives with overarching strategic goals. Overcoming these obstacles requires targeted investments in digital infrastructure, leadership support, and promoting a strong knowledge-sharing culture. We also identify a set of potential metrics for assessing KM effectiveness, including operational efficiency indicators, employee and customer satisfaction levels, patent data, knowledge stock, and structural capital. While these metrics build upon insights from the literature, further research is necessary to validate their applicability and reliability as measures of KM success in rapidly changing technology environments. Despite these challenges, Knowledge Management presents transformative potential for organizations seeking to leverage knowledge as a strategic asset, driving continuous innovation, improving organizational performance, and sustaining a competitive edge in an increasingly knowledge-intensive economy. By providing a structured understanding of KM's role, challenges, and possible success metrics, this study offers valuable insights for researchers and practitioners, guiding them in refining Knowledge Management strategies to enhance adaptability, collaboration, and long-term resilience in technology-driven industries.

Keywords: Technology-Based organizations, Innovation, Knowledge management, Knowledge metrics, Competitive advantage

1. Introduction

Knowledge Management (KM) practices are essential for organizations seeking to effectively manage and leverage their knowledge resources (Jauhari & Pratihar, 2010; McInerney & Koenig, 2011; McKeen et al., 2006). While KM has been extensively studied across various industries, the unique and rapidly changing landscape of technology-based organizations calls for a deeper investigation into how KM functions within these environments (Ahumada-Tello et al., 2022; Kocaoglu, 1999). In tech-driven sectors, where innovation and agility are key to sustaining competitiveness, understanding the specific impacts of KM is critical.

While prior research highlights KM's benefits and challenges, further focus is needed on its implementation and measurement in technology-based organizations. These organizations must manage rapid technological advancements, foster innovation, and ensure effective knowledge sharing (Earley, 2014; Samadi, 2011; Zighan, 2022), warranting a closer examination of KM's role.

This study conducts a rapid literature review to examine KM's benefits, challenges, and metrics in technology-based organizations. It explores KM's advantages, implementation challenges, and evaluation metrics, providing insights into its application in tech-driven environments. By clarifying these aspects, the study aims to help

researchers and practitioners refine KM practices, fostering sustainable growth and competitiveness in innovation-driven sectors.

2. Methodology

This study used a Rapid Review to synthesize research on KM in technology-based organizations. This method accelerates systematic reviews by narrowing database searches and streamlining result synthesis. While efficient, it may limit review depth and quality assessment. Nonetheless, it provides timely evidence for decision-making in fast-evolving fields like technology.

The research focused on the following questions:

- RQ01: What benefits have technology-based organizations experienced from implementing internal KM practices?
- RQ02: What are the main challenges technology-based organizations face in implementing KM?
- RQ03: What metrics do technology-based organizations use to measure the success of KM initiatives?

2.1 Search Strategy

The rapid review systematically searched for Scopus, which was selected for its size and popularity. Table 1 presents the search string used to identify articles on KM in technology-based companies, limited to the past ten years for relevance. Included document types were articles, conference papers, and reviews, all in English, which may exclude relevant studies in other languages.

Table 1: Search String for Scopus database

Search String
TITLE(knowledge AND (tech OR technology-based OR Tech-based OR technology-driven)) AND PUBYEAR > 2014 AND PUBYEAR < 2025 AND (LIMIT-TO(DOCTYPE,"ar") OR LIMIT-TO(DOCTYPE,"cp") OR LIMIT-TO(DOCTYPE,"re")) AND (LIMIT-TO(LANGUAGE,"English"))

2.2 Screening and Selection Process

The search yielded 231 articles, which were screened by removing duplicates and reviewing titles and abstracts for relevance. After this filtering, 48 articles underwent a full-text review. Following independent evaluation, 19 articles were selected for the final analysis, as shown in Table 2. This study included research on KM practices in technology-based organizations, published in English between 2014 and 2025. Exclusion criteria removed studies that did not directly address KM in these organizations and literature reviews.

2.3 Data Extraction

A standardized data extraction form was developed to capture relevant information from each included study. The extracted data included:

- Study identification (year, author, title)
- Main benefits and outcomes from KM practices
- Implementation challenges
- Metrics used to measure KM success

A thematic analysis identified recurring themes on KM benefits, challenges, and success metrics in technology-based organizations, offering a holistic view of KM's impact on organizational outcomes in the tech sector.

Table 2: Selected studies after applying inclusion and exclusion criteria

Year	Title	Reference
2024	Relationship between open innovation and innovation performance within high-tech firms: The mediating role of knowledge management capability	(Wu & Nachiangmai, 2024)
2023	Knowledge management in high-tech products and customer satisfaction: The smartphone industry	(Varriale et al., 2023)
2023	Assessing social capital and knowledge sharing in the high-tech industry: a moderating role of hypercompetition	(Lin & Huang, 2023)
2023	Identifying and prioritizing the factors affecting the knowledge flow in high-tech industries	(Zahedi et al., 2023)

Year	Title	Reference
2022	The Effect of Knowledge Management on the Sustainability of Technology-Driven Businesses in Emerging Markets: The Mediating Role of Social Media	(Tajpour et al., 2022)
2022	Innovative work behavior in high-tech enterprises: Chain intermediary effect of psychological safety and knowledge sharing	(Xu & Suntrayuth, 2022)
2021	Fostering knowledge sharing in the innovation process: Information and communication technology-based versus face-to-face relationships	(Ceci et al., 2021)
2021	The Impacts of Knowledge Management Practices on Innovation Activities in High- And Low-Tech Firms	(Law et al., 2021)
2021	Relationship Between Conditions of Knowledge Management and Innovation Capability in New Technology-Based Firms	(Acosta-Prado et al., 2021)
2021	Knowledge-oriented leadership in high tech companies on B2B and B2C markets	(Soniewicki, 2021)
2021	Integration of Knowledge Management Systems and Product Data in a Single Information Space of a High-Tech Enterprise	(Porsev et al., 2021)
2020	Mediation impact of marketing intelligence in the relationship between technology based knowledge sharing and product innovation	(Al-Hashem, 2020)
2019	Showcasing knowledge: The promotion of knowledge management in a technology-based organization	(Krause et al., 2019)
2019	Knowledge integration methods, product innovation and high-tech new venture performance in China	(Guo et al., 2019)
2018	Knowledge management strategies, intellectual capital, and innovation performance: a comparison between high- and low-tech firms	(Buenechea-Elberdin et al., 2018)
2018	Knowledge Management Capability Impact on Enterprise Performance in Russian High-Tech Sector	(Gorlacheva et al., 2018)
2018	Operational knowledge management in a manufacturing enterprise in the high-tech sector - Case study	(Zimmer & Madeja, 2018)
2017	Knowledge Management and Collaboration strategies for technology-based firms in Baja California	(Ahumada-Tello et al., 2017)
2015	Managing knowledge creation in high-tech R&D projects: A multimethod study	(Chandrasekaran & Linderman, 2015)

3. Findings

The findings from this rapid literature review provide valuable insights into the benefits, challenges, and success metrics of KM practices in technology-based organizations.

3.1 RQ01: What Benefits Have Technology-Based Organizations Experienced From Implementing Internal KM Practices?

One of the most cited benefits of KM is enhanced innovation performance. Wu & Nachiangmai (2024) highlight that KM, particularly when integrated with open innovation, improves knowledge capture, storage, and sharing, fostering innovation. Al-Hashem (2020) and Ceci et al. emphasize KM's role in product innovation through knowledge sharing and marketing intelligence. Law et al. (2021) note its importance in managing market uncertainties and technological complexities. Acosta-Prado et al. (2021) further highlight KM's role in balancing knowledge exploration and exploitation, strengthening innovation in dynamic environments. Additionally, Buenechea-Elberdin et al. (2018) and Tajpour et al. (2022) stress KM's contribution to sustaining innovation by enhancing intellectual capital and knowledge transfer.

KM also plays a critical role in new product development. Law et al. (2021) and Wu & Nachiangmai (2024) state that integrating diverse knowledge sources through KM fosters creativity and supports product innovation. Guo et al. (2019) highlight the importance of coordinated knowledge integration in high-tech industries, ensuring the successful development and launch of innovative products. Beyond development, KM enhances product performance by improving technical knowledge management. Varriale et al. (2023) show how knowledge about key product modules, such as processors and touchscreens, optimizes product design, improving functionality and customer satisfaction. Law et al. (2021) and Guo et al. (2019) further confirm KM's role in managing technological complexities, enhancing both innovation and product quality.

At the organizational level, KM strengthens overall performance by optimizing resource management and fostering innovation. Gorlacheva et al. (2018) identify KM as a mediator between innovation and business outcomes, while Xu & Suntrayuth (2022) link it to improved employee collaboration and knowledge-sharing environments. Ahumada-Trello et al. (2017) emphasize KM's role in leveraging intangible assets like intellectual property, enhancing long-term sustainability. Tajpour et al. (2022) further suggest that KM supports business survival by fostering continuous learning and knowledge transfer. Additionally, KM enhances intellectual capital by improving structural and relational assets. Buenechea-Elberdin et al. (2018) highlight how codification and personalization strategies reinforce internal knowledge systems and external networks, ensuring continuous competitiveness.

Competitive advantage is another significant benefit of KM. Varriale et al. (2023) note that accumulating knowledge on critical product components in industries like smartphones strengthens market positioning. Ahumada-Trello et al. (2017) emphasize KM's role in managing intellectual property and technology transfer, which is crucial for maintaining a competitive edge. Tajpour et al. (2022) and Soniewicki (2021) highlight knowledge creation and leadership as key drivers of long-term competitiveness, especially in fast-paced, technology-driven industries. Furthermore, KM significantly enhances R&D performance by fostering knowledge creation within teams. Chandrasekaran & Linderman (2015) show that KM improves psychological safety in project teams, encouraging collaboration and leading to innovative solutions in high-tech R&D.

Finally, KM contributes to operational efficiency, employee satisfaction, and intellectual capital. Porsev et al. (2021) highlight its role in reducing downtime through better knowledge access, improving staff satisfaction with information support, and optimizing internal communication. These elements collectively create a more efficient, innovative, and competitive organization.

3.2 RQ02: What are the Main Challenges Technology-Based Organizations Face in Implementing KM?

Cultural challenges and collaboration are central to effective KM. Chandrasekaran & Linderman (2015) note that team diversity can hinder psychological safety, which is essential for intuitive knowledge creation. Wu & Nachiangmai (2024) emphasize the need for investments in fostering a knowledge-sharing culture. Lin and Huang (2023) highlight that hyper-competition in high-tech firms disrupts social dynamics crucial for KM. Zahedi et al. (2023) stress the role of supportive cultures in overcoming barriers to knowledge flow. Cultural obstacles, such as high power distance (Xu & Suntrayuth, 2022) and lack of trust (Zimmer & Madeja, 2018), further complicate KM implementation. Tajpour et al. (2022) argue that poor communication between managers and employees limits knowledge transfer sustainability in technology-based organizations.

Aligning KM with organizational strategies and technology is another key challenge. Acosta-Prado et al. (2021) stress the importance of integrating KM with strategic goals and ICT tools to drive innovation. Buenechea-Elberdin et al. (2018) emphasize the complexity of maintaining KM strategies suited to a company's technological level. Tajpour et al. (2022) advocate for integrating KM with digital tools like social media, warning that failure to modernize KM strategies can hinder business sustainability.

Organizational flexibility and investment are also crucial. Wu & Nachiangmai (2024) highlight the need for significant investments in KM infrastructure, training, and technology, while Zahedi et al. (2023) emphasize flexible structures to facilitate knowledge flow. Acosta-Prado et al. (2021) agree, noting that adaptability is vital for KM in rapidly evolving environments. Tajpour et al. (2022) add that rigid KM practices limit modernization and hinder competitiveness in tech-driven industries.

Balancing knowledge exploration and exploitation is another challenge. Acosta-Prado et al. (2021) stress the need for agility in adopting new knowledge while maintaining existing competencies. Krause et al. (2019) discuss the transition from knowledge sharing to creation, while Buenechea-Elberdin et al. (2018) highlight the challenge of adapting KM strategies in fast-paced industries. Tajpour et al. (2022) argue that continuously applying and transferring knowledge is essential for business performance and sustainability.

A lack of formal KM awareness and structured KM practices further impedes effectiveness. Krause et al. (2019) note the absence of internal marketing and communication tools to promote KM, while Zimmer & Madeja (2018) highlight inefficiencies caused by informal knowledge-sharing mechanisms. Tajpour et al. (2022) emphasize the need for structured KM environments to facilitate seamless knowledge exchange.

Finally, managing knowledge retention is a key challenge. Varriale et al. (2023) argue that organizations must balance retaining general versus specialized knowledge across product modules. They suggest that maintaining

in-depth knowledge while leveraging external expertise helps enhance customer satisfaction while controlling costs and complexity.

3.3 RQ03: What Metrics do Technology-Based Organizations use to Measure the Success of KM Initiatives?

While explicit KM metrics are not consistently identified, the literature suggests potential indicators of KM success. Porsev et al. (2021) highlight operational efficiency, where reduced downtime due to better problem-solving knowledge and employee satisfaction with information support reflect KM effectiveness. Varriale et al. (2023) link KM to customer satisfaction scores and patent filings, suggesting that improved product knowledge and innovation can measure KM's impact. Buenechear-Elberdint et al. (2018) and Kianto et al. (2014) emphasize structural capital, where knowledge codification and storage signal KM success. Finally, Soniewicki (2021) associates knowledge-oriented leadership with competitiveness, implying that enhanced organizational performance may result from effective KM.

4. Discussion

The review findings highlight KM practices' significant benefits for technology-based organizations, particularly in enhancing innovation performance. Studies indicate that KM, when integrated with open innovation and ICT tools, fosters knowledge sharing, converts tacit to explicit knowledge, and improves product and overall innovation outcomes (Al-Hashem, 2020; Buenechea-Elberdin et al., 2018; Ceci et al., 2021; Wu & Nachiangmai, 2024). This aligns with broader literature asserting KM's positive impact on innovation (Gloet & Terziovski, 2004; Hung et al., 2010).

Additionally, KM enhances new product development by integrating diverse knowledge sources, aiding in technological complexity management and market adaptation, leading to higher product performance (Guo et al., 2019; Law et al., 2021; Pitt & MacVaugh, 2008). It also optimizes operations and leverages intellectual capital, strengthening innovation capacity and competitive advantage (Ahumada-Tello et al., 2017; Gorlacheva et al., 2018; Tajpour et al., 2022). Furthermore, KM-driven structural and relational capital accumulation ensures long-term competitiveness and improved business performance performance (Buenechea-Elberdin et al., 2018; Mer et al., 2023; Varriale et al., 2023). Table 3 summarizes these KM benefits.

Table 3: Benefits from KM practices

Benefit	Authors
Enhanced innovation performance KM improves innovation by enabling better knowledge capture, storage, and sharing, particularly in high-tech organizations.	(Acosta-Prado et al., 2021; Al-Hashem, 2020; Buenechea-Elberdin et al., 2018; Ceci et al., 2021; Law et al., 2021; Tajpour et al., 2022; Wu & Nachiangmai, 2024)
Improved new product development KM integrates diverse knowledge sources and enhances technological complexity management, driving product innovation.	(Guo et al., 2019; Law et al., 2021; Wu & Nachiangmai, 2024)
Increased product performance KM optimizes knowledge of key components, improving product design, performance, and customer satisfaction.	(Guo et al., 2019; Law et al., 2021; Varriale et al., 2023)
Improved organizational performance KM boosts performance by improving efficiency and fostering collaboration and innovation through knowledge sharing.	(Ahumada-Tello et al., 2017; Gorlacheva et al., 2018; Tajpour et al., 2022; Xu & Suntrayuth, 2022)
Strengthened intellectual capital KM strengthens structural and relational capital, enhancing innovation and competitiveness.	(Buenechea-Elberdin et al., 2018)
Competitive advantage Effective KM ensures long-term competitiveness by fostering knowledge creation, innovation, and agility in dynamic markets.	(Ahumada-Tello et al., 2017; Soniewicki, 2021; Tajpour et al., 2022; Varriale et al., 2023)
Improved R&D performance KM fosters knowledge creation in project teams, enhancing collaboration and driving innovation in high-tech R&D.	(Chandrasekaran & Linderman, 2015)
Improved operational efficiency and employee satisfaction KM minimizes downtime and enhances staff satisfaction by improving knowledge access and communication.	(Porsev et al., 2021)

The reviewed studies highlight that implementing KM in technology-based organizations faces several challenges, with cultural barriers and fostering collaboration being central issues. High power distance, lack of trust, and poor communication inhibit effective knowledge sharing, making it challenging to build the collaborative culture necessary for KM success (Chandrasekaran & Linderman, 2015; Xu & Suntrayuth, 2022; Zimmer & Madeja, 2018). Indeed, organizational culture is widely recognized in the literature as a significant obstacle to leveraging intellectual assets and implementing effective KM practices (Khakpour et al., 2009; Long & Fahey, 2000).

Additionally, the reviewed studies suggested that aligning KM practices with organizational strategies and integrating them with existing processes and ICT tools is complex, particularly in fast-evolving high-tech environments (Acosta-Prado et al., 2021; Buenechea-Elberdin et al., 2018). This perception is echoed by Smith et al. (2010), who argue that most organizations do not effectively align their KM initiatives with their overall business strategy. Similarly, organizational inflexibility and the need for significant investments in KM infrastructure, such as specialized training and technology, were also identified as barriers to KM effectiveness in the reviewed studies (Wu & Nachiangmai, 2024; Zahedi et al., 2023).

Furthermore, another finding in the reviewed studies is that organizations struggle to balance knowledge exploration with exploitation, requiring constant adaptation of KM strategies to manage both new and existing knowledge (Acosta-Prado et al., 2021; Krause et al., 2019), which is a widely acknowledged view in the literature (Lavie et al., 2011; Stadler et al., 2013). Finally, lack of formal KM systems and awareness were also identified in the reviewed studies as factors that can lead to inefficiencies and hinder the transition from knowledge sharing to knowledge creation (Krause et al., 2019; Tajpour et al., 2022), which is also supported in the existing literature (Memon et al., 2020), and in this regard, Varriale et al. (2023) point out that determining the appropriate knowledge retention level is a challenge. Table 4 presents the challenges to effective KM implementation.

Table 4: Challenges to effective KM implementation

Challenge	Authors
Cultural challenges and fostering collaboration Investing in a knowledge-sharing culture with psychological safety is crucial for fostering intuitive knowledge creation.	(Chandrasekaran & Linderman, 2015; Lin & Huang, 2023; Tajpour et al., 2022; Wu & Nachiangmai, 2024; Xu & Suntrayuth, 2022; Zahedi et al., 2023; Zimmer & Madeja, 2018)
Aligning KM with organizational strategies and technology Aligning KM with strategic goals and ICT integration is vital for innovation, while outdated strategies hinder sustainability and performance.	(Acosta-Prado et al., 2021; Buenechea-Elberdin et al., 2018; Tajpour et al., 2022)
Organizational flexibility and investment needs Effective KM demands investment in infrastructure, training, technology, and adaptable structures to handle evolving knowledge environments.	(Acosta-Prado et al., 2021; Tajpour et al., 2022; Wu & Nachiangmai, 2024; Zahedi et al., 2023)
Balancing knowledge exploration and exploitation Balancing knowledge exploration and competency maintenance is crucial for competitive advantage.	(Acosta-Prado et al., 2021; Buenechea-Elberdin et al., 2018; Krause et al., 2019; Tajpour et al., 2022)
Lack of formal KM awareness and intentional KM practices Without formal KM systems and communication tools, organizations face challenges in transitioning from knowledge sharing to creation, leading to inefficiencies.	(Krause et al., 2019; Tajpour et al., 2022; Zimmer & Madeja, 2018)
Determining appropriate knowledge retention Organizations must manage knowledge effectively without incurring unnecessary costs or complexity.	(Varriale et al., 2023)

Although no formal metrics were proposed, the reviewed studies suggest potential measures for assessing KM effectiveness in key areas. Porsev et al. (2021) highlight operational efficiency, particularly downtime reduction due to knowledge gaps, implying it is a relevant metric, while employee satisfaction with information support could serve as an indirect measure through surveys. Varriale et al. (2023) link customer satisfaction to product knowledge, suggesting that surveys or reviews could assess KM's success in knowledge communication. They also mention patent data and knowledge stock as indicators of a company's technological knowledge base, implying that patent filings, mainly linked to product modules, could reflect KM-driven innovation. Buenechear-Elberdint et al. (2018) and Kianto et al. (2014) emphasize structural capital, proposing that the extent of knowledge codification and storage signals KM effectiveness. Together, these indicators offer a multi-

dimensional evaluation of KM's impact on operational efficiency, innovation, and strategic knowledge management. Table 5 presents the potential metrics for measuring KM effectiveness.

Table 5: Potential metrics for measuring KM effectiveness based on insights from reviewed studies

Potential Metrics	Authors
Operational efficiency Downtime reduction and employee satisfaction with information support indicate KM effectiveness in minimizing inefficiencies and enhancing operational efficiency.	(Porsev et al., 2021)
Customer satisfaction Customer satisfaction scores from reviews or surveys can measure KM's effectiveness in enhancing product-related knowledge.	(Varriale et al., 2023)
Patent data and knowledge stock Patent filings, especially those tied to product modules, can serve as a metric for KM's impact on innovation and knowledge accumulation.	(Varriale et al., 2023)
Structural capital KM effectiveness can be measured by codified knowledge volume, usage rate, update frequency, coverage, and employee satisfaction with KM systems.	(Buenechea-Elberdin et al., 2018)

5. Conclusion

Knowledge Management in technology-driven firms must be understood as a dynamic, integrative capability that turns dispersed expertise into actionable innovation. Our rapid review confirms that KM enhances innovation performance—especially when combined with open innovation practices—and supports new product development by integrating diverse knowledge sources (Wu & Nachiangmai, 2024; Law et al., 2021; Guo et al., 2019) . At the same time, cultural barriers such as lack of psychological safety and misalignment with strategic objectives continue to impede KM's full potential (Chandrasekaran & Linderman, 2015; Acosta-Prado et al., 2021) . Our interpretation highlights that tackling these challenges is not merely a matter of technology deployment but of deliberately shaping organizational norms and governance structures to sustain knowledge flows.

To translate these insights into practice, organizations should establish recurring, cross-functional knowledge-sharing workshops and "KM hackathons" that encourage open dialogue and peer learning, thereby reducing silos and building trust (Chandrasekaran & Linderman, 2015) . Embedding KM in formal governance—by creating a senior-led steering committee with clear accountability for KM outcomes—ensures that initiatives are aligned with corporate strategy and receive the necessary resources (Acosta-Prado et al., 2021) . Deploying integrated digital platforms, such as AI-driven intranet agents that index research reports, patents, and meeting records, accelerates knowledge discovery and reuse, reducing search times and operational friction (Porsev et al., 2021) . Piloting Communities of Practice around emerging domains like edge computing or DevOps further balances exploration and exploitation, enabling teams to capture evolving best practices in fast-changing contexts (Buenechea-Elberdin et al., 2018; Acosta-Prado et al., 2021) .

Building on these interventions, we introduce the concept of a "KM Digital Twin"—a real-time model of an organization's knowledge assets and flows. By continuously mapping expertise networks, identifying bottlenecks in collaboration graphs, and simulating the effects of proposed interventions (e.g., targeted training or platform upgrades), a KM Digital Twin elevates KM from retrospective reporting to predictive orchestration. This living model can recommend mentor-mentee matches based on complementary skill sets and forecast the impact of governance changes on knowledge sharing, empowering leaders with scenario-driven decision support.

Accurate measurement remains critical. We advocate combining traditional metrics—operational efficiency gains (Porsev et al., 2021), customer satisfaction scores (Varriale et al., 2023), patent filings and knowledge-stock assessments (Varriale et al., 2023)—with novel, twin-derived indicators such as collaboration density and intervention ROI estimates. Structural capital metrics, like codified knowledge volume and system usage rates, provide further insight into KM system health (Buenechea-Elberdin et al., 2018) . Such a multi-dimensional measurement system ensures both quantitative rigor and real-time adaptability.

In sum, while cultural resistance, strategic misalignment, and metric selection pose real hurdles, the combined application of structured cultural programs, formal governance, advanced digital platforms, and the KM Digital Twin concept offers a comprehensive roadmap. By embracing these solutions, technology-based organizations can move beyond overcoming implementation challenges to fully leverage KM as a strategic asset—driving

continuous innovation, operational excellence, and sustained competitive advantage in an increasingly knowledge-intensive economy.

Ethics Declaration: Ethical clearance was not required for the development of this research.

AI Declaration: AI tools such as Grammarly and ChatGPT were used solely for language revision. The authors' analysis and interpretations are their own.

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A Ten-Step Guideline to Implementing Knowledge Management in Higher Education

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Abstract: The value of knowledge management (KM) in today's fast-paced world cannot be emphasised. It is a crucial factor that can determine the success or failure of any institution. To guarantee that KM practices are sustainable, institutions must identify and maximise the use of the elements that contribute to KM's success. This identification is especially vital for Higher Education Institutions (HEIs), as effective knowledge sharing is crucial to the institution's growth and development, as well as to enhancing a country's industrial sustainability. This article examines the unique environment of Higher Education Institutions (HEIs) and identifies Critical Success Factors (CSFs) for successful Knowledge Management (KM) implementation, considering external and internal forces and enablers. The research strategy involved a thorough, systematic literature review using academic databases. Key terms related to knowledge management, higher education, strategies, and critical success factors were identified. The search was limited to peer-reviewed journal articles, conference papers, and books published between 1994 and 2025. The study was limited to articles published between 1994 and 2025 to ensure relevance, with 47 of the 96 studies evaluated and deemed significant for the research. The study emphasises the importance of KM in HEIs, highlighting the need for a comprehensive institutionalisation strategy where organisations seek synergy between the management of critical political, economic, technological, legal and social forces and factors such as leadership, governance, technology, infrastructure, trust, people, structure, strategy, finance and culture. The ten-step guideline for institutionalising KM is intended for use by HEIs. While helpful, this guideline oversimplifies the complex nature of KM, particularly concerning KM CSFs in other organisations. Further research is needed to explore variances in KM success factors across industries and the practical implementation of KM in diverse sectors. The research offers a ten-step guideline for the effective institutionalisation of KM in HEI, focusing on resource allocation, collaboration, trust, alignment, and prioritising investments. The research highlights the significance of a holistic perspective to KM institutionalisation in HEIs.

Keywords: Knowledge, Knowledge management, Critical success factors, Higher education, Higher educational institutions, Developed and developing countries

1. Introduction

In today's fast-paced world, the importance of Knowledge Management (KM) cannot be overstated. It is a critical aspect that can determine the success or failure of any institution. To ensure that KM practices are sustainable, institutions must identify and maximise the utilisation of the factors critical to KM's success. This recognition is crucial for higher education institutions (HEIs), as effective knowledge sharing is essential to the institution's growth and development, and enhances sustainability in a nation's industry.

Wamundila and Ngulube (2011) argued that universities have a crucial role in addressing societal challenges by developing, managing, and sharing knowledge. As knowledge management (KM) becomes increasingly vital to the success of the global economy, Kanwal, Nunes, and Arif (2019) argue that for higher education institutions (HEIs), this means harnessing the collective intelligence of students, faculty, and staff to lay a strong foundation for societal sustainability. The argument is that the management of knowledge within universities must not only enable the optimisation of student retention, improve graduation rates, modernise existing transaction-based systems, improve teaching and learning processes, and support research and development activities but, more importantly, universities intellectual capital must be leveraged for sustainable development initiatives with a focus on ensuring, and promoting national and international competitiveness.

Despite KM's success in other industries, faculty members at a university tend to emphasise accomplishments more than the achievement of common institutional aims and goals. Primarily, the individualism of professors and the exclusivity of faculties hinder knowledge exchange, making it inefficient and non-systematic, which in turn leads to a decrease in the willingness to pursue common knowledge management (KM) goals (Iqbal et al., 2011). As Kabilwa (2018) explain, for the most part, KM in higher education highlights the importance of knowledge retention in supporting the development of professors and researchers and meeting students' expectations. As discussions around KM in higher education gain momentum, sustainable KM practices must be explored beyond the individual and faculty. KM within the context of HEIs must focus on creating a culture of continued education and improvement, ensuring that knowledge is efficiently utilised and applied for the

benefit of all society (Shahbudin, Nejati, and Amran, 2011; Kabilwa, 2018; Kordab, Raudeliuniene, and Meidute-Kavaliauskiene, 2020).

Kruger and Johnson (2013) have highlighted the challenges HEIs in developing nations face when institutionalising KM practices. According to a survey conducted by these authors, educational institutions in South Africa had the lowest KM maturity compared to other industries in the country. In developing countries like South Africa, language barriers and intolerance are often the significant obstacles that university staff and students face, rather than technology.

While Haryani and Suryasari (2020) advocate for a comprehensive strategy for KM in HEIs and the cultivation of a culture of knowledge-sharing, development, and training among stakeholders, authors such as Abu Naser et al. (2016), Rohman (2019), and Kordab et al. (2020) caution that to create such a conducive culture, effective leadership at all levels is necessary. Considering the rapidly evolving landscape, Kordab et al. (2020) emphasise the need for a unified KM strategy across industries to promote sustainability. Ojo (2016), Alshahrani (2018), and Kordab et al. (2020) thus propose that when pooling knowledge from diverse sources and co-creating it with stakeholders, KM concepts must be integrated into daily operations.

Recognising the vital role that Higher Education Institutions (HEIs) play in promoting Knowledge Management (KM) within society, this article presents the findings of an investigation aimed at identifying the key factors that facilitate effective KM in HEIs. Through a systematic literature review of KM practices in higher education from 1994 to 2025, the study seeks to explore the essential components for successful Knowledge Management and to propose guidelines for implementing a ten-step plan that aligns KM initiatives within higher education institutions.

2. Methodology

Conducting a systematic literature review involves a structured process for identifying and evaluating relevant materials to provide insightful, evidence-based responses to research inquiries. By adopting this approach, researchers can effectively assess the suitability and effectiveness of interventions or activities concerning society and institutions, as emphasised in Biggam's research (2011).

With reference to Figure 1 below, this study employed a systematic approach for a comprehensive literature search, focusing on academic databases such as Scopus, Web of Science, and Google Scholar, which were selected for their extensive coverage and relevance. Initially, a collection of keywords and search terms related to "knowledge management," "higher education," "strategies," and "critical success factors" was established to determine the strengths and weaknesses of knowledge management (KM) practices in higher education institutions (HEIs). All data captured were analysed through four procedural steps: identification, screening, eligibility, and inclusion (Page et al., 2021). By adhering to these steps, thoroughness and impartiality were ensured, incorporating only the most relevant and high-quality sources for analysis. As such, the research was restricted to peer-reviewed journal articles, conference papers, and books, with a focus on articles that examined the enabling role of higher education in facilitating the dissemination of knowledge into industry. The study was limited to articles published between 1994 and 2025 to ensure relevance, with 47 of the 96 sources consulted deemed significant for the research.

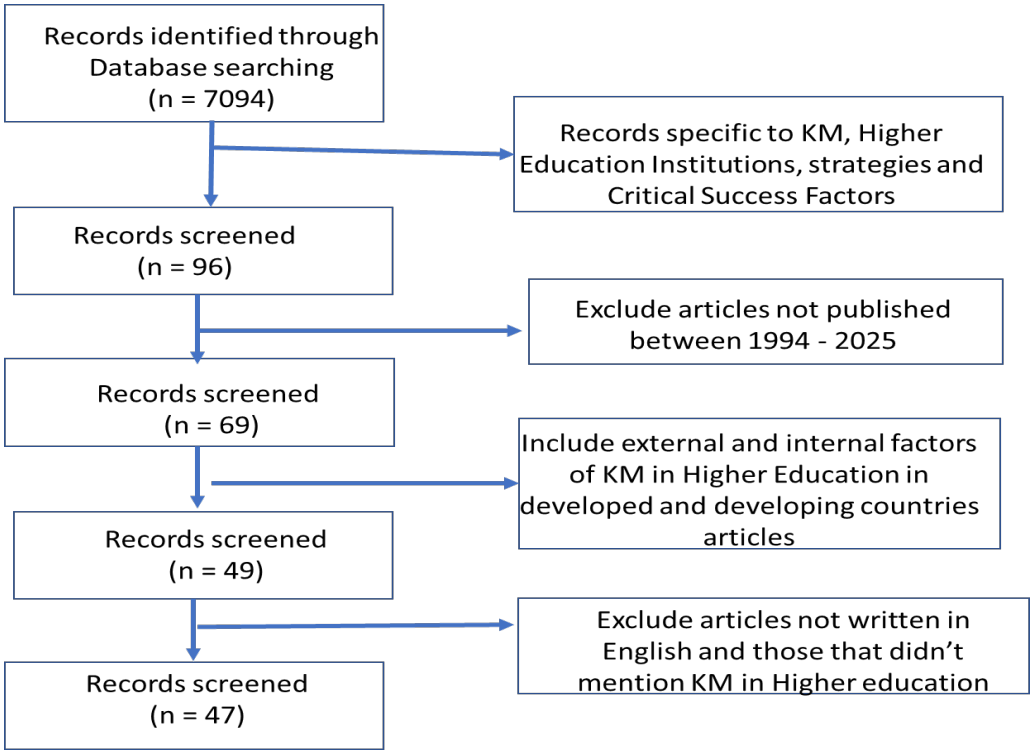


Figure 1: The PRISMA selection process of relevant literature

What was found was that the effectiveness of knowledge management in HEIs is strongly dependent on a range of critical factors that must be strategically addressed.

3. Factors Critical to KM Success in HEIs

The success of knowledge management in HEIs relies on a comprehensive approach that integrates essential internal assets and resources, including technology, people, and processes. These factors, which contribute to practical ways of working, are further supported by several influential organisational elements, such as culture, trust, structures, strategy, governance, leadership, and finance. Beginning with external influences, the subsequent sections will explore the literature surrounding these topics in greater depth to determine the most influential organisational elements on knowledge management (KM) within higher education institutions (HEIs).

3.1 External Forces

On a strategic level, sharing knowledge between HEIs and industry is crucial for economic, social, and environmental sustainability and essential for promoting entrepreneurship and national growth. Any nation's political considerations should prioritise the need for skills development, especially regarding environmental concerns, where the importance of knowledge for sustainable development and economic stability cannot be underscored. On a Macro level, governments should lead by harmonising ICT infrastructures with KM systems. Similarly, HEIs should lead by widening access to knowledge and innovation through exchanging experience with industry, cultivating adaptability, evaluating successful practices, and incorporating improvement in learning and curriculum to promote sustainability (Basu & Sengupta, 2007; Bimbe, Brownlee, Gregson, and Playforth, 2015; Modebelu & Duvie, 2015).

3.2 Strategy

Effective KM requires careful consideration of goal and strategy-related factors. HEIs must recognise the importance of KM in developing effective strategies for managing the academic environment. HEIs must have knowledge-based operations aligned with the institution's vision, mission, and competitive strategy. HEIs can optimise efficiency, streamline activities, and balance knowledge sharing and expertise retention by implementing a holistic strategy prioritising processes. Ultimately, by prioritising knowledge-enabling strategic factors, HEIs can foster collaboration, enhance operational efficiency, and facilitate effective KM practices. Individual HEIs must therefore constantly change and tailor their strategic approach to address unique

challenges in different contexts (Maponya, 2005; Metcalfe, 2006; Heisi, 2009; Omona, Van der Weide, and Lubega, 2010; Abu Naser et al., 2016; North & Kumta, 2018).

3.3 Leadership

Effective leadership plays a pivotal role in the successful implementation of KM within HEIs. Leaders in higher education environments should thus actively engage in orchestrating team-building activities that foster camaraderie and mutual respect among faculty and staff. By fostering a culture of collaboration, leaders can cultivate a vibrant and inclusive environment where knowledge sharing flourishes. Such a supportive environment fosters cooperation and enhances the overall learning experience, allowing individuals to freely exchange insights, ideas, and expertise. Ultimately, such leadership styles cultivate a sense of community that is instrumental in driving innovation and academic excellence. As such, HEIs' leadership should aim to optimise training and innovation programs while recognising the vital role that academia plays in societal knowledge management. By promoting experiential learning, HEIs' leadership in support of knowledge sharing not only enhances the educational experience but also empowers employees to actively engage in knowledge-sharing practices, fostering a more efficient and collaborative institutional environment. (Kandadi, 2006; Ojo, 2016; Alshahrani, 2018).

3.4 Governance

Several ways to enhance governance and ensure organisational success have been identified, including mitigating risk and ensuring compliance. By focusing on knowledge governance, HEIs establish a robust foundation for fostering an environment of creativity, cooperation, and continuous development. To overcome resource limitations, cultural barriers, and obstacles to successful KM implementation, KM governance should include instituting governance models that grant authority over KM strategy and formulate an all-encompassing framework to enable KM in HEIs. This would entail integrating the KM strategy with broader HEI objectives, increasing KM-related decision-making, and creating mechanisms to evaluate and fulfil the knowledge requirements of all stakeholders in HEIs (Metcalfe, 2006; Bimbe et al., 2015; Alshahrani, 2018)

3.5 Process

Successful and sustainable KM processes mainly depend on resource availability, infrastructure, and a stable organisational culture. The primary difference between KM practices in developed and developing nations is that developed nations have ample resources and infrastructure and are equipped to foster effective KM practices. In contrast, developing nations face resource constraints, leadership changes, and cultural barriers that hinder the collection, storage, application, and distribution of knowledge. To overcome these challenges, developing countries must recognise the potential of HEIs in distributing knowledge between industry and society. The common thread seems to be that a nation's collective KM processes and practices require sufficient ICT infrastructures, architectures, organisational structures, leadership and collaborative cultures that promote innovation and problem-solving (Nonaka, 1994; Al-Alawi, Al-Marzooqi, and Mohammed, 2007; Ahmad, Madhoushi, & Yusof, 2011; Bhusry & Ranjan, 2011; Belanger & Van Slyke, 2012).

3.6 People

By promoting a culture of knowledge exchange and horizontal communication, universities act as catalysts for cultivating a knowledge-oriented environment essential to innovation and sustainable development. For knowledge transfer and innovation in society, HEIs play a central role in lifelong learning, problem-solving, and knowledge-sharing. The literature suggests that higher education institutions (HEIs) must address challenges beyond merely skill development by providing tailored training programs that promote collaboration and knowledge exchange. While academic skills such as presenting theories, coaching, and mentoring contribute to learning, it has been observed that fostering commitment to horizontal communication with industry and stakeholders is achieved primarily through incentivising knowledge exchange and integrating KM into employee roles. (Smith & Schurink, 2005; Maponya, 2005; Norulkamar & Hatamleh, 2014; Modebelu & Duvie, 2015; Ojo, 2016).

3.7 Technology

A recommended strategy for HEIs is to implement plans that prioritise embracing technology as a catalyst for the seamless integration of IT tools. This involves maximising existing infrastructure or developing a robust technological framework. To achieve this, it is essential to establish a specialised KM group within the HEI that can advise, train, and coach users on effective system utilisation, thereby enhancing stakeholder engagement and communication. Additionally, universities should promote e-learning platforms to standardise learning

experiences and facilitate efficient knowledge transfer. It became apparent that to nurture KM within HEIs, the objective of technological use should be to establish an environment where technology is effectively utilised and disseminated within and beyond HEIs' borders. This aims to promote a culture of knowledge exchange and development among all societal stakeholders. (Omona et al., 2010; Norulkamar & Hatamleh, 2014; Modebelu & Duvie, 2015; Ojo, 2015; Chen & Burstein, 2016; Alshahrani, 2018; Arias-Perez et al., 2019).

3.8 Culture

It was found that barriers such as knowledge hoarding impede cross-functional cooperation. To address this, HEIs established communities of practice that share common goals and promote team learning and open communication. By fostering a culture of collaboration, knowledge sharing, and trust, it was found that HEI can ensure the success of KM initiatives, even amidst busy schedules and beyond the institution's borders. It is, therefore, essential to promote open communication channels, particularly within communities of practice and stakeholders, while also recognising and addressing cultural barriers that may hinder cross-functional cooperation, such as knowledge hoarding (Davenport & Prusak, 1998; Al-Alawi et al., 2007; Schreurs, Sammour, Al-Zoubi, and Vanhoof, 2008; Rohman, 2019).

3.9 Trust

It was found that establishing a culture of open knowledge-sharing is essential for effective KM initiatives. Trust, particularly interpersonal, was found to be crucial in fostering effective communication and knowledge sharing in academic and corporate settings. The literature proposes that HEIs cultivate interpersonal trust within and beyond their educational community to promote a positive culture that encourages knowledge sharing. As such, literature supports the idea that HEIs prioritise honesty as the foundation for effective knowledge-sharing among students, staff, and faculty. Furthermore, universities should take the initiative to create platforms that foster social networking within the academic community, emphasising the essential role of trust in promoting effective communication and knowledge exchange among all societal stakeholders.(Al-Alawi et al., 2007; Modebelu & Duvie, 2015; Ojo, 2016; Alkatheeri, 2018).

3.10 Structure

Organisations with flat structures and low hierarchies promote knowledge sharing, whereas highly formalised institutions hinder adaptability and spontaneity. In HEIs, particularly in developing countries, a balanced organisational structure is critical to support effective KM and create an environment that fosters knowledge sharing, creation, and innovation. HEI leadership promotes flat organisational structures with low hierarchies, encouraging and facilitating knowledge sharing among personnel while balancing formalisation to ensure organisational stability without compromising adaptability and spontaneity in knowledge-related activities. The goal is to introduce or strengthen decentralised structures over time that promote an environment conducive to successful knowledge creation and innovation, fostering creative problem-solving that aligns with the needs of knowledge-intensive activities (Bhusry & Ranjan, 2011; Abu Naser et al., 2016; Alshahrani, 2018).

A solid financial foundation appears crucial for providing a climate conducive to research, innovation, and knowledge transfer. While universities in developed nations have more resources to invest in advanced technologies and support research, innovation, and knowledge dissemination, HEIs in developing countries face challenges such as limited financial resources, inadequate infrastructure, and competing priorities. To address these challenges, it is essential in developing countries that leadership allocate funds for KM initiatives in operating and capital budgets to establish frameworks, purchasing tools, and incentive programs to motivate knowledge workers (Benson, Bugnitz, & Walton, 2004; Modebelu & Duvie, 2015; Lategan, 2017; Alkatheeri, 2018).

Unlocking the full potential of institutional knowledge requires a strategic approach; the following ten-step guideline provides a roadmap for implementing successful knowledge management in higher education.

4. Guidelines for Implementing Knowledge Management in Higher Education

From the literature reviewed, and regarding Figure 2 below, the literature supports the notion that several Critical Success Factors (CSFs) are crucial to KM success in HEI. Somewhat similar to Du Toit and Kruger's IT Alignment Model, which deals with the management of data, information, and intelligence, it became evident that managing knowledge within Higher Education Institutions is an extension of data, information and intelligence management. This complex process involves multiple stakeholders and factors operating at both macro and micro levels. These factors encompass national and institutional strategies, leadership dynamics at various levels, cultural nuances, technological integration, and financial investments. As society evolves, the

literature suggests that higher education institutions must assume a significantly more prominent role in shaping a nation's sustainable development through knowledge transfer and innovation. Regarding the arguments proposed in Section 3, it was reported that people (Smith & Schurink, 2005; Maponya, 2005; Norulkamar & Hatamleh, 2014; Modebelu & Duvie, 2015; Ojo, 2016), institutionalise KM through processes (Nonaka, 1994; Al-Alawi, Al-Marzooqi, and Mohammed, 2007; Ahmad, Madhoushi, & Yusof, 2011; Bhusry & Ranjan, 2011; Belanger & Van Slyke, 2012), supported by technology (Omona et al., 2010; Norulkamar & Hatamleh, 2014; Modebelu & Duvie, 2015; Ojo, 2015; Chen & Burstein, 2016; Alshahrani, 2018; Arias-Perez et al., 2019), as represented by the green triangle in the model's centre. A deeper analysis revealed that the KM processes, which encompass acquiring, storing, distributing, reusing, and sharing knowledge, must be supported by architectural structures and technology infrastructure that facilitate management. It was found that such technologies must be at hand through supportive infrastructures for use by knowledge workers (Bhusry & Ranjan, 2011; Abu Naser et al., 2016; Alshahrani, 2018), and that the most challenging part of the KM work triangle is building organisational structures to identify, nurture and reward people with the right skills to do the work and share the knowledge (Nonaka, 1994; Al-Alawi, Al-Marzooqi, and Mohammed, 2007; Ahmad, Madhoushi, & Yusof, 2011; Bhusry & Ranjan, 2011; Belanger & Van Slyke, 2012).

In sections 3.8 and 3.9, it was argued that trust and culture are the forces driving knowledge sharing and that developing an organisational culture conducive to KM is crucial to KM and business competitiveness in a constantly changing environment (Davenport & Prusak, 1998; Al-Alawi et al., 2007; Schreurs, Sammour, Al-Zoubi, and Vanhoof, 2008; Modebelu & Duvie, 2015; Ojo, 2016; Alkatheeri, 2018; Rohman, 2019). Furthermore, in section 3.2 to 3.4, it was argued that it is through organisational strategies, governance, policies and planning (Maponya, 2005; Metcalfe, 2006; Basu & Sengupta, 2007; 2009; Omona, Van der Weide, and Lubega, 2010; Bimbe, Brownlee, Gregson, and Playforth, 2015; Modebelu & Duvie, 2015; Heisi, 2009; Abu Naser et al., 2016; North & Kumta, 2018), that external Macro (PESTEL) and micro (Industry) threats and opportunities addressed in 3.1 are mitigated and, as such, it is policies and planning that set the stage for the structuring of people (section 3.6), processes (section 3.5) and technology (section 3.7) through leadership (section 3.3), trust and culture (Davenport & Prusak, 1998; Al-Alawi et al., 2007; Schreurs, Sammour, Al-Zoubi, and Vanhoof, 2008; Rohman, 2019). Finally, it was argued that, over time, KM structures must mature - thus not only be evaluated and maintained, but also enhanced and changed through services and innovation.

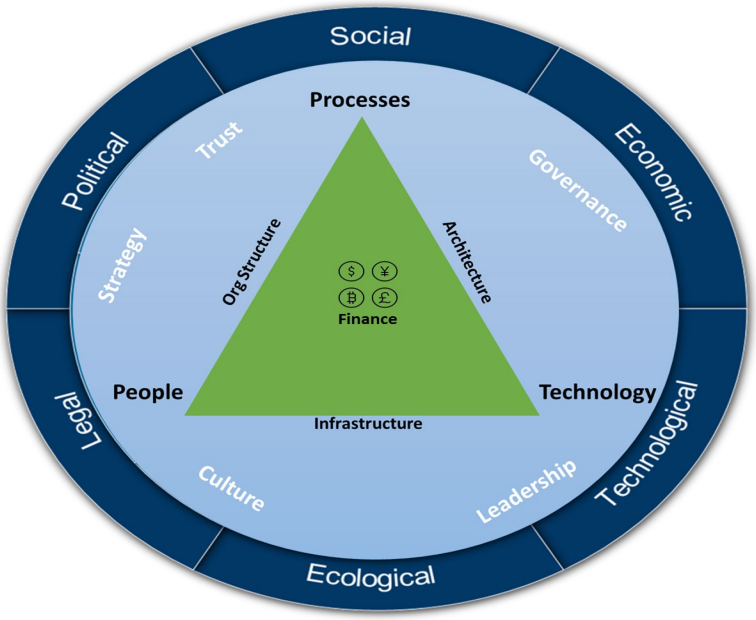


Figure 2: KM Alignment model

In summary, what was found was that KM can be defined as the collaboration between skilled people, strategy, governance, structure, culture, policy, maturity, maintenance and services to adequately integrate and exploit organisational knowledge into an often-hostile environment where Industry and Macro Forces dictate economic reality. A knowledge-oriented strategy and governance thus set the stage for developing industry-specific infrastructure and architecture to facilitate skilled individuals in acquiring, creating, and

sharing knowledge through supportive organisational structures. Over time, this improved individual and organisational maturity, innovation, profitability and performance (Rus, Lindvall, & Sinha, 2001).

Regarding the factors critical to KM success in HEIs, as identified in Section 3 above, as opposed to data and information management, it is proposed that HEIs first acknowledge their role as knowledge custodians and their potential to disseminate knowledge to industry and society. They also need to envision establishing dedicated structures and forums to share expertise and knowledge with stakeholders (Dneprovskaya & Shevtsova, 2023). As the *second step*, HEIs must focus in-house and address KM hierarchical barriers by strategically managing knowledge as an enabler within the broader academic environment. As such, KM strategies must support business activities, and business strategies must be conducive to sharing knowledge and retaining expertise (Ehms & Langen, 2002). To achieve this, as a *third step*, HEIs must actively empower knowledge-sharing operations and acknowledge the crucial role of skilled leadership. As such, HEIs must encourage academic leaders to promote experiential learning through internal team-building exercises, thereby fostering teamwork among students, staff, and faculty members (Paulzen & Perc, 2002; Pee & Kankanhalli, 2009).

As the *fourth step***,** to aid leaders in tackling resource constraints, cultural barriers, and challenges in implementing KM successfully, HEIs must implement governance models. This involves delegating control over planning, strategy, and KM execution. Higher Education Institutions should also develop mechanisms within their governance frameworks to assess and meet the knowledge needs of all stakeholders. For instance, establishing a comprehensive framework for KM governance could strengthen decision-making authority within the HEI (Paulzen & Perc, 2002; Gottschalk, 2002; Thornley et al., 2016). Therefore, as the *fifth step*, KM processes should be integrated with organisational objectives and formalised into job roles, where processes that promote cooperation and collective achievement are strategically promoted. As argued, it is cardinal that HEI leaders raise awareness about the importance of knowledge sharing, addressing cultural attitudes, and enhancing commitment to KM processes (Pee & Kankanhalli, 2009; Paulzen & Perc, 2002; Gottschalk, 2002; Thornley et al., 2016).

To ensure that knowledge workers are equipped with the necessary skills and knowledge for effective KM, it is recommended that HEIs implement customised training programs as a *sixth step*. A focus should accompany this on promoting collaboration, open communication, and teamwork to facilitate knowledge exchange (Thornley et al., 2016). Additionally, incentive systems that recognise and reward collective achievements in knowledge exchange and communication should be established. HEIs should address people- and skill-related challenges in developing nations by prioritising customised training programs, fostering collaboration, establishing incentive systems encouraging expertise and experience exchange, recognising individuals' knowledge exploration and exploitation, and promoting collective achievements (Abu Naser et al., 2016; Omona, Van der Weide, and Lubega, 2010).

As the *seventh step* to effectively promote KM within HEIs, the ICT infrastructure must support and enhance KM processes. HEIs must address obstacles such as information infrastructure issues and competing priorities. This can be achieved through the development and maintenance of reliable technological infrastructure for seamless KM processes, the use of technology as a catalyst for the integration of IT tools, and the promotion of knowledge sharing by creating a specialised KM group to advise, train, and coach users on practical system usage for increased engagement and communication. Incorporating eLearning platforms to standardise learning experiences and facilitate efficient knowledge transfer is also recommended, along with developing strategies to overcome resource limitations (Gottschalk, 2002; Kulkarni & Freeze, 2004).

One of the most crucial advice for HEIs is cultivating a culture that supports KM. Considering this, the *eighth step* to successful KM in HEIs is to establish and nurture communities of practice within the organisation, promoting a culture of cooperation, knowledge sharing, and trust among knowledge workers (Paulzen & Perc, 2002; Pee & Kankanhalli, 2009; Mehner, Rothenbusch & Kauffeld, 2025). This involves providing ample time and space during work hours for collaboration, fostering an environment that encourages KM projects, prioritising a culture of sharing within the institution, and underscoring the importance of knowledge sharing despite busy schedules to boost the success of KM initiatives. KM Strategies should thus focus on overcoming cultural barriers, such as knowledge hoarding, and promoting open communication channels within the institution, particularly within communities of practice, to facilitate knowledge exchange and team learning as integral components of KM. Building interpersonal trust within the academic community is crucial for fostering a positive corporate culture and promoting knowledge sharing. Therefore, HEIs should implement measures to foster and maintain trust in higher education settings, emphasising honesty as a foundation for effective

knowledge sharing among faculty, staff, and students. Finally, initiatives and platforms that facilitate social networking among university community members, thus including industry and government, should be created, recognising the role of trust in promoting effective communication and knowledge sharing (Paulzen & Perc, 2002; Pee & Kankanhalli, 2009).

To cultivate a culture of trust and knowledge-sharing among all stakeholders in HEIs, it is crucial to develop initiatives that encourage creative problem-solving by aligning the organisational structure with the needs of knowledge-intensive activities. HEIs must balance formalising internal and external structures to ensure stability while allowing adaptability and spontaneity in knowledge-related activities. As a recommended *ninth step*, promoting flat organisational structures with minimal hierarchies or strengthening decentralised structures between all stakeholders can create an environment that facilitates successful knowledge creation and innovation (Hubert & Lemons, 2010; Pee & Kankanhalli, 2009; Paulzen & Perc, 2002; Gottschalk, 2002; Thornley et al., 2016).

To successfully implement these recommendations, HEIs, as the *tenth and final step*, secure and maintain sufficient funding in both operational and capital budgets to support KM initiatives. As such, HEIs should prioritise a significant financial investment in information sharing, focusing on establishing frameworks, acquiring tools, and implementing incentive programs. To overcome challenges such as limited financial resources, inadequate infrastructure, and competing priorities, it is recommended that HEIs prioritise technological advancements and allocate resources to invest in cutting-edge technologies that enhance research, innovation, and knowledge dissemination. Higher Education Institutions must strengthen their research and innovation capacity through targeted financial support, enabling them to remain at the forefront of knowledge creation and dissemination (Kruger & Johnson, 2009).

5. Conclusion

The discourse surrounding KM in HEIs underscores its importance in fostering sustainable development and competitiveness in today's rapidly changing world. As demonstrated by research, the journey towards KM maturity differs between nations and organisations, necessitating tailored approaches that maximise factors unique to each context. Ultimately, the sustainability of KM in HEIs lies in recognising and harnessing the collective intelligence of diverse stakeholders, fostering a culture of ongoing learning and collaboration, and continuously adapting strategies, processes, and technologies to meet evolving challenges and opportunities in the knowledge economy.

The article proposes a ten-step guideline designed for knowledge management leaders and practitioners in HEIs. This framework aims to assist them in developing well-defined long-term strategies and KM structures that empower higher education institutions (HEIs) to sustain knowledge within their academic environment effectively. By adhering to these ten steps, effective leadership can streamline KM processes, cultivate a KM culture that enhances leadership effectiveness and team dynamics, and incorporate the latest technological advancements. This comprehensive approach will lay a solid foundation for both the exploration and exploitation of knowledge management, fostering research, innovation, and the achievement of goals both within and beyond higher education institutions.

6. Limitations of the Study

The research examined the significance of knowledge management (KM) in higher education and identified the factors that facilitate knowledge sharing. Additionally, it provided guidelines for implementing KM within academic environments. However, as academic institutions operate under diverse income levels and criteria specific to their countries, this study remains generic. It does not cater to the unique needs of individual institutions based on their economic status. Further research is therefore required to customise these guidelines to suit specific situations.

7. Future Research

This study is limited by its reliance on a systematic literature review. Consequently, the conclusions drawn may not apply to all contexts of academic institutions in different countries. Given that these institutions differ in terms of income groups and other national criteria, there is a need for further investigations to adapt the proposed guidelines. The study also does not address the empirical validation or pilot testing of the findings, nor does it consider the challenges associated with implementation or potential barriers. Additionally, it overlooks various factors, such as institutional size, type, and contextual variations, which oversimplify the complex and interconnected nature of KM implementation. Future research should aim to identify specific

knowledge management frameworks and maturity models that can aid in addressing the unique KM challenges faced by different HEIs in developed versus developing nations. Such a tailored approach will help create models that align with the specific needs of individual institutions or groups of institutions, rather than relying on a one-size-fits-all solution that is likely to fail in the long run.

Ethics Declaration: Ethical clearance was not required for this research, as it is based on a literature review described in the methodology section.

AI Declaration: The authors declare that no AI tools were used to create this research paper.

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Impact of Diverse Support on Performance of Industry–Academia Collaborative Research Teams

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Abstract: Bibliometric analyses show that industry–academia collaborative research projects tend to achieve higher performance. However, these collaborations often encounter barriers such as connection difficulties, resource constraints, differences in organizational culture, and institutional distance between industry and academia. Effective support from governments, firms, and universities is crucial to address these challenges and enhance the performance of industry–academia collaborative research teams. This study empirically examines the impact of such support on research performance using data from more than 200 collaborative research teams in Japan. This study differs from previous studies in several aspects. First, bibliographic information is matched with survey data, which enables team-level analysis instead of focusing on firms, universities, or regions. Bibliometric analysis provides an objective performance measure, i.e., the citation counts of research papers, whereas survey data offer abundant insights into team dynamics. Second, whereas most prior studies primarily examined financial support, this study considers a broader range of support measures, including the introduction of appropriate collaborators (networking), funding, provision of research equipment, management of intellectual property (IP), and assistance with administrative work. Empirical results reveal that all support measures, except for assistance with administrative work, significantly enhance research-team performance. Notably, assistance with administrative work presents a significant negative impact. Comparing the positive effects of various support measures, soft measures such as networking and IP management exert a greater impact than hard measures such as funding and equipment provision. Further analysis of the unexpected negative impact of administrative assistance indicates that administrative support occasionally results in cultural conflicts between industry and academia. These conflicts partially mediate the negative relationship between administrative support and team performance. However, administrative support from a third party in the presence of cultural conflicts within a team improves team performance. Further research is necessitated to determine the type of administrative support that can effectively bridge the organizational culture gap and enhance team performance.

Keywords: Industry–academia collaboration, R&D support, Team performance, Japan

1. Introduction

Collaborative industry–academia research is expected to produce innovative outcomes by combining the heterogeneous and complementary knowledge of both sectors. Previous studies across various countries and time periods demonstrated that papers resulting from such collaborations tend to be cited more frequently and have a greater impact than single-authored papers or those co-authored solely within academia (Pohl 2021; Lebeau et al. 2008; Schneiderman 2018). However, institutional differences between industry and academia present challenges that complicate collaborative research (Sauermann and Stephan 2010; Bruneel, D'Este, and Salter 2010; Albats, Bogers, and Podmetina 2020; Crescenzi, Fillippetti, and Iammarino 2017; O'Dwyer, Filieri, and O'Malley 2023).

In industry, research and development (R&D) is typically conducted in structured teams with limited individual discretion, with emphasis on practical goals aligned with corporate strategies. Firms are cautious about publishing research findings, as they aim to retain economic value and maintain a competitive advantage. By contrast, academia emphasizes individual creativity within disciplinary frameworks, thus endowing researchers with greater autonomy to disclose their findings through publications and conference presentations and gain recognition in the scientific community. These differences in incentives, decision-making processes, and cultural norms render collaboration challenging and highlight the necessity for supportive measures.

Several studies examined the support mechanisms for industry–academia collaboration. Some have analyzed the impact of R&D tax incentives and subsidies on collaboration performance (Cheng et al. 2020; Brokel 2015). However, these studies focus primarily on financial support and assess performance at the firm or regional level instead of at the industry–academia collaborative research team (IA team hereinafter) level. Seppo, Rõigas, and Varblane (2014) conducted an international comparison of various support measures, such as R&D cooperation, knowledge transfer, infrastructure, and research funding, within European countries, but did not examine their effects on research performance. Similarly, studies on the effectiveness of technology transfer offices (TTOs) (Siegel, Waldman, and Link. 2003, Siegel, Veugelers, and Wright 2007; Chapple, et al. 2005) assessed TTO-level efficiency but not their direct impact on IA team outcomes. Okamuro and Nishimura (2013) analyzed how university intellectual property (IP) policies influence industry–academia collaborative research, where they demonstrated that flexible and fair policies positively impact firm performance. However, their study was not

conducted at the team level, and performance was measured subjectively using a seven-point Likert scale to assess patenting and new product development.

Despite these efforts, no prior research has systematically analyzed support measures that positively influence IA team research performance using objective performance indicators. Bibliometric databases, such as Scopus and Web of Science, show that IA teams generally receive more citations than other teams. However, they lack detailed information regarding the support measures that the teams receive. Conversely, questionnaire-based studies provide detailed information regarding IA teams but rely on subjective performance assessments from team members. To address these limitations, this study conducts an empirical analysis that combines a questionnaire survey with bibliographic data. The questionnaire gathers information regarding IA team characteristics and the types of support received, whereas citation counts from the Web of Science serve as an objective indicator of research impact. This approach enables an empirical investigation into the support measures that contribute to the success of industry–academia collaborative research.

The remainder of this study is organized as follows: Section 2 presents the framework and key research questions based on prior literature. Section 3 describes the data and empirical model. Section 4 presents the results and their interpretations. Finally, Section 5 summarizes the findings and discusses implications for future research.

2. Prior Research and Conceptual Framework

Albats, Bogers, and Podmetina (2020), based on interviews with 10 European and U.S. firms, and Galán-Muros and Plewa (2016), based on a survey of European universities, highlighted and verified four barriers and two drivers of industry–academia collaboration from an industrial perspective. The first barrier is connection, which refers to the difficulty in identifying the suitable partner and establishing a contact. The second barrier is insufficient resources. The third barrier relates to differences in organizational culture, such as motivation, communication styles, language, time horizons, and bureaucracy between industry and academia. The fourth barrier, i.e., internal organizational differences, includes disagreements over IP rights and firms' limited ability to acquire university-generated knowledge. Drivers are associated with the availability of complementary resources and the relationships between partners. Complementary resources include funding, human resources, and knowledge. Relational drivers include trust, commitment, shared goals, and a balance between different expectations.

The third and fourth barriers have been widely recognized in the literature. For example, in terms of research orientation, universities tend to be discipline oriented, whereas firms focus on problem solving (Bruneel, D'Este, and Salter 2010; Lam 2007, 2011; Sauermann and Stephan 2010; Muscio and Vallanti 2014). Differences in reward structures further complicate collaboration, as universities emphasize reputation building through publications, whereas firms prioritize R&D, which enables the appropriation of knowledge for private gain (Lam 2007, 2011; Sauermann and Stephan 2010). Additionally, IP conflicts have been highlighted frequently (Bruneel D'Este, and Salter 2010; Muscio and Vallanti 2014).

To overcome these barriers, researchers suggest that recurrent collaboration with the same partners and diverse interaction modes (e.g., joint research projects, consultancy, and employee training) can mitigate difficulties (Bruneel, D'Este, and Salter 2010; Gallagher et al. 2023; Muscio and Vallanti 2014). Effective project management, including clear objective setting, progress monitoring, effective communication, and assigning high-quality project managers, has been emphasized as well (Barnes, Pashby, and Gibbons 2002). Studies on human capital highlight the importance of certain competencies and personal characteristics, such as communication and agility skills, negotiation abilities, scientific and technical knowledge, awareness of differences between universities and firms, open-mindedness, curiosity, and tolerance for failure (Albats, Bogers, and Podmetina 2020). Additionally, industry researchers with university experience, or vice versa, have been identified as beneficial for bridging these two sectors (Lam 2011; Albats, Bogers, and Podmetina 2020).

However, no empirical study has systematically examined the effectiveness of support measures in overcoming these barriers. This study assesses the impact of various support measures on IA teams by considering five types of support corresponding to the four barriers identified by Albats, Bogers, and Podmetina (2020) and Galán-Muros and Plewa (2016), as follows: networking to address connection barriers, funding and equipment provision to mitigate resource constraints, administrative assistance to support organizational culture differences, and IP management to resolve internal organizational barriers. Administrative work in the research process is an area in which organizational cultural differences typically emerge; it includes contract negotiations, external funding applications, progress monitoring, and budget management. These support measures are

provided not only by public organizations (including central and local governments and international institutions) but also by universities and firms.

Whereas support measures are generally expected to enhance team performance, their effectiveness may vary. For example, researchers in both academia and industry can connect frequently through academic conferences and personal networks without relying on third-party facilitators (Murakami 2025). Using data from a large-scale survey in Japan, Nishimura et al. (2022) discovered that researchers seeking highly capable partners primarily leverage their own contacts, whereas university and industry research collaboration support units are more commonly involved when geographical proximity is a key factor instead of the research partners' capabilities. Consequently, IA teams formed through personal networks may outperform those created through external referrals.

Administrative assistance may not necessarily guarantee improved outcomes. Administrative support that can standardize bureaucratic processes through clear formats, guidelines, and common rules allows researchers to focus on their research and improve their performance. However, if guidelines lack flexibility or conflicts arise regarding procedural standards, then managing administrative tasks internally instead of relying on external support may be more efficient. Similar conflicts may occur in IP management due to third-party involvement. Therefore, an empirical investigation is performed in this study to address the following five research questions:

R1: Is the performance of IA teams that received the introduction of collaborative partners better than that of other teams?

R2: Is the performance of IA teams that received funding support better than that of other teams?

R3: Is the performance of IA teams that received equipment support better than that of other teams?

R4: Is the performance of IA teams that received administrative support better than that of other teams?

R5: Is the performance of IA teams that received support in managing IP better than that of other teams?

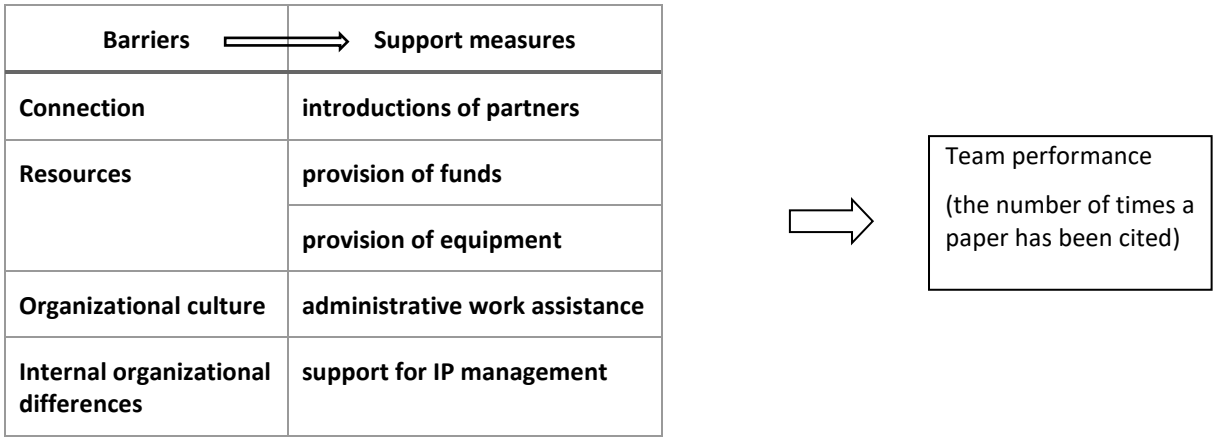


Figure 1: Analytical framework

3. Data and Model

To answer the research questions above, this study used data obtained through an online survey conducted in 2024. Participants were selected using the Science Citation Index Expanded, which is a database from the Web of Science that encompasses science, medicine, and technology. The target sample comprised teams that published papers in 2017 or 2018, with at least one member affiliated with a Japanese industry and at least one with a Japanese university, while teams with non-Japanese addresses were excluded. All 1,231 teams that satisfied these criteria and provided contact information were invited to participate in the survey. Each team representative or a member familiar with the overall team situation was instructed to respond; 234 valid responses were obtained, which yielded a response rate of 19%. This study used the number of citations (NC) as the performance indicator, based on citation data as of September 13, 2024. Poisson regression analysis was performed using the logarithm of the NC as the dependent variable. For log transformation, the NC was converted to 1 when it was zero. Table 1 presents the explanatory variables used in the model. The five variables representing support were coded as dummy variables and set to 1 if the IA team received support, regardless of the provider. The control variables included the technology readiness levels (TRLs), which indicate the stage of new technological development. The first five of the nine TRL stages were identified. Among them, the basic

research in which papers are primarily published formed the base. A dummy variable for 2018 was included because the papers published in 2017 and 2018 had different citation periods. The team size was capped at 20 members. Although papers with more than 100 authors are not rare in scientific, medical, and technical fields, members of teams exceeding 20 may struggle to fully understand the overall team situation, and in some cases, may not be familiar with each other.

As the availability of complementary resources and relationships between academia and corporate researchers were identified as key drivers of industry–academia collaboration, complementary knowledge, trust, and past collaboration were included as control variables. The complementary-knowledge variable was calculated as the average of responses to two questionnaire items regarding the success factors of industry–academia collaboration: the importance of members' diverse expertise and the importance of their diverse approaches and methodologies for the research theme, which were measured on a five-point Likert scale. Similarly, the trust variable was derived as the mean of responses to two items: "confidence in the competence and responsibility of other members" and "building emotional bonds with other members (reciprocal interpersonal care and concern)." Additionally, as prior collaboration may contribute to relationship building, the number of papers published by a team comprising approximately half or more of the authors of the focal paper before its publication was included as an explanatory variable, which is referred to as the "past collaboration variable."

Table 1: Definition of variables

Variable names	Definition
Log_NC	Logarithm of NC (number of times a paper has been cited)
Introduction support	Support with introductions of partners = 1, Others = 0
Funding support	Support with funding = 1, Others = 0
Equipment support	Support with equipment = 1, Others = 0
Administrative support	Support with administrative work = 1, Others = 0
IP support	Support with management for IP = 1, Others = 0
TRL2	Technology concept or application formulated = 1, Others = 0
TRL3	Proof of concept = 1, Others = 0
TRL4	Validation in laboratory environment = 1, Others = 0
TRL5	Validation in relevant environment = 1, Others = 0
Team size	Number of team members
2018 dummy	Publication in 2018 = 1, Others = 0
Complementary knowledge	Average of two variables indicating complementary knowledge
Trust	Average of two variables indicating trust
Past collaboration	Number of papers published in the past with more than half of the members (4 categories: 0, 1–3, 4–9, and 10 or more)

The descriptive statistics are presented in Table 2. Most teams received financial support (86%), equipment support (89%), administrative support (61%), and IP support (68%), whereas relatively few received introduction support (29%). Both the complementary knowledge and trust variables indicated an average score exceeding 4 on the five-point Likert scale, thus suggesting that the study leading to the publication of papers was based on strong complementary knowledge and trust among team members. Owing to space limitations, the correlation matrix is not shown herein. Nonetheless, the highest correlation observed was 0.58 between the IP and administrative support variables, whereas all other correlations were below 0.38.

Table 2: Descriptive statistics

Variables	Minimum	Maximum	Average	Standard deviation
NC	1	94	15.6	17.3
Introduction support	0	1	0.29	0.46
Funding support	0	1	0.86	0.35
Equipment support	0	1	0.89	0.31

Variables	Minimum	Maximum	Average	Standard deviation
Administrative support	0	1	0.61	0.49
IP support	0	1	0.68	0.47
TRL2	0	1	0.62	0.49
TRL3	0	1	0.47	0.50
TRL4	0	1	0.39	0.49
TRL5	0	1	0.15	0.36
Team size	2	19	6.65	3.39
2018 dummy	0	1	0.47	0.50
Complementary knowledge	1	5	4.43	0.71
Trust	1	5	4.33	0.70
Past collaboration	1	4	2.41	0.95

Note: N ＝ 218

4. Results of Analysis Regarding Impact of Support Measures on Team Performance

The results of the analysis based on the data and model presented in the previous section are listed in Table 3. First, focusing on the five variables corresponding to the research questions, the coefficients of all variables except administrative support were significantly positive at the 5% or 1% level, thus indicating that receiving such support improves research performance, as measured based on the NC. The number of citations was 1.47 times higher with introduction support than without it, 1.13 times higher with funding support, 1.22 times higher with equipment support, and 1.38 times higher with IP support. Therefore, soft support, such as introduction and IP support, is more effective than hard support, such as funding and equipment support. This finding aligns with those of Nishimura and Okamuro (2011), who examined cluster policies in Japan and discovered that indirect networking/coordination support exerted a greater impact on commercial success and innovation than direct R&D subsidies.

However, the coefficient for administrative support was significantly negative at the 1% level, thus indicating that IA teams receiving this support have significantly fewer citations (0.58 times) than those without it. Although administrative assistance is expected to allow researchers to focus more on their research and improve performance, the results suggest the opposite. Even when administrative support was categorized by provider—public institutions, universities, or firms—each administrative support variable indicated a significantly negative coefficient for the Log_NC variable. Owing to space limitations, detailed results are omitted herein. One possible explanation is that, as suggested earlier, third-party intervention may have caused conflicts due to the strict control of administrative procedures and disagreements over the applicable rules and standards. Therefore, this study hypothesizes that IA teams receiving administrative support are more likely to experience conflicts arising from cultural differences, which consequently mediates lower team performance. The next analysis examines this hypothesis.

Table 3: Estimation results

	Model 1		Model 2		Model 3	
Variables	**Coefficient**	**Standard error**	**Coefficient**	**Standard error**	**Coefficient**	**Standard error**
Introduction support	0.384**	0.0416	0.391**	0.0416	0.381**	0.0418
Funding support	0.123*	0.0601	0.143*	0.0604	0.163**	0.0610
Equipment support	0.201**	0.0657	0.194**	0.0658	0.179**	0.0663
Administrative support (AS)	-0.553**	0.0455	-0.535**	0.0457	-0.684**	0.0803
IP support	0.321**	0.0500	0.313**	0.0501	0.309**	0.0501
TRL2	-0.092*	0.0361	-0.091*	0.0361	-0.088*	0.0361

	Model 1		Model 2		Model 3	
Variables	**Coefficient**	**Standard error**	**Coefficient**	**Standard error**	**Coefficient**	**Standard error**
TRL3	-0.110**	0.0364	-0.109**	0.0365	-0.116**	0.0366
TRL4	-0.045	0.0371	-0.053	0.0372	-0.046	0.0374
TRL5	-0.147**	0.0519	-0.162**	0.0522	-0.159**	0.0522
Team size	0.065**	0.0044	0.066**	0.0044	0.067**	0.0044
2018 dummy	-0.146**	0.0354	-0.120**	0.0362	-0.124**	0.0363
Complementary knowledge	0.325**	0.0314	0.326**	0.0314	0.327**	0.0313
Trust	-0.177**	0.0257	-0.198**	0.0265	-0.200**	0.0266
Past collaboration	0.104**	0.0181	0.110**	0.0183	0.117**	0.0185
Cultural conflicts (CC)			-0.067**	0.0208	-0.125**	0.0337
AS_CC					0.094*	0.0419
N		218		218		218
LogL		-1704.6		-1699.3		-1696.8
AIC		3439.1		3430.7		3427.6

**p < 0.01, *p < 0.05

The survey included questions about the difficulties encountered during industry–academia collaboration. The answers were recorded based on a five-point Likert scale (1 = not applicable to 5 = applicable). One of the items was “conflicts due to cultural differences.” The answer to this question is the cultural conflict variable (CC). A new model incorporating it along with the explanatory variables in Model 1 yielded the results shown in Model 2 (see Table 3). The cultural conflict variable had a significantly negative coefficient at the 1% level, and the coefficient for administrative support (AS) remained significantly negative at the 1% level, although its absolute value decreased from 0.553 to 0.535. This indicates that cultural conflict partially mediates the negative effect of administrative support on performance. Moreover, Model 3, which included the interaction term (AS_CC) of the administrative support and cultural conflict variables, showed that the AS_CC variable was significantly positive at the 5% level and that the “administrative support” and “cultural conflict” variables remained significantly negative at the 1% level. Therefore, whereas both administrative support and cultural conflict are factors that originally degraded performance, the performance improved when administrative support was provided in the presence of cultural conflict.

Finally, focusing on the control variables in Table 3, the complementary knowledge variable—a key driver of industry–academia collaboration—was significantly positive at the 1% level, thus indicating that IA teams with access to diverse expertise and methodological approaches performed better, as measured based on citation counts. This result is consistent with those previous studies that highlighted the importance of complementary knowledge in successful industry–academia collaborations. However, the coefficient for the “trust” variable was significantly negative at the 1% level, thus suggesting that higher levels of cognitive and emotional trust among team members were associated with lower research performance, which is contrary to prior findings. Because approximately 85% of the respondents selected 4 or higher on the trust scale (ranging from 1 to 5), this suggests that whereas some degree of trust is necessary, excessive trust may degrade performance.

The “past collaboration” variable, which also represents relationships among team members, was significantly positive at the 1% level, thereby indicating that teams with a history of jointly publishing papers performed better. This aligns with previous studies proposing that repeated collaboration with the same partners helps overcome industry–academia barriers (Bruneel, D’Este and Salter 2010, Gallagher et al. 2023; Muscio and Vallanti 2014).

Additionally, the nature of research influences citation frequency. When examined based on the TRL stage, the coefficients for TRL 3 and TRL 5 were significantly negative, thus suggesting that papers at the proof-of-concept stage (TRL 3) and the validation-in-relevant-environment stage (TRL 5) were cited less frequently than those involving more basic research. Furthermore, team size showed a significantly positive coefficient at the 1% level,

thus indicating that citation counts increased with team size, provided that the team comprised 20 or fewer members.

5. Conclusion

Collaborative research between industry and academia has been promoted in various countries. However, researchers argued that the institutional distance between industry and academia complicates collaborative research. Therefore, this study analyzed the effectiveness of support measures for teams conducting industry–academia collaborative research, with emphasis on how these measures improve research performance. The analyses revealed that introduction, funding, equipment, and IP support contributed to improved research performance. Additionally, soft support, such as introduction and IP support, appeared to be more effective than hard support, such as funding and equipment. Whereas more than 80% of the teams received hard support, the number of teams that received IP and introduction support was relatively low, i.e., 68% and 29%, respectively. Therefore, expanding these types of soft support would increase the number of successful cases in industry–academia collaborative research. Meanwhile, administrative support appeared to be related to cultural conflicts and negatively impacted research performance. Approximately 61% of the total sample received administrative support, of which 47% was provided by universities, 38% by both universities and firms, 10% by firms, and 3% by public institutions. However, this negative impact was observed regardless of the support provider. Many previous studies have discussed the cultural differences between industry and academia. These differences tend to manifest in administrative work, such as contract operations at the beginning of research, preparation for external-funding applications, and the progress and budget management of research projects. This study showed that cultural conflicts caused or increased by the intervention of a third party partially mediated the negative effects of administrative support on performance. Simultaneously, the intervention of a third party in administrative work in the presence of cultural conflicts within a team might have improved team performance. In the future, administrative support that can prevent differences in organizational culture from resulting in conflicts should be examined.

Additionally, the sample for this study was limited to IA teams that had successfully published papers. In other words, the differences in performance among successful teams were analyzed. However, many IA teams are unable to publish papers or patents. A future endeavor may include identifying effective support measures by comparing such teams with those achieving publication success. Furthermore, this study used data from IA teams comprising researchers from Japanese firms and universities. Although the uniqueness of industry–academia collaborative research in Japan is not indicated, future studies using data from other countries are necessary to generalize the findings of this study.

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Dynamic Capabilities in Social Entrepreneurship: A Case Study on Social Value Creation

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Abstract: Social enterprises address societal challenges in entrepreneurial ways. This duality of combining social purpose and business is said to cause tension. There is limited understanding of how this reflects dynamic capabilities in social enterprises. Another underexplored area is how individuals make sense of still-maturing organizational dynamic capabilities. This study examines how social enterprises manage tensions between social mission and financial sustainability. The study focuses on social entrepreneurs sensemaking of their organizational dynamic capabilities that enable social value creation. Using a qualitative approach and content analysis, this study contributes to the literature on dynamic capabilities in social entrepreneurship. It illustrates how sensing, seizing, and reconfiguring capabilities are described to manage tensions while developing a social business. The data consists of interviews of six social entrepreneurs. The analysis reveals how social entrepreneurs identify societal needs and develop business and mobilize resources with a value-driven approach. Furthermore, the dual mission does not cause only tensions, but also enables business, and this requires building dynamic capabilities for the organization. The findings illustrate how social entrepreneurs enhance organizational and network capabilities crucial for business development, without losing sight of their social mission.

Keywords: Social value creation, Social entrepreneurship, Dynamic capabilities

1. Introduction

Social entrepreneurs build businesses that aim to create social good, balancing financial goals with positive social and/or environmental impact (Weerawardena et al, 2021; Schaefer et al, 2022). Understanding how social enterprises manage the tension between their social mission and financial sustainability is crucial for ensuring that both objectives are met (Smith et al, 2013). While social value creation is central to social entrepreneurship, the literature on dynamic capabilities, the abilities required to create and sustain this value, remains fragmented. While the importance of dynamic capabilities in enabling social enterprises to adapt, innovate, and leverage resources is acknowledged (see Bhardwaj & Srivastava, 2024), research has tended to neglect examining how capabilities are shaped by the experiences of social entrepreneurs themselves.

This study seeks to respond to that omission by advancing the understanding of dynamic capabilities within the context of social value creation. Rather than focusing solely on competitive advantage or market adaptation, this research explores how dynamic capabilities are employed by social entrepreneurs to manage tensions. This study focuses on two research questions. Firstly, *what kind of tensions and enablers social entrepreneurs describe amidst the evolution of social business, particularly considering together social and business goals?* And secondly, *how do sensing, seizing, and transforming capabilities contribute to managing tensions in social enterprises?*

This study investigates the dynamic capabilities social entrepreneurs identify as critical for creating social value. Based on interviews with six social enterprises and the thematic analysis, the findings shed light on managing tensions while using sensing, seizing, and transforming capabilities. Entrepreneurs identify societal and environmental needs, recognize viable opportunities, mobilize resources through value-based approaches, and develop organizational and network capabilities for growth aligned with their social mission.

2. Theoretical Background and Framework

Social entrepreneurship definitions highlight the creation of social value as a key component (Mair & Martí, 2006; Dacin et al, 2010). There are various ways to explain social value creation. Mair & Martí 2006 view social value creation in social enterprises focuses on prioritizing social change and addressing societal needs over profit generation, with an emphasis on catalysing sustainable impact through contextually embedded initiatives. Equally, Di Domenico et al. (2010) view social value creation as an essential component of social entrepreneurship. They see social bricolage as a mechanism for social value creation. Social entrepreneurs create value by making do with existing resources, refusing to be constrained by limitations, and improvising in response to resource-scarce environments. Weerawardena et al. (2021) approach value creation underlining

the motivation of it and describing that social entrepreneurship focuses on solving social problems where markets fail. Social enterprises create opportunities that benefit the society by addressing unmet social gaps. Entrepreneurs use different resources and business models to make a positive impact. In social entrepreneurship, the goal is to maximize social good. Whereas Pret & Carter (2017) view social value creation as an embedded practice within entrepreneurial communities where social value creation happens as a response to community expectations. These perspectives highlight different aspects of how social enterprises create value.

Social enterprises pursue dual objectives: to achieve social impact while maintaining financial viability. Dynamic capabilities, as introduced by Teece et al. (2007), refer to a firm's ability to integrate, build, and reconfigure internal and external competencies to address changing environments. Sensing refers to a firm's ability to recognize opportunities and threats. Seizing is about acting on perceived opportunities by mobilizing resources and implementing solutions. Reconfiguring involves reshaping resources, processes, and business models to adapt to changing environments. (Teece, 2007) It is widely known that in social enterprises the imbalance between social and financial goals can cause conflicts and mission drift. (Best et al, 2021; Tykkyläinen & Ritala, 2021) It has been suggested that social enterprises need dynamic capabilities beyond the traditional firms (Bhardwaj et al, 2022).

Ince & Hahn (2020) provide a perspective on how dynamic capabilities help social enterprises survive tensions. The propose social enterprises enhance survivability through setting structures for getting easily feedback from stakeholders, managing varying stakeholder expectations, and resources in flexible ways, and selectively adapting their business model to turn tensions into opportunities. Bhardwaj et al. (2022) view the development of dynamic capabilities in social enterprises as an ongoing process that integrates both traditional business practices and mission-driven initiatives. They emphasize the role of organizational routines in developing dynamic capabilities. Among generic dynamic capabilities, Bhardwaj et al. (2022) suggest social enterprises have some distinctive capabilities to social enterprises. In their case study, social enterprises focused on creating sustainable livelihoods for their beneficiaries and they were shaping their business models to improve the lives of the people they aimed to help. They suggest a business model is built to support sustainability of their target groups. Moreover, they observed that social enterprises have seizing capabilities by directly engaging with their beneficiaries and involving them in co-creation. Bhardwaj & Srivastava (2024) synthesize perspectives from studies on dynamic capabilities in social enterprises, concluding themes of dynamic capabilities of social enterprises. Social enterprises need dynamic capabilities in identifying opportunities, handling resources and adapting to changes. Bhardwaj & Srivastava (2024) identify themes of bricolage, alliance building, legal support, learning, effectuation, improvisation, knowledge management, innovation, marketing, and co-specialization.

3. Methodology

This qualitative study is an illustrative case study (Baškarada, 2014). It focuses on six thematic interviews with social entrepreneurs who lead social enterprises in three different countries, namely Finland, Latvia and Sweden. The interviews allow for an in-depth exploration of business evolution and dynamic capabilities employed managing tensions. The interviewees were purposefully selected with the following criteria. They are well established social enterprises that have developed their business model for more than several years. They identify as social enterprises and are also formally recognized through national label or status or co-operative form. Each online interview lasted about one hour and was recorded through Teams with the participants' consent. The table below describes data about interviewees social enterprises.

Table 1: List of data source social enterprises

Social enterprise	Organizational form	Social mission	Market activities	Country
A	Limited liability company	To offer inclusive, dignified employment to people with (particular) special needs	Consulting services	Sweden
B	Cooperative	To offer inclusive, dignified employment to unemployed, non-Swedish speaking women	Handicrafts	Sweden
C	Limited liability company	To offer inclusive, dignified employment to people with special needs	Handicrafts	Latvia

Social enterprise	Organizational form	Social mission	Market activities	Country
D	Limited liability company	Alleviate loneliness by providing a free helpline and to offer inclusive, dignified employment opportunities for people with special needs	Call center services	Latvia
E	Limited liability company	Creating employment and advocating localness in textile production	Textile products	Finland
F	Limited liability company	To promote sustainable, affordable, community-focused, energy-efficient housing	Consulting services	Finland

Content analysis was used as the main approach for analysing the empirical data. Coding in qualitative research is a cyclical process of interpretation (Saldaña 2021). Thematic analysis was conducted for interpreting tensions and enablers, and dynamic capabilities in managing these. In the analysis, based on research questions and theoretical framework, a set of first round codes was manually developed. Descriptions of tensions and enablers and changes in developing social business were sought. In the second round, the interviews were reread identifying what dynamic capabilities interviewees describe in managing these cross-pressures, or synergies. In the final phase of the analysis, in the third round, these were organized into broader themes that addressed the research questions.

4. Findings

The following section presents the findings based on three key themes: balancing the social mission with financial viability, social value creation and scaling, and governance and stakeholder relationships. These themes describe the tensions, enablers, and dynamic capabilities that shape the strategies and practices of social enterprises in navigating evolving circumstances.

4.1 Social Mission and Financial Survival - Tensions and Enablers and Dynamic Capabilities

Social enterprises face challenges in balancing their social mission with business. These tensions are present in many ways, interviewees describe quality and pricing or products and services, and what customers value. Many interviewees emphasize that a product or service that comes from a social enterprise is not the reason why customers make buying decisions. In this sense social enterprises compete in similar markets with other enterprises.

One of the key tensions is serving the benefits and considering their terms and conditions while also serving customers. Each firm has different beneficiary groups, with employees as their main focus, many of them are work-integration enterprises. Efforts to integrate inclusive processes, such as employing people with disabilities or offering products that serve a social good, require additional capabilities, time, resources, and modifications to production processes. These have financial implications. In many cases, firms need to test whether their model works, if they have skills to facilitate production in terms that meet also the financial and other realities.

The tension between financial concerns and social mission further intensifies in situations where firms face external pressure. Interviewees describe how Covid pandemia influenced their business. Banks loaning money or investors, despite their growing interest in supporting socially responsible businesses prioritize financial returns. Besides being financially profitable, social entrepreneurs also refer to the need to prove the economic worth of their social endeavours. The concept of "real work" and "real money" is mentioned, emphasizing the legitimacy in the business along with social mission.

Sensing involves spotting opportunities to create value through mechanisms like eco-friendly products and dignified employment and addressing both employee and customer needs. The organizations build mindfulness about specific social challenges. Seizing translates insights from sensing into actionable strategies. It requires decisions that align social impact with financial growth. In all case firms' social mission and business also link with each other. Recognizing societal needs and creative solutions lead to businesses.

Reconfiguring highlights the flexibility of social enterprises in responding to challenges. When financial pressures or market changes arise, interviewees describe how firms made reconfigurations. For example, Case B explored

new B2B customer segments. Case E reassessed the value chain and partnerships. Case C adapted production processes. In each of these decisions both social goals and financial sustainability were considered.

4.2 Value Creation and Scaling Tensions and Enablers and Dynamic Capabilities

The theme of value creation and scaling within social enterprises presents a tension between staying true to their social mission in value creation. In case enterprises business is not separate from social mission. Value creation has multiple logics. At organizational level firms aim to maintain inclusive, mission-driven processes while responding to market pressures. Recognizing value-aligned partnerships, detecting needs within social contexts, identifying new customer segments requires social enterprises to be reflexive.

Scaling social business is an opportunity to grow desired impact. It requires sensing social needs, social mission and market in new ways. In some cases, interviewees describe their social enterprises have navigated the choice between scalable, broader solutions and the more individualized, handicraft-based work. In one case, industrial scaling opportunities would have changed the work of the primary group they are serving by providing inclusive employment as well as their product and customers. The handcraft-based work has been central to them, a part of their original mission. Scaling growth while staying true to what is seen as social value is managed. They had to make choices about what was more relevant for them, and they chose the original social mission and original business model.

nnovation rooted in the social mission is evident when social enterprises co-create products with beneficiaries and choose ethical revenue models. But there are also tensions, for example in one case handcrafted methods preserve meaningful work but may limit scalability. Reconfiguring internal processes and external strategies is crucial for sustaining and scaling value. Social enterprises evolve practices, service logics, and interactions to meet social and market demands. They restructure partnerships, adapt communication strategies, and create new customer engagement models to serve dual goals. A learning culture strengthens sensing, action, and adaptation, enabling value creation.

4.3 Governance and Relationships Tensions and Enablers and Dynamic Capabilities

Governance, how the organization is controlled and held accountable, is one of the themes where tensions and synergies of social business are experienced and where dynamic capabilities are needed. Smaller social enterprises have less governance structures. Anyway, in all cases governance directs social business because it is a framework for processing important knowledge, making strategic decisions and governing mission and business. Tensions and synergies can come from multiple levels and some tensions are not related to social mission, but they are tensions that governing any business could have such as orientation to time and managing knowledge. Owners often invest long-term to support the mission or social business. Decisions about board composition and stakeholder involvement can create conflicts among internal and external groups. In governance and managing stakeholder relationships, sensing involves recognizing the need to adapt to changes in the social context and identifying opportunities to engage key stakeholders. Seizing entails the creation of inclusive governance structures that allow social enterprises to bring together the perspectives of diverse stakeholders. This requires adapting and managing tensions too. For example, in Case B, inviting work-integration employees to the board is constrained by external regulations. Despite these tensions, many social enterprises build inclusive governance practices and, in many cases, benefit from community support.

Dynamic capabilities are needed for sensing and managing expectations or uncertainties. There are also external constraints influencing tensions, particularly if social enterprises have official status in their country and they have additional reporting obligations. In addition, there are many kinds of time-consuming information requests or expectations. Social enterprises struggle with external stakeholders' lack of awareness whereas some experience they are expected to provide proof about social impact.

4.4 Summary of Themes

In the analysis, tensions and enablers were categorized into three groups. They are related to financial survival and social mission, topics related to value creation and scaling and governance and stakeholder relationships. In all these tensions and enablers social enterprises use dynamic capabilities, sensing, seizing and reconfiguring. The purpose guide business choices but there are also trade-offs when something does not work out. Notably, social mission and business are not just causing tension but there are several situations where they align well. Table 2. below presents interpreted themes, dynamic capabilities and exemplifying codes.

Table 2: Underlying themes of dynamic capabilities in managing tensions and enablers

3rd round themes:	2nd round codes about dynamic capabilities	Exemplifying 1st round codes about tensions and enablers
Dynamic capabilities related to balancing social mission and financial viability	Tensions	"*We are doing well because we are taking care of people (with special needs).*" (A)
	<u>Sensing</u>	
	Sensing what it means to "do well" in terms of social mission and financial viability	"*We are doing well because we are doing one thing… you have to focus on main thing. And also doing it for real, you are getting economics and all of it.. … we are doing real work and getting real money and that is also interesting for our consultants, they are also doing real work, they are doing it on same terms than other people*". (A)
	Making strategic priorities	
	Tension between social mission and business model, quality and affordability of services/products while serving social mission	
	Financial challenges	
	<u>Seizing</u>	*"The status of a social entrepreneur doesn't change anything... even though there is much talk about investors wanting to put their money into ecological and sustainable companies, these companies also need to prove that they are worth investing in… The investor counts on getting their money back and making a profit from it.."* (F)
	-Demonstrating market competence, capturing value within market logics without compromising social mission	
	-Challenging trade-offs between serving the target group and meeting internal competence needs	
	Solving financial issues, applying finding	
	Creative inclusive production process	*"I have tried to integrate employees with mental disabilities. I tried to do it for a year, unfortunately, my trying was unsuccessful."* (D)
	Building partnerships	
	<u>Reconfiguring</u>	
	Growing and scaling	"*They (customers) know that this is a social enterprise, and it can be part of the selling point but it´s not a base that they do buying decision on*." (B)
	Solving problems during crisis	
	Developing product portfolio	
	Enablers	"*It takes a little bit more time…Maybe they need some extra help or equipment. Finance is hard. But I think the mindset is more important*" (B)
	<u>Sensing</u>	
	-Market oriented and social needs and value-oriented opportunity recognition	"*Achieving both social meaning and financial sustainability has required careful balancing*." (C)
	Organizational wide competences for sensing together	
	<u>Seizing</u>	"*The motivation to start (our social enterprise) came from recognizing both a societal challenge and a creative strength among visually impaired individuals*." (C)
	-Framing offering around values and needs	
	-	"*It is both environment and the social part of it… So, we make products out of these rugs*" (B)
	Ability to learn and focus on strategic models that works	
	Seizing opportunities for financial resilience and growth aligned with social mission	"*We know that local consumers are more interested in buying local*

3rd round themes:	2nd round codes about dynamic capabilities	Exemplifying 1st round codes about tensions and enablers
	Combining multiple value creation mechanisms (social/environmental) Reconfiguring -Creating practices for value creation while balancing financial and social mission	*products rather than it is produced as cheaply as possible*" (E)
Dynamic capabilities related to value creation and scaling	Tensions Sensing Mission driven/inclusive processes vs. market/customer expectations Building partnerships takes time, detecting value alignments Choices between scalability vs. handicraft work Seizing -Trade-off in pricing, between limited reach (high cost) and affordability (more social impact) -Creating meaningful employment and aligning commercial logics -Balancing investment in people and need for operational efficiency -Innovating and keeping social focus -Creating value for common good while having the same rules than other enterprises Reconfiguring -Managing capacity while growing -Managing resources (time etc.) Enablers Sensing Recognizing opportunities for in social context or market Listening beneficiaries and stakeholders Building mutually beneficial partnerships	"*We are talking about things that are hard (with our employees)…We are trying to be as clear as possible to explain…*" (A) *"...very much of what we produce at the moment is quite exclusive, and perhaps if it were more affordable then more would be bought and facilitate more social impact if more could be produced. So, yes, the biggest challenge right now is that the cost of this product is quite high*." (C) "*We get a lot of help from the public employment service."* (A) "*It is an online store from which we aimed to seek growth…we can´t grow capacity without limit but we can grow revenue by excluding one retailer*." (E) "*We have to play with same rules than any other enterprise… …. Benefits that we create they are for municipalities and for national level…"* (F) "*There's an ongoing challenge in integrating visually impaired individuals into product creation while also ensuring the end products are competitive in the market."* (C) "*Involving visually impaired children in designing the first product…helped establish a meaningful, participatory creative process*." (C) *"We have to play with same rules than any other enterprise"* (F)

3rd round themes:	**2nd round codes about dynamic capabilities**	**Exemplifying 1st round codes about tensions and enablers**
	-Sensing alignment with policy goals and public sector collaboration opportunities <u>Seizing</u> Co-creation with target groups Adapting services to meet the needs Acting on shared values Obtaining access with the help of public sector Intentionally generating spillover value <u>Reconfiguring</u> -Reconfiguring internal practices (hiring and orientation) New strategies for new customer segments Adapting and evolving interactions, service-logics and practices	"*Our employees understand that products are expected to meet a certain level of quality*…" (E)
Dynamic capabilities related to strategy, governing and managing relationships	Tensions <u>Sensing</u> -Envisioning social impact -Lack of awareness from external stakeholders -Misalignments in partnership communication, expectations, values, and institutional logics -Sensing opportunities while ensuring key stakeholders being heard Sensing evolution of social need and context Uncertainty in support structure <u>Seizing</u> -Tensions in ability to assess and measure social impact -The capability to balance interests and constraints -Building inclusive governance structures and practices -Constraints based on legislation, statuses, labels, rules <u>Reconfiguring</u> Mechanisms for adapting and orienting resources timely, involving multiple stakeholders	"*…to measure this social impact is very difficult. We have done it previously*." (D) "*Unemployment agency that I get help from they are very strict with that if you are to have this kind of support system (for our beneficiaries), they cannot be part of company´s board or decision making…that´s the rules…I have to find other ways to make them be part of decision making and so on*." (B) *"For example, I am talking about banks…. Knowledge is very low."* (B) "*I would like to promote social enterprise as something where people make important things happen. If we would not take this textile material they would otherwise go to waste. So, it´s a good thing they are working here producing beautiful things out of these…it´s a real job…I wish policy makers would see it that way and I am not sure if they do*." (B) "*My leadership is very inclusive and very flat organization.*" (B) "*If we don´t have a support system, who is going to help us? There need to be funding in policy system that to these kinds of organizations that are part of the support system around us*." (B)

3rd round themes:	2nd round codes about dynamic capabilities	Exemplifying 1st round codes about tensions and enablers
	-Lack of legitimacy in the society and market requires competence for building legitimacy (for policy makers and society to notice social enterprises "making important things happen" and the "the real job" of social enterprises	"*We cooperate. With municipalities we wanted to cooperate very much. … … We have tried, it didn't work out. It didn't seem that municipality was very interested.*" (D)
	Enablers: <u>Sensing</u> Building shared mission with stakeholders	"*Social enterprises act based on ideology… … there are actors who are not in a favor of model that we advocate because investors do not have position in it (our model)… … … if this (our business) grows, it can become market disruption*" (F)
	<u>Seizing (can also be reconfiguring when they create internal change)</u> -Value-based ecosystem alignment (choosing stakeholders based on chosen ethical lens such as locality) -Engagement and inclusive practices Community support/embeddedness in local context Stakeholder awareness Legislation, statuses and labels -Building partnerships and practices with the public sector and other stakeholders	"*All of our supply chain is domestic. (Our social mission) it is localness and creating employment.*" (E) "We are collaborating with public employment services…we…have this model... When they (employees) are starting, after a period we continue and hire them… After six months it´s a regular employment." (A)

5. Discussion

This case study illustrates how dynamic capabilities, more particularly sensing, seizing, and reconfiguring processes are described to be built and used in social enterprises. This study categorizes the challenges into three groups (financial survival vs. social mission, value creation and scaling, governance and relationships). These are areas where social entrepreneurs face tensions and develop dynamic capabilities in their firms. They build organizational sensemaking, seizing and reconfiguring. In all these categories they build focus on social mission while also being attuned to the world around them, and all phases of dynamic capabilities are interactional processes with the outside world. They allow them to make strategic choices that prioritize mission-aligned innovation, such as inclusive co-creation or selective growth that maintains meaningful work. Through reconfiguring they adapt internal practices, service logics, and partnerships to better align social impact with financial sustainability. Tensions are managed through experimentation, value-driven decisions, and continuous learning. Regardless of prioritization of social value creation, social enterprises need to achieve competitive advantage, as pointed out by the original dynamic capabilities' conceptualization (Teece et al, 1997). These competences help social enterprises to balance social mission with operational needs. While social enterprises do not seek for market dominance, they still need capabilities for competitiveness as they operate in the market.

These findings offer a perspective on dynamic capabilities within social entrepreneurship. Prior literature on social enterprises has not addressed dynamic capability perspective in governing social enterprise. The findings support the notion by Bhardwaj et al. (2022) about social enterprises shaping their business models to support beneficiaries' sustainable livelihoods by actively engaging them in co-creation and demonstrating seizing capabilities to address social needs. The findings also align with Bhardwaj & Srivastava (2024) as they demonstrate how social enterprises continuously adapt by engaging beneficiaries, shaping business models to

meet social needs, and co-creating sustainable solutions. Also, the themes of alliance building and knowledge management are present. In addition, learning and bricolage are emphasized in cases.

Consistent themes of sensing, seizing, and reconfiguring emerge, highlighting capabilities such as co-creation, alliance building, innovation, learning, and bricolage (Bhardwaj & Srivastava, 2024). These processes are evident in managing financial sustainability, balancing social mission tensions, and addressing synergies in value creation, scaling, governance, and relationships. The ongoing nature of dynamic capabilities is also supported by previous literature (Bhardwaj et al, 2022).

In summary, this study contributes to the literature on dynamic capabilities and social entrepreneurship by illustrating how dynamic capabilities are made sense of. Dynamic capabilities facilitate the identification of societal needs, the mobilization of resources through value-driven approaches, and the development of organizational capabilities that align social mission with market demands. This approach allows for a more detailed understanding of how capabilities develop and are enacted in creating social value.

Data is based on the social entrepreneur's experiences and interpretations of the interviewees. It does not represent the broader population of social enterprises. To better understand dynamic capabilities in social value creation, future studies require broader samples. Future research could explore the mechanisms of value creation in greater depth within specific contexts, considering different types of social enterprises. Additionally, the behavioural micro foundations of the dynamic capabilities should be further studied. It would be valuable for future studies to explore shared meanings and values in developing dynamic capabilities within organizations and ecosystems.

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Systematic Literature Review: The Contribution of Creative Leadership to Sustainable Business Development

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Abstract: The purpose of this research was to establish the relevance of Creative Leadership for Sustainable Business Development. The systematic literature review approach was used as the key method for fact finding and the indicated insights were established from an inception pool of 263 journal articles from two databases namely; Scopus (160 articles) and Web of Science (103 articles). Upon exclusion of some articles using the PRISMA 2020 guideline, 189 articles were reviewed and finally 44 articles were incorporated given their specific relevance to the topic. The intext review was carried out with a comprehensive metanalysis aimed at establishing the findings linked to the key research questions. The findings indicate that there is an adequate sign that the involvement, development and guidance of employees is possible and with creative leadership, the adoption of innovative approaches is seamless with the involvement of the employees. The results of the study provide insights that indicate a cordial relevance for creative, innovative, risk resilient and entrepreneurial oriented leadership if a business is keen about embracing change and creativity so as to attain sustainable business development. Creative leadership in organizations is found to drive intricate realities such as the adoption of ESG, ethical leadership and green practices given that management, more so if comprised of experienced members better appreciates the need for mindfulness in the adoption of innovative approaches to business. With the digital trend developments, big data analytics realities, social media marketing and emerging innovative approaches to business practices, the need for creativity as a driving factor by management is seen to be pertinent. Sustainability and therefore the posterity of the organization is assured with the design of a suitable strategy that incorporates creative management approaches and shape the organizational culture, goals and values towards longer term and therefore envisaged sustainable business development. Creative leaders that advocate for collaboration between private entity stakeholders and for government involvement are also found pertinent for sustainable business development. With these findings, organizational leadership and management teams can be inspired to confidently aspire for the adoption of creative approaches that can drive their businesses towards sustainable development.

Keywords: Creative leadership, Leadership, Creative management, Sustainable business development, Sustainable business, Business development

1. Introduction

The need for creativity in the sustainable development of business seems to be a multi-faceted endeavor that requires the involvement of the leadership, the employees, key stakeholders and aligned systems in place to work together in a bid to enhance the performance of the business or organization while remaining relevant to the changing environmental implications. Lee et al (2020) highlight that, to enhance individual creativity, the need to build a close leader – follower relationship, and the need for the creation of appropriate idea generation processes are highlighted.

A human centered approach is noted as important when exploring solutions for sustainability challenges with creativity by Saleh and Brem (2023). Cacciatore (2023) highlights that leaders that seek for heightened performance of their employees are implored to pay special attention to their conduct towards the employees so as to enable them to enhance their creative performance. There is need for a two-pronged approach where the leaders are mindful of their behavior towards the employees who in turn seek for more creativity in the workplace enhancing sustainable development. Chief Digital Officers (CDOs) who trigger digitization and organization creativity still need to appreciate the development of technology for organizational creativity and humanity (Scuotto et al, 2022)

Yoldas and Yildirim (2023) report that intellectual thinking of administrators can affect their creative leadership behavior whereby managers with intellectual thinking skills tend to exhibit creative leadership characteristics such as problem solving, innovation and visioning more effectively. Transformational leadership is therefore seen to positively affect individual creativity (Kayani et al, 2023). Restuputri et al (2023) find that creative leadership supports organizational performance. This provides a basis for reliance on creativity to overcome factors that may affect organizational or business growth such that if managed with creativity, an entity can be guided by the leadership to keep afloat and continue to grow sustainably.

Alzghoul et al (2023) find that strategic thinking coupled with knowledge oriented leadership lead to an increase in the creativity of employees. This provides us with an indication of the need for the leadership in an organization to provide visionary direction for the business while advocating for creative work approaches. Zahur et al (2022) further affirms that knowledge-oriented leadership indeed has a significant effect on team creativity.

In light of the literature on creative leadership and sustainable business development, it still remains obscure as to whether the adoption of creativity in leadership indeed leads to sustainable business development. This systematic literature review research paper seeks to determine the implication of creativity by management for sustainable business development. This paper seeks to delve deeper and establish;

- The extent to which creativity by leaders contributes to sustainable business development?
- What are the key challenges in creative leadership for sustainable business development?
- Indicate the key recommendations observed for creative leadership to enable sustainable business development?

2. Methodology

A systematic literature review was conducted to establish the relationship between creativity and sustainable business development. The PRISMA 2020 guideline (Page et al, 2021) is adopted.

2.1 Search Approach

The process to establish the available journal articles in reference to the topic was carried out. The researcher limited the journals to the most current findings related to the topic. The key words derived from the topic and searched for included; ("creative leadership" OR "leadership" OR "creative management") AND ("sustainable business development" OR "business development" OR "sustainable business"). The two source databases were; Web of Science and SCOPUS.

2.2 Selection Process

The selection process commenced with a total of 263 journal articles selected from two renown databases. The Scopus database provided for a total of 160 articles while the Web of Science Database contributed 103 articles. The articles published before January 2020 were excluded from the selection and so were the duplicate and unpublished articles. Furthermore, all articles with inconclusive abstracts in relation to the topic were excluded too. The Inclusion Criteria on the other hand was as illustrated in Table 1 below;

Table 1: The inclusion criteria

INCLUSION CRITERIA
Articles were selected from two databases, including Scopus and Web of Science.
Articles published in the period January 2020 to February 2025
All articles considered were written in English.
Selected articles had Open Access.

As illustrated in the table above, all articles selected were in English. The selection was restricted to the publish period of years between 2020 and February 2025 providing suitable answers to the research questions posed based on the latest findings. Overall, out of 189 abstracts and titles that were reviewed, 44 journal articles were finally selected. The PRISMA 2020 in Figure 1 for the article review process.

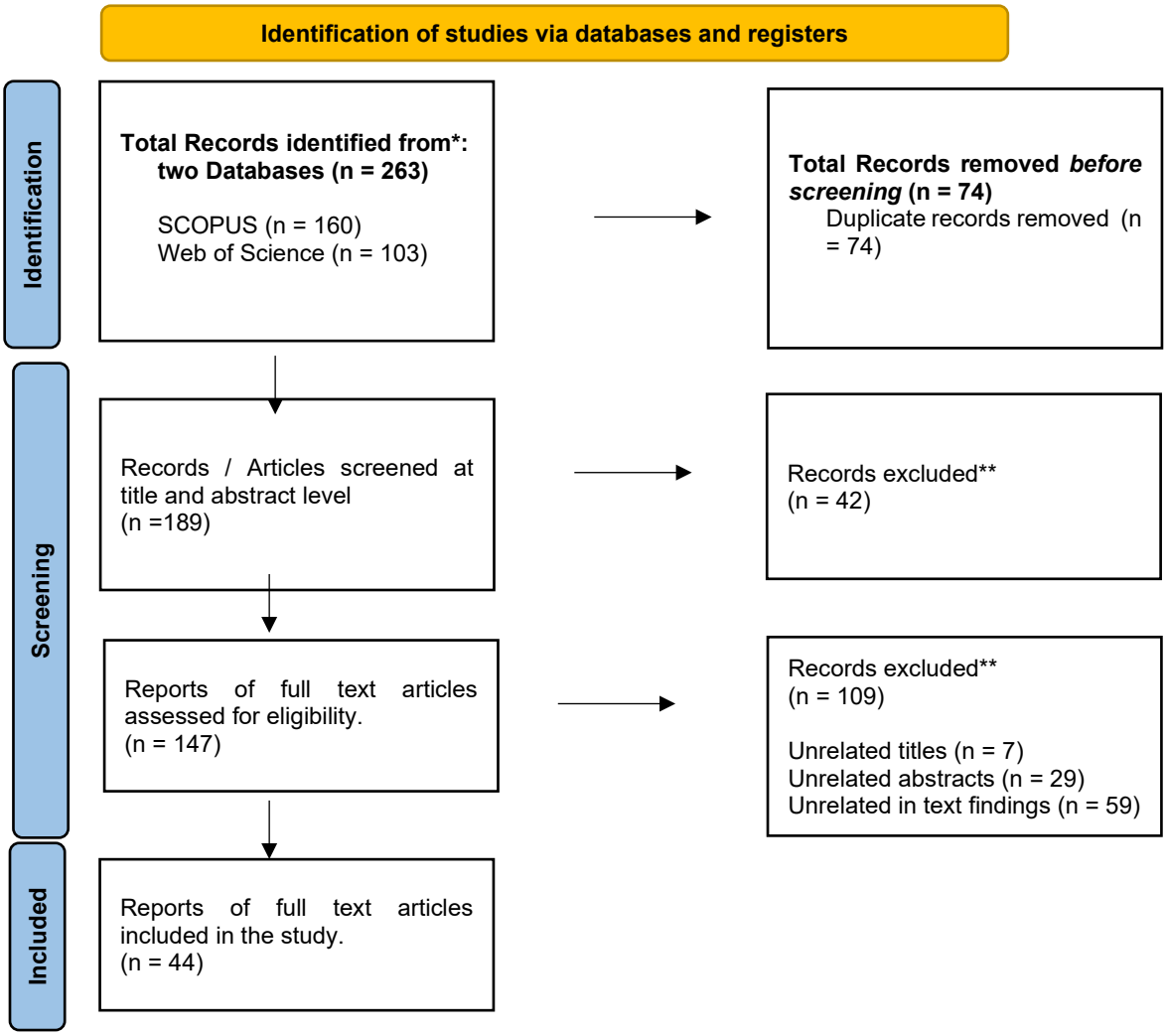


Figure 1: The PRISMA 2020 selection of the final articles

2.3 Descriptive Analysis of Articles

The number of related articles for this study were highest in 2024 with 55 articles, while the 2023 articles were the second highest with over 42 articles. The total of 44 recent articles were selected out of the 189 articles with the inclusion criteria illustrated in Table 1. These further provided for a viable basis for the comprehensive review and compilation of this paper. Table 2 below indicates the selected number of articles per year as illustrated;

Table 2: Selected articles per year

	YEAR	NO. ARTICLES	SELECTED ARTICLES
1	2020	29	02
2	2021	32	05
3	2022	24	03
4	2023	42	23
5	2024	55	9
6	2025	7	2
	TOTAL	**189**	**44**

The final selection of 44 articles that were fully representative and contributory to the relevant findings constituted Qualitative design (13), Quantitative (24) and used the mixed design (7).

3. Results

3.1 Creative Leadership Contributing to Sustainable Business Development

The contribution of creativity by leaders and its contribution to the sustainable development of businesses is a multi-faceted endeavor that requires various interventions aimed at improving the specific aspects of the business so as to attain business development sustainably.

Organizational leadership enables the development of the culture and innovation proficiency that in turn influences sustainable performance of businesses (Chowdhury et al, 2022). This provides an inception reassurance that with creative and innovative leadership, sustainable business development is attainable. Farhan (2024) furthermore, looks at the three areas for sustainable development in an organization, namely; having visionary leadership, improving innovative leadership mindsets and adopting an appropriate business leadership approach, in addition, that a business could be sustained in the long run if staff are encouraged to have an innovative mindset. Aziz and Manab (2020), further find that risk resilience and leadership are essential for and inevitable long term business development.

Flexible work arrangements increased employee's psychological empowerment which in turn increased their innovation performance (Wang and Xie, 2023). Its notable that transformational leadership fosters innovation through sustainable practices (Abu Bakir et al, 2024). Transformational leadership, in this instance, is more inclined to creative leadership, coupled with work engagement of employees, specifically looking at the provision of required resources to do the work, actively contributes to job performance (Gutu et al, 2022). Ambidextrous leaders are attained when they learn how to inspire and motivate people and at the same time educating people in the direction of set goals and so, transformational leadership such as this, has a higher impact on sustainability performance (Katou et al, 2023). The fostering of innovation calls for the alignment of an organization's vision and core values with leadership strategies and customer orientation while managing the challenge of employee experience (Linh et al, 2025). Businesses need to remain agile and responsive to change, thus innovation remains the key aspect as a strategic tool for sustainable adaptation and growth (Bashynska et al, 2024). The leadership of an organization is key in shaping the organizational culture which, being in support of organizational learning, creates conditions for sustainable business development (Zivanovic et al, 2023).

The organizational capacity to change is reviewed by Carvajal-Castrillón et al (2023) where they establish that promoting creative development; and with optimizing of communication spaces and conducting workshops to stimulate creativity, and encouraging employees to participate in initiatives can pave a way towards change. In addition, Shihata et al (2023) found that the development of staff with an inclusive approach led to intellectual capital enhancement and therefore improved organizational sustainability. Elzek et al (2023) look at the development of staff with an inclusive approach leading to intellectual capital enhancement and therefore improved organizational sustainability, they further highlight the importance of strategic work force planning and succession management. Upon incorporating creative thinking techniques in leadership, job training and skills development, managers can foster creative behaviors for appropriate and original solutions that benefit the posterity of the organization (Lee et al. 2025). With creative leadership, any work environment can be transformed sustainably, which is further established among the disabled in Indonesia (Purnomo et al, 2023). Nan and Chaiprasit (2023) further highlight empirically that resilient leadership has a positive and significant impact on sustainable business performance

Environmental Innovation strategies can thus be implemented through sustainable leadership as a management strategy (Hu et al., 2023). There is a positive relationship between GHRM practices, ethical leadership, green process innovation and sustainable company performance as indicated by Liu et al, (2023). Ethical leadership and organizational performance have a strong relationship indicating the impact of ethical leadership in enhancing organizational performance (Kawiana et al, 2023; Akpamah, 2023). The level of productivity by employees and employers and the general profitability of a business are enhanced by ethical leadership (Bláha et al, 2021). In addition, human Capital Management and ESG Performance have a strong and positive relationship and when mediated with a long term CEO tenure, there are thus better chances of alignment with the attainment of strategic organizational goals (Cai et al, 2024). Setyaningram et al (2023) found that managers dealing with green creativity SMEs needed to be able to produce novelty and originality as well as consider compatibility with the wants and needs of consumers. In addition, integrating leadership strategies inclined to a green entrepreneurial approach alongside innovation through digital media business sustainability and improved performance can also be attained by SMEs (Antara et al, 2024).

The emphasis of the positive and strong relationship between digital transformation and sustainable business (Chen et al, 2024). Big data analytics is found to have a positive relationship with sustainable business operations (Bag et al, 2021). Chatterjee et al (2021) confirmed that with Social Media Marketing, there is a strong and positive improvement of sustainable business development Kaftan et al (2023) furthermore establish that innovation and digitalization (such as; Smart metering or the internet of things) are becoming the main drivers of the sustainable economic transformation of small and medium enterprises post-pandemic period. The significant transformation of the Maritime Industry was attributed to digital technology that enhanced sustainability and efficiency together with substantial organizational capital and management acumen (Koilo, 2024). Gutu and Medeleanu (2023) note that eligibility profiles for remote work (hybrid and telework) need to be established so as to attain sustainability of the workforce. Notably, as highlighted by Shuhua and Kanokporn (2023), enterprise innovation plays a mediating role between resilient leadership and sustainable business performance. Its no wonder its established that Digital Leadership positively influences sustainable business performance (Saddique et al, 2023).

Dressler (2023) looks at the need for business model design components to be aligned with strategy and the need for the creative process to integrate sustainability into the company strategy. Change, purpose and leadership are noted to be required as a strategy that sustains the business (Bugwandin and Bayat, 2022). Skills and competencies that are enhanced for women entrepreneurs in emerging economies lead to long term success in business (Akther et al, 2024). Ercantan et al (2024) found that entrepreneurial leadership fosters an encouraging and supportive environment in the workplace which in turn leads to sustainable competitive advantage.

The study by Da Rocha Oliveira Teixeira et al (2023) looks at the collaboration between producers in networks such as the Lucca Biodinamica in Italy, which catalyze innovation, knowledge dissemination and collaborative initiatives which in turn enhance strategy uptake and enable advocacy for sustainability. Vigoroso et al (2023) further found that the business and social interests of company leaders who collaborate through open innovation are attained. Intra organization relations or internal relationships in a business also contribute greatly to its sustainability (Slupska et al, 2023). Collaboration is therefore key for business sustainability, both by private and public sectors. The role of Government is explored in terms of the contribution of Business Development Services (BDS) to the transformation of rural based Micro Enterprises so as to enable access to the export market, however, minimizing the cost of the provision of BDS requires that the government comes up with a supportive institutional framework and policies to provide the BDS, suitable to the needs of the Micro Enterprises (Kazungu, 2023). Akpamah (2023); he further establishes that given that most business leaders may not afford leadership training, Government's intervention to provide and finance leadership trainings and seminars for SMEs would be beneficial.

3.2 The Challenges Faced in Creative Leadership for Sustainable Business Development

Business sustainability and development is a daunting task to attain without creative and flexible leadership (Farhan, 2024). Finding business partners and customers that share the same vision, in this case, towards sustainability remains a challenge for businesses, along with the huddle of unconducive regulations, bureaucracies and corruption in the statutory environment as seen in Romania, Costache (2021).

Without ethical and moral grounding, leaders may not be able to enforce sustainability (Sebastian and Hühn, 2024). In their study, Bashynska et al (2024) found that linking leadership and ethics remained a challenge given that its in that way that leaders would need to make ethically sound decisions and act in a socially and environmentally responsible manner, in addition, that the ethical dimension called for innovation to be pursued responsibly given the impact on communities, environments and future generations.

Micro businesses are normally faced with capital constrains that may hinder them from ably investing in technology. Rusliati et al (2020) established that inadequate technology adaptation makes micro businesses to progressively loose customers to the point of closure.

3.3 Recommendations of Creative Leadership for Sustainable Business Development

There is need for senior management to create a culture, motivate managers and convince share holders to create an approach where long term orientation strategies are prioritized. Gerlich (2023) however finds that the short term orientation is prevalent.

Kantabutra (2021) indicates that with a widely shared organizational culture, the sustainability of the organizational vision and values drives emotionally committed staff that seek to attain the roll out of corporate sustainable practices.

Innovation and creativity, more so by the leadership of a business entity, remain an overarching need for the sustained development and longevity of a business. Kumari and Bisht (2023) emphasize that management plans for effective business development, acknowledging operations in a fast changing technologically advancing world. Managers need to remain teachable and flexible enough, so as to adapt seamlessly, innovate continuously, and keep up with the latest developments that facilitate making sound, strategic and impactful decisions leading to the envisaged sustainable business development.

4. Conclusion

The purpose of this research was to establish the relevance of Creative Leadership for Sustainable Business Development. The intext review was carried out with a comprehensive metanalysis utilizing the PRISMA 2020. The key findings are indicative that creative leadership, has a cordial relevance for creative, innovative, risk resilient and entrepreneurial orientation for a business to attain sustainable development.

Creative leadership in organizations is found to drive intricate business sustainability realities such as the adoption of ESG, ethical leadership and green practices with the digital trend developments, big data analytics realities, social media marketing among other emerging innovative approaches to business practices. Sustainability and therefore the posterity of the organization is assured with the enactment of a suitable strategy that shapes the organizational culture, goals and values towards sustainable business development. Creative leaders that advocate for collaboration between private entity stakeholders and for government involvement, are also found pertinent for sustainable business development.

With these findings, organizational leadership and management teams can be inspired to confidently aspire for the adoption of creative approaches that can drive their businesses towards sustainable development. In regards to the literature review however, the restriction was with open access articles which much as they restricted the research to an extent, the researcher believes that the findings therefrom sufficiently provided insights to the topic and the respective research questions. In conclusion, creativity by leaders is a multifaceted and yet intrinsic need for organizations to be able to attain sustainable development.

Ethics Declaration: The authors of affirm that this paper was compiled ethically with originality and without conflicting interests.

AI Declaration: This article was based on thorough research by the authors, without the utilization of AI.

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Sharing as Power: Keys Strategies for Breaking Knowledge Silos

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Abstract: This paper develops an integrative framework proposing actionable strategies for dismantling knowledge silos within corporate environments. Guided by a qualitative methodology, data was gathered from knowledge management (KM) professionals across physical and digital domains using a triangulation approach. The findings illuminate the critical importance of executive-level engagement and sustained commitment to KM initiatives, while simultaneously highlighting the fundamental role of interpersonal trust in overcoming barriers to collaboration and intellectual exchange. We identify five key strategic approaches that demonstrate symbiotic relationships across two organizational movements—Top-Down and Bottom-Up—which, when implemented cohesively, can effectively mitigate detrimental knowledge silos and enhance cross-functional knowledge flows. This work contributes original perspectives to the currently limited literature on addressing intra-organizational knowledge barriers. By situating knowledge silos and knowledge hiding within the broader context of knowledge risks, this study emphasizes the importance of comprehensive knowledge risk management in sustaining knowledge-driven innovation and organizational effectiveness. For future research, we propose investigating optimized technological systems that can effectively support and reinforce embedded knowledge-sharing routines within organizational contexts.

Keywords: Knowledge silos, Knowledge sharing, Knowledge hiding, Knowledge risks, Knowledge risks management

1. Introduction

Organizational knowledge is a critical strategic asset that drives competitiveness and innovation in today's dynamic business environment (Bratianu, 2015; Nakash et al. 2023; Serenko and Bontis, 2016). However, knowledge silos—where expertise and information remain confined within specific departments or units—pose a substantial threat to organizational effectiveness. These silos hinder knowledge accessibility, obstruct collaboration, and limit the organization's capacity for innovation and adaptation (Bolisani and Handzic, 2015; Bundred, 2006; Connelly et al. 2012; Offsey, 1997; Zhao et al. 2019).

One of the primary drivers of knowledge silos is the "knowledge is power" syndrome, wherein employees deliberately withhold critical knowledge to maintain individual leverage within the organization (Toma and Butera, 2009). This behavior not only weakens collaborative efforts but also results in redundant work and inhibits knowledge-driven innovation (Nakash and Bouhnik, 2022). To counteract these risks, organizations must cultivate a culture that discourages knowledge hoarding and actively promotes knowledge sharing as a means to enhance business performance (Pereira and Mohiya, 2021).

Despite the well-documented negative consequences of knowledge silos—such as reduced efficiency, diminished innovation, and decreased competitiveness (Fenwick et al. 2012; Hwang and Krackhardt, 2020)—there remains a notable gap in applied research on practical strategies for overcoming them. Existing literature primarily focuses on the adverse effects of knowledge silos, yet actionable solutions remain underexplored, particularly from the perspective of knowledge management (KM) professionals.

This study seeks to address this gap by examining strategies recommended by KM professionals to dismantle knowledge silos and enhance knowledge sharing within organizations. By leveraging insights from practitioners, this research aims to develop practical interventions that foster collaboration, knowledge transparency, and organizational learning. Beyond improving knowledge accessibility, these initiatives are crucial for mitigating knowledge risks—such as knowledge loss, redundancy, and fragmentation—that can compromise organizational resilience and long-term sustainability (Bratianu, 2018; Durst et al. 2019; Durst and Zieba, 2020).

The findings of this study will culminate in the development of a model designed to optimize the use of core business knowledge while mitigating associated risks. Implementing these strategies will enable organizations to strengthen their innovation capabilities, enhance adaptability in a rapidly changing environment, and sustain their competitive advantage. Furthermore, integrating knowledge risk management (KRM) practices will be essential to safeguarding knowledge assets and ensuring their continued strategic value in an increasingly knowledge-driven economy.

This paper proceeds as follows: Section 2 provides a theoretical background to the research topic. Following this, Section 3 details the research strategy and methodology adopted. Section 4 presents the results, and Section 5 concludes with key insights, limitations, and directions for future research.

2. Theoretical Background

Knowledge is broadly defined as a valuable organizational resource that exists in two primary forms: explicit and tacit. Explicit knowledge is structured, codified, and easily transferable through formal channels such as documents and databases, whereas tacit knowledge is embedded in personal experience and intuition, making it difficult to articulate and share (Nonaka & Takeuchi, 1995). Knowledge sharing refers to the process through which individuals exchange knowledge to enhance collective understanding, decision-making, and innovation. This exchange can occur formally, through structured repositories and training, or informally, via interpersonal interactions and collaboration. Effective knowledge sharing is essential for organizational learning and performance but is often hindered by various barriers (Haas and Hansen, 2007; Ipe, 2003; Kaushal and Nyoni, 2025).

The phenomenon of knowledge silos is closely intertwined with knowledge hiding, defined as the deliberate concealment or withholding of knowledge that individuals possess (Serenko and Bontis, 2016). Knowledge hiding can manifest in various forms, such as evasive hiding (avoiding sharing knowledge), playing dumb (pretending not to know), or rationalized hiding (justifying why knowledge is not shared) (Connelly and Zweig, 2015; Connelly et al. 2012; Gagné et al. 2019; Hernaus et al. 2019). This behavior is detrimental to organizational performance as it impedes knowledge sharing, collaboration, and innovation, often leading to the creation of knowledge silos (Burmeister et al. 2019; Connelly et al. 2019).

Research indicates that knowledge hiding often arises from individual motivations such as self-preservation, strengthening personal reputation, or perceived lack of reciprocity in knowledge exchange (Burmeister et al. 2019; Cerne et al. 2015; Chatterjee et al. 2021; Connelly et al. 2012; Siachou et al. 2021). Individuals may hide knowledge to maintain control over expertise that gives them power or leverage within their team or organization, further contributing to the formation of knowledge silos (Restubog et al. 2020).

The consequences of knowledge hiding extend beyond individual actions to affect team dynamics and organizational culture. When knowledge is hoarded or concealed, it creates barriers to effective communication and collaboration, leading to inefficiencies and missed opportunities for innovation, and reinforcing knowledge silos (He et al. 2021; Restubog et al. 2020). Moreover, the presence of knowledge hiding behaviors can erode trust among team members and hinder the development of a supportive and cooperative work environment (Connelly et al. 2019).

Organizational factors, such as leadership style and organizational culture, play crucial roles in either exacerbating or mitigating knowledge hiding behaviors. Leadership that emphasizes transparency, open communication, and knowledge sharing norms can create an environment where hiding knowledge is discouraged and sharing is rewarded, thus breaking down knowledge silos (Connelly et al. 2012). Conversely, cultures that prioritize individual achievements over collective goals may inadvertently encourage behaviors that perpetuate knowledge hiding and the creation of knowledge silos (Cerne et al. 2015).

The presence of knowledge silos and knowledge hiding behaviors introduces significant knowledge risks that can undermine an organization's ability to sustain its competitive advantage. Knowledge risks refer to threats associated with the loss, mismanagement, or misuse of critical organizational knowledge (Durst and Zieba, 2019; Durst et al. 2019). These risks can manifest in various ways, including knowledge loss due to employee turnover, fragmentation of expertise across isolated teams, and the deterioration of organizational memory over time (Bratianu, 2018; Durst and Zieba, 2020; Nakash and Bouhnik, 2022).

Effective KRM is crucial for mitigating these threats and ensuring the long-term sustainability of knowledge assets. It involves identifying, assessing, and addressing potential vulnerabilities in knowledge flows to prevent disruptions in knowledge accessibility and utilization (Durst, 2019; Durst et al. 2019). By integrating KRM principles into their KM strategies, organizations can proactively mitigate the detrimental effects of knowledge silos and knowledge hiding (Nakash and Bouhnik, 2022).

3. Method

This qualitative study employed a triangulated research approach, integrating multiple data sources to develop a comprehensive understanding of the phenomenon under investigation. Importantly, the findings presented

in this paper form part of a broader research initiative examining the role, evolution, and future of the KM discipline (Nakash et al. 2022). The research received approval from the institutional ethics committee and was conducted in accordance with the protocols accepted by the scientific community.

The methodological approach included conducting in-depth semi-structured interviews and facilitating two focus groups, engaging a total of 52 participants. These participants comprised 27 organizational KM consultants and 25 knowledge managers, ensuring a diverse range of expert perspectives on knowledge-sharing challenges and interventions. The interviews and focus groups provided rich qualitative insights into the mechanisms sustaining knowledge silos and the strategies for mitigating them.

To further enhance data richness, cyber-ethnography was employed, involving a systematic content analysis of 20,349 posts and comments collected over four years from two public Facebook communities dedicated to KM. This approach allowed for the capture of organic, real-world discussions among KM professionals, offering valuable insights into prevailing attitudes, barriers, and solutions regarding knowledge silos.

The participants in this study represented various industrial sectors, including technology, media, telecommunications, public administration, government, and finance, ensuring a broad representation of organizational contexts. All research procedures adhered to strict ethical protocols, ensuring participant anonymity and confidentiality. The study followed a grounded theory approach (Khan, 2014), employing iterative thematic analysis (Terry et al. 2017) to systematically code and identify emergent patterns across the three qualitative data sources.

4. Findings

The human element was emphasized as critical for enabling effective KM processes and preventing knowledge silos, which pose significant risks to organizational continuity and innovation. Participants highlighted that KM inherently involves behavioral dynamics that shape an organization's knowledge flows. Consequently, dismantling deleterious knowledge silos is imperative to prevent counterproductive individualistic cultures rooted in competition, which can significantly harm organizational learning and cooperation. The study participants propose that implementing five interrelated, actionable strategies across symbiotic Top-Down and Bottom-Up movements can facilitate breaking down barriers to knowledge sharing while concurrently mitigating knowledge risks such as expertise loss and inefficient knowledge retention (see **Figure 1**).

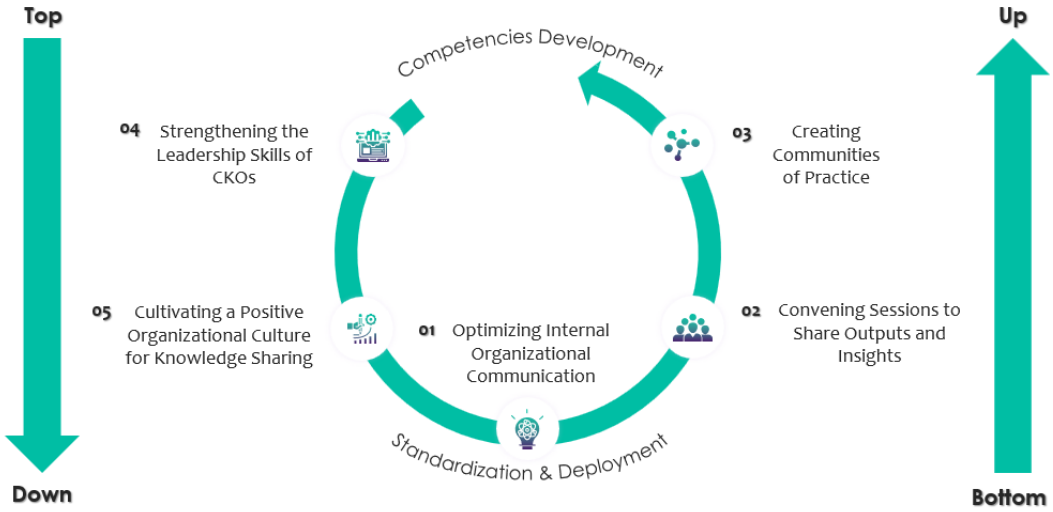


Figure 1: An Integrative Model for Breaking Knowledge Silos in Corporations

4.1 Top-Down Strategies: Centralized Hierarchical Approaches Led by Managers

4.1.1 Developing chief knowledge officers' (CKOs) leadership skills

CKOs play a pivotal role in promoting and implementing an organization's KM strategy and related policies. By enhancing the leadership skills of CKOs, organizations can ensure that these officers are better equipped to engage employees in knowledge retention activities and foster a culture of continuous learning. Improved leadership capacities enable CKOs to effectively address and overcome objections to initial KM initiatives,

which can often be met with resistance. Additionally, skilled CKOs can identify and recruit change agents within the organization who can champion KM practices and support their widespread adoption. By persuading employees towards cooperative behaviors and fostering a collaborative environment, CKOs can significantly enhance the overall effectiveness of KM processes. Furthermore, leveraging artificial intelligence (AI) tools can assist CKOs in identifying knowledge gaps, predicting areas for improvement, and providing data-driven insights to support their leadership efforts. Addressing these challenges is critical for managing knowledge risks, ensuring that expertise is not lost due to turnover, and fostering institutional knowledge resilience.

4.1.2 Cultivating a supportive culture of knowledge sharing

Recognizing, appreciating, and rewarding contributions to organizational knowledge systems are pivotal actions for dismantling the barriers that underpin knowledge silos. By actively acknowledging and valuing the efforts of employees who engage in knowledge sharing, organizations can create an environment that encourages openness and collaboration. This recognition can take various forms, such as public acknowledgments, awards, or incentives, which serve to motivate employees to continue sharing their knowledge and expertise. An interpersonal climate that resists the tendency to hide knowledge and instead fosters trust among employees is essential for promoting social cooperation and establishing norms of reciprocity. A failure to cultivate such a culture heightens knowledge risks, as key knowledge may remain locked within isolated units, thereby jeopardizing the organization's ability to respond to emerging challenges.

4.2 Bottom-Up Strategies: Distributed Collaborative Approaches Led by Employees

4.2.1 Facilitating communities of practice (CoPs)

CoPs are voluntary employee groups that share a common interest and are dedicated to the pursuit of learning and the development of knowledge. These groups optimize knowledge flow within organizations by fostering open discourse and creating structured mechanisms for the exchange of insights. CoPs can take the form of online forums, structured mentorship programs, or event-driven initiatives such as hackathons. By actively engaging in such communities, employees prevent knowledge hoarding, surface hidden knowledge gaps, and contribute to collective intelligence. AI tools can further enhance CoPs by recommending relevant content, facilitating networking among members, and summarizing key discussions to improve accessibility and retention.

4.2.2 Convening sessions to share outputs and insights

Structured knowledge-sharing sessions bring together employees from diverse specializations to exchange project insights, lessons learned, and innovative solutions. These sessions expose tacit knowledge, which is often difficult to document yet essential for innovation and organizational learning. By promoting cross-functional collaboration, such meetings enhance knowledge flows, reduce redundancy, and mitigate knowledge fragmentation risks. Over time, this practice not only strengthens collaborative behaviors among employees but also aligns these behaviors with the achievement of broader business goals. The continuous exchange of knowledge and ideas during these sessions can lead to the identification of new opportunities, the development of innovative solutions, and the overall intellectual growth of the organization. AI-powered tools can facilitate these sessions by organizing key takeaways, improving knowledge accessibility, and ensuring that valuable insights are retained within the organization.

4.3 Combining Top-Down and Bottom-Up Strategies

4.3.1 Optimizing internal organizational communication

Strengthening formal and informal communication channels ensures rapid knowledge dissemination. Managers can optimize official communication through intranets and knowledge portals, while employees can drive informal networks such as "knowledge cafés." AI-enhanced platforms can support real-time content curation and automated knowledge synthesis, ultimately strengthening organizational resilience against knowledge risks. By fostering a culture of open communication and continuous feedback, organizations can ensure that knowledge flows seamlessly across all levels. By integrating these formal and informal communication strategies, organizations can create a dynamic and responsive knowledge-sharing ecosystem, thereby contributing to the organization's overall agility and innovation capacity.

5. Conclusion

This investigation has uncovered five interconnected strategic approaches that organizations can deploy to overcome detrimental knowledge silos—comprising two centralized strategies, two decentralized approaches, and one integrated method. The proposed conceptual framework systematically integrates these complementary techniques, demonstrating how they can function synergistically to enhance organizational knowledge flows and dismantle persistent knowledge barriers. This research contributes substantive insights to the currently limited scholarly discourse on addressing knowledge silos, particularly in terms of practical implementation strategies, which remain notably underexplored in the extant literature.

The managerial implications of this study hold considerable significance for CKOs and organizational leadership teams. By comprehensively understanding and strategically implementing these approaches, CKOs can provide evidence-based guidance to executive stakeholders on mitigating knowledge risk through the reduction of knowledge-hoarding behaviors. Moreover, the findings enrich the KRM literature by establishing clear connections between silo mitigation strategies and the broader framework of organizational risk governance. This contribution is particularly valuable as it bridges theoretical constructs with actionable implementation pathways that organizations can deploy to systematically address knowledge vulnerabilities.

The findings are derived from subjective interpretations inherent to qualitative research, and it is possible that not all perspectives have been captured. Future research should continue to explore and validate these strategies, ensuring they remain relevant and effective in an ever-evolving organizational landscape. At the sociotechnical level, subsequent research might investigate which technological interventions most effectively support the establishment of human-cultural relationships that facilitate optimal systematic knowledge transfer while minimizing knowledge-related risks. Furthermore, longitudinal studies examining the implementation impacts of these actionable techniques within organizational settings would prove valuable. By methodically tracking transformations in knowledge flows pre- and post-implementation through robust mixed-methods research designs, scholars can refine their understanding of both the advantages and limitations of these strategies in practice, thereby contributing to more sophisticated approaches to KRM.

AI Declaration: The author confirms that no AI tools were used in the creation of this manuscript. All research, analysis, and writing were conducted manually, adhering to the highest standards of academic integrity.

Ethics Declaration: This study was conducted in accordance with the ethical standards of the Institutional Ethics Committee. The participants provided informed consent prior to their inclusion in the study, ensuring confidentiality and anonymity.

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Implementing CTI Exchange: A Framework for the DYNAMO Project Pilot Phase

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Abstract: Effective Cyber Threat Intelligence (CTI) exchange is essential for strengthening cybersecurity resilience across critical sectors such as healthcare, energy, and maritime. While theoretical CTI governance models exist, their real-world implementation remains challenging due to issues with trust, compliance, interoperability, and real-time collaboration. This paper aims to address these challenges by proposing a practical knowledge transfer framework for the pilot phase of CTI Exchange governance implementation. Building on two prior research studies that developed a CTI exchange governance model specifically tailored for the DYNAMO platform, this paper focuses on putting that model into practice. By utilizing the insights and methodologies from previous work, the study presents a structured approach to applying, testing, and refining governance principles in real-world settings, ensuring effective operationalization of the model through the DYNAMO platform's capabilities. The DYNAMO project, an EU initiative, offers a comprehensive approach to cyber resilience and business continuity, providing organizations with tools and strategies for threat intelligence generation, analysis, and dissemination. The proposed framework includes strategies for piloting DYNAMO tools with pilot preparation, stakeholder engagement, sector-specific governance adaptations, and evaluation metrics. It also defines clear roles and responsibilities to support consistent application of governance mechanisms, with continuous refinement based on empirical feedback. The framework also emphasizes the importance of cross-sector collaboration, ensuring that various stakeholders, including governmental bodies, private organizations, and technical experts, are actively involved throughout the process. Tailored guidelines for the healthcare, energy, and maritime sectors address sector-specific regulatory and operational challenges. Although the pilot phase has not yet been executed, the guidelines presented here provide a robust roadmap for preparing, launching, and iteratively refining CTI exchange pilots. Ultimately, this work lays the foundation for scalable, secure, and compliant CTI-sharing governance that enhances collaboration and cyber resilience across critical infrastructure environments.

Keywords: Cyber threat intelligence, CTI exchange, Governance model, Knowledge Transfer, DYNAMO Project, Piloting

1. Introduction

Cyber Threat Intelligence (CTI) plays a pivotal role in organizational cyber resilience by enabling stakeholders to proactively identify and address threats, learn from past incidents, and anticipate future risks (Johnson et al., 2016). The importance of real-time CTI sharing is especially pronounced in multi-organization contexts, timely exchange of threat insights allows partners to coordinate responses and contain incidents more effectively (CISA, 2023). Within the DYNAMO project (an EU-funded cyber resilience initiative)[1] , the need for rapid and secure CTI sharing among partners is critical to support a shared situational awareness and synchronized defense across healthcare, energy, and maritime sectors.

However, practical challenges related to governance, including legal compliance, mutual trust, data sensitivity, and technological interoperability, often hinder seamless intelligence exchange (Rajamäki & Nepal, 2025, Fan et. al., 2019). These governance issues can create reluctance in sharing information and limit the benefits of collective cyber defense (ENISA, 2017). DYNAMO has developed a suite of cybersecurity tools that support proactive threat detection, analysis, and incident response across critical infrastructure sectors such as health, maritime and energy . CTI exchange mechanisms are central in this toolset, ensuring that actionable intelligence (e.g. indicators of compromise, TTPs, and warnings) is disseminated securely among stakeholders. To fully leverage DYNAMO's capabilities, a structured governance framework is required so that these CTI-sharing tools can be integrated in practice. Effective governance would provide common standards (such as using STIX/TAXII for threat data format) and policies (e.g. defining trust groups and data handling rules) that enable organizations to share intelligence confidently and in compliance with regulations (Johnson et al., 2016). In essence, governance acts as the key element that drive the technical CTI platform with the participating organizations'

[1]DYNAMO : https://horizon-dynamo.eu/

processes and regulatory obligations, facilitating a smooth operationalization of cross-sector threat intelligence sharing (Rajamäki et al., 2025).

Recognizing these needs, prior studies have explored what kind of governance model best suits the DYNAMO platform's CTI exchange requirements. For example, Rajamäki et. al., (2025) developed a tailored CTI exchange governance model emphasizing trust agreements, standardized data formats, regulatory compliance, real-time collaboration, and continuous learning.

This paper builds on such groundwork by moving from theory to practice. Specifically, we extend the earlier conceptual model into a pilot implementation framework for DYNAMO's tools, with a strong focus on CTI exchange. In doing so, this study addresses the gap between high-level governance principles and their application in real-world settings, aiming to support that the DYNAMO platform's CTI sharing capabilities are adopted and utilized effectively across its partner organizations.

1.1 Research gap and Objectives

While various governance models for CTI exchange exist, many lack concrete implementation guidelines that can be directly applied in structured pilot programs or real operational environments (Rajamäki & Nepal, 2025) . In other words, prior frameworks often stop at the policy level and do not provide detailed roadmaps for how to put governance principles into action within organizations or multi-party consortia. This gap is evident in critical sectors where generic cybersecurity frameworks (e.g., NIST's Risk Management Framework or ENISA guidelines) offer foundational guidance but may not account for sector-specific challenges and the nuances of inter-organizational collaboration (Rajamäki & Nepal, 2025). There is a clear need for a practical approach that translates governance theory into actionable steps for pilots, ensuring that well-intended policies yield improved information-sharing outcomes on the ground.

Objectives: This paper aims to bridge the above gap by developing a practical, sector-specific implementation framework for governance-driven CTI exchange. Key objectives include:

- Develop a comprehensive implementation framework for governance-driven CTI exchange.
- Provide structured guidelines for piloting CTI governance using the DYNAMO platform across critical sectors.
- Ensure that the piloting framework supports both CTI exchange governance and the broader implementation of DYNAMO tools.
- Outline knowledge transfer approaches for adoption, evaluation, and iterative refinement.

1.2 Research Methodologies

This study is based on a qualitative and exploratory approach aimed at developing a practical framework for piloting CTI exchange governance within the DYNAMO project. The methodology involves four key steps:

1. **Building on previous research:** The work draws directly from earlier studies that developed a CTI governance model specifically for the DYNAMO platform. These prior efforts provided conceptual foundations, including the governance pillars and key considerations for secure and effective CTI exchange.
2. **Understanding DYNAMO requirements:** We reviewed the goals, structure, and planned deliverables of the DYNAMO project to support alignment with its technical and strategic needs. This included identifying how CTI sharing tools are expected to function in practice and what governance components are necessary to support them.
3. **Reviewing existing literature and supporting documents:** A literature review was conducted focusing on CTI exchange, governance challenges, and knowledge transfer in cybersecurity contexts. The literature included target keyword searches using mostly google scholar and used keywords such as "Cyber Threat Intelligence governance", "CTI exchange", "cybersecurity knowledge transfer", "knowledge transfer", among others. Literature was selected based on relevance to CTI governance implementation from peer-reviewed articles, conference proceedings, white papers, and institutional reports. In addition, reference materials were sourced from authoritative organizations including CISA, NIST, and ENISA. Findings were thematically categorized and synthesized to design the pilot preparation strategies.
4. **Drawing insights from related pilot projects:** We analyzed example pilot initiatives to understand how governance models have been applied and evaluated in similar multi-stakeholder, critical

infrastructure settings. These cases offered practical insights into piloting strategies, stakeholder engagement, and adaptation across sectors.

This methodology supports that the proposed pilot framework is both grounded in research and tailored to the operational context of the DYNAMO platform and its partner sectors.

1.3 Structure of Paper

The following sections 2 and 3 introduce DYNAMO Platform and related work respectively. Section 4 describes the role of governance in DYNAMO piloting followed by piloting strategies in section 5. Sections 6 and 7 provide an overview of sector-wise CTI governance adaptation and KPIs respectively. The final two sections are discussion and conclusion.

2. The DYNAMO Platform

DYNAMO is a European Union initiative designed to enhance cyber resilience in critical infrastructure sectors such as healthcare, energy, and maritime. The project integrates advanced cybersecurity tools to support proactive threat intelligence exchange and response coordination. By fostering collaboration among experts and stakeholders, DYNAMO supports that organizations can effectively counter evolving cyber threats while maintaining compliance with industry regulations.

DYNAMO emphasizes a structured resilience cycle encompassing preparation, prevention, protection, response, recovery, and continuous adaptation. Sector-specific risk scenarios are developed to simulate cyber-attack impacts and refine strategies to combat the cyber defenses with collaboration, development of advanced tools and CTI-sharing mechanisms. The project considers three key perspectives:

- **Technology perspective** – Development and optimization of cybersecurity tools to enhance threat detection and mitigation.
- **Data perspective** – Analysis of gathered data, ensuring relevant, actionable intelligence for stakeholders.
- **Social perspective** – Establishment of governance policies and trust-building measures for secure and effective collaboration.

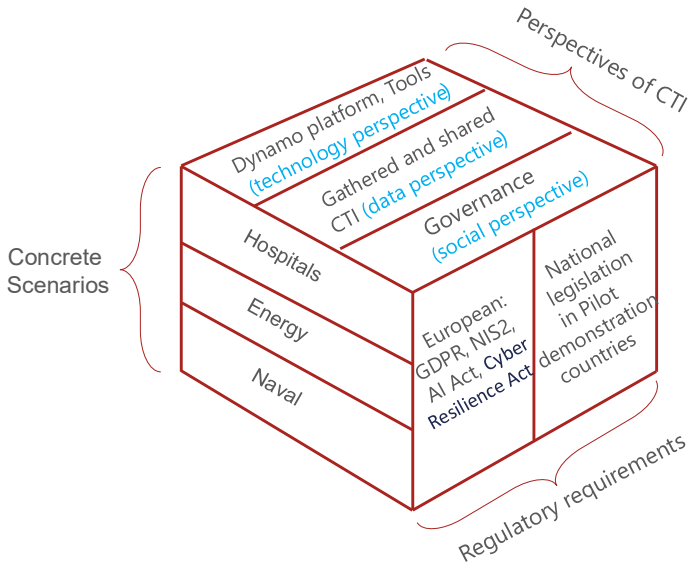


Figure 1: DYNAMO CTI perspective, regulatory requirements and use cases

By offering tailored security strategies, DYNAMO mitigates threats such as ransomware in healthcare, SCADA vulnerabilities in energy infrastructure, and navigation system compromises in the maritime sector. The platform's integrated approach enables organizations to build robust defense mechanisms against cyber risks.

3. Related Work

3.1 CTI Exchange, Governance and Existing Implementation Examples

Several prior works have laid the foundation for understanding CTI, its exchange mechanisms, and the governance challenges that accompany them. Johnson et al. (2016) provided a framework for understanding the benefits and limitations of CTI sharing, emphasizing the importance of structured information formats and trust-based networks. Jin et al. (2024) revisited these themes, empirically testing CTI sharing outcomes and highlighting the importance of CTI exchange in a standard manner emphasizing on technical standards like STIX and TAXII have been instrumental in supporting automated CTI exchange. These are further supported by platforms like MISP, an open-source tool explored by Wagner et al. (2016), which offers structured environments for indicator sharing and collaborative analysis. Furthermore, Saeed et al. (2023), who presented a systematic review of CTI practices in organizations and their alignment with resilience objectives and highlighted the importance of CTI implementation.

Despite these technological enablers, governance issues remain central. Rajamäki et al. (2024) addressed this through a proposed governance framework tailored for the DYNAMO CTI Tool, incorporating steering structures, role-based access, and legal alignment with the NIS2 directive. Their work is complemented by Rajamäki et. al., (2025), who refined the model into five governance pillars. The present paper builds directly on these foundations, translating their theoretical model into a pilot-ready framework.

In terms of implementation strategy, this study also draws on lessons from pilot projects like NIST Cybersecurity Framework (CSF) Pilot at Intel (Casey, 2015) and C3ISP (Fan et al., 2019), which demonstrated how piloting in critical infrastructure contexts can identify sector-specific governance requirements. Together, these works underscore the need for practical frameworks that not only outline governance principles but support their staged adoption in diverse operational settings.

3.2 Knowledge Transfer in DYNAMO Context

In the context of this study, knowledge transfer refers to the process of taking previous theoretical work and applying it in a practical setting. Many literatures on knowledge transfer focus on transfer of knowledge between researcher and practitioner (Ward et. al., 2009), inter organizational unit transfer of knowledge (Argote et. al., 2000) and transferring knowledge among employees to build the security posture of an organization (Saad, 2021). However, for the DYNAMO project, it involves translating the governance model introduced in earlier research (Rajamäki et. al., 2025) into a pilot framework that can be tested and implemented with real stakeholders. This governance model, which is structured around trust and collaboration, standardization, regulatory alignment, real-time response, and continuous improvement was developed conceptually, but has not yet been operationalized.

This pilot phase serves as a bridge between theory and practice. While the model outlines governance principles for CTI exchange, implementing it in real-world settings allows for validation, adaptation, and contextual refinement, which we believe are core aspects of effective knowledge transfer in DYNAMO context. Thus, in the DYNAMO pilot, knowledge transfer is not a passive step but a strategic phase of the research, transforming static governance models into practical, adaptable frameworks through stakeholder engagement, iteration, and hands-on experimentation.

4. Governance Model and its Role in Piloting

In the rapidly evolving landscape of cyber threat intelligence (CTI) exchange, establishing a robust governance model is crucial. This section discusses the theoretical governance model, its guiding role in pilot design, the conceptual CTI exchange governance framework for DYNAMO piloting, and the importance of piloting DYNAMO tools for governance validation.

4.1 Overview of the Theoretical Governance Model

Previous research established a governance model tailored to DYNAMO's CTI exchange needs(Rajamäki et. al. 2025). The governance model is structured around five key pillars:

- **Collaboration & trust** – Establishing formal agreements (NDAs, MOUs) to facilitate secure and confidential CTI exchange.
- **Data sensitivity & standardization** – Utilizing structured formats (STIX/TAXII) and anonymization tools for secure data handling.

- **Compliance & regulatory alignment** – Ensuring adherence to regulations (GDPR, HIPAA, NERC-CIP).
- **Real-time collaboration & response** – Implementing automated threat-sharing mechanisms.
- **Continuous learning & improvement** – Conducting periodic training and refinement based on empirical feedback.

4.2 How Governance Guides Pilot Design

Governance principles shape the pilot framework in several ways:

- **Pilot structure** – Governance defines how and what tools are introduced, who oversees the piloting, compliance, training, and how feedback is integrated, and so on.
- **Stakeholder engagement** – Governance mandates who the stakeholders are involved in pilots and their structured roles.
- **Evaluation metrics** – Governance-driven success criteria are set for measuring compliance, trust-building, and regulatory alignment.

This supports that governance is not just an afterthought but the foundation of pilot design, providing an adaptive framework that aligns with sector-specific requirements. The governance model outlined above provides the foundation for structured pilot implementation. By embedding compliance mechanisms, trust-building structures, and regulatory alignment protocols into the pilot, this framework supports that CTI-sharing policies are effectively tested in a controlled setting.

4.3 Conceptual CTI Exchange Governance Framework for DYNAMO Piloting

Figure 2 illustrates the Conceptual CTI Exchange Governance Framework within the DYNAMO Platform, presenting a hypothetical model of how cyber threat intelligence (CTI) exchange could be structured and governed in a pilot scenario. This conceptual framework supports that governance mechanisms, including data classification, sensitivity control, compliance, and risk management, are embedded into the CTI-sharing process to maintain security, regulatory compliance, and trust among participating critical infrastructure (CI) organizations.

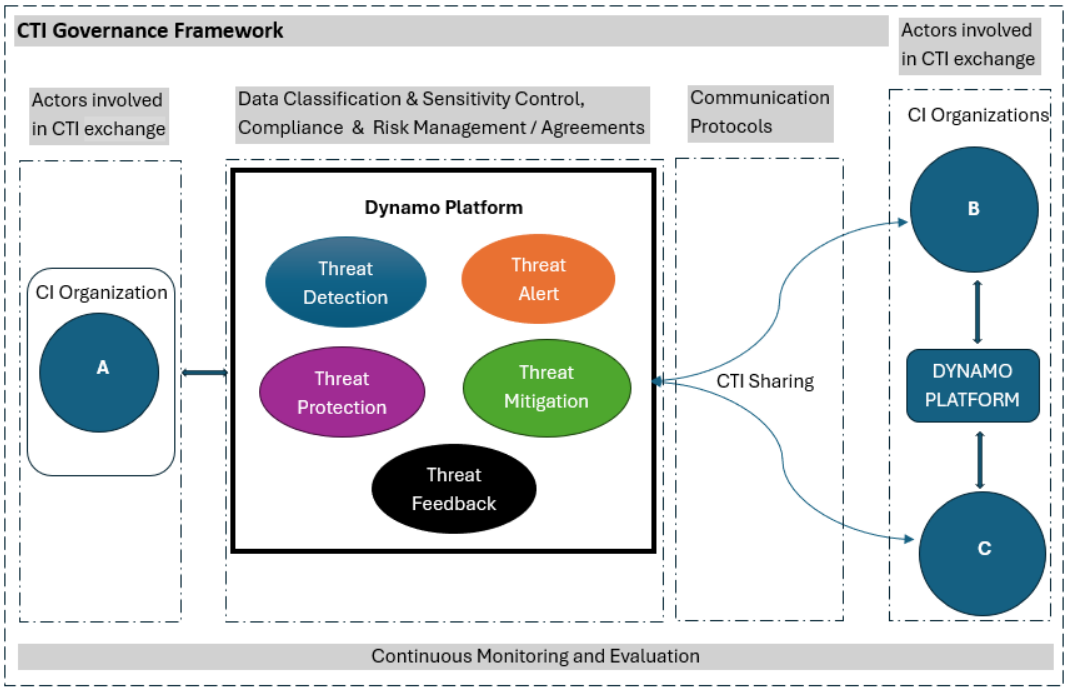


Figure 2: Graphical illustration of CTI sharing governance structure for DYNAMO partners within Single Critical Infrastructure Sector

The components illustrated in Figure 2—Threat Detection, Alert, Protection, Mitigation, and Feedback—represent the core technical functions of the DYNAMO platform. Each of these corresponds to one or more of the five governance pillars (Section 4.1), supporting that CTI-sharing mechanisms are secure, compliant, and adaptable. Furthermore, these components are deployed progressively across the phases of implementation

described in Table 1, for instance, Detection and Alert mechanisms activated during preparation, Protection and Mitigation during execution, and Feedback driving iterative refinement in the final phase.

4.4 Why Piloting DYNAMO tools is key to Governance Validation

DYNAMO tools act as a practical testbed for applying governance principles. This includes:

- Testing governance policies in real-world CTI exchange scenarios.
- Ensuring that DYNAMO's technical capabilities align with governance requirements.
- Validating compliance mechanisms across sectors.

Unlike a standard technical pilot, this pilot measures how well governance models integrate into tool deployment, ensuring that governance-driven insights are applied across industries.

5. Pilot Preparation Strategies and Stakeholder Engagement

This section discusses defining the pilot scope, governance role assignments in the pilot, and stakeholder engagement models. The first subsection explores how the scope of the pilot is defined and delineated. The second subsection focuses on the assignment of governance roles and their importance for the success of the pilot. The third subsection examines stakeholder engagement models and their role in the implementation of the pilot.

5.1 Defining the Pilot Scope

To ensure a comprehensive and effective pilot, it is essential to clearly define the scope, including setting objectives, selecting relevant sectors, and aligning with DYNAMO's capabilities:

- Objective Setting: Define piloting goals and expected outcomes.
- Sector Selection: Justification for piloting in healthcare, energy, and maritime sectors.
- Alignment with DYNAMO Capabilities: How DYNAMO's tools support governance testing.

Table 1 illustrates how the pilot can be conducted in phases.

Table 1: Phased Implementation of the pilot

Phase	Duration	Activities
Preparation Phase	Month xx-xx	Define governance policies, onboard stakeholders, and establish compliance frameworks.
Execution Phase	Month xx-xx	Deploy CTI-sharing governance protocols, monitor compliance, and evaluate interoperability.
Evaluation & Refinement Phase	Month xx-xx	Assess governance adoption, conduct feedback loops, and refine policies based on stakeholder input.

5.2 Governance Role Assignments in Pilot

The Platform Administrator (DYNAMO Central Team) is responsible for technical oversight and platform management, ensuring seamless operation and continuous availability of the platform. Sector-Specific Governance Leads tailor policies to meet the unique requirements of each sector and ensure compliance with relevant regulations. Inter-Organizational Liaison Officers facilitate smooth coordination and communication between different organizations, playing a crucial role in maintaining up-to-date information and seamless collaboration. Compliance and Risk Managers monitor adherence to regulations and report on compliance, ensuring all activities are conducted in accordance with established rules and identifying and managing potential risks. The Monitoring and Evaluation Team collects and analyzes data to refine the governance model, using the gathered information for continuous improvement and enhancement of governance practices. These roles and their responsibilities are summarized in Table 2 and align with the respective phases in Table 1 to ensure a structured implementation.

Table 2: Key pilot roles and responsibilities

Role	**Responsibilities**
Platform Administrator (DYNAMO Central Team)	Technical oversight and platform management.

Role	Responsibilities
Sector-Specific Governance Leads	Tailoring policies per sector and ensuring compliance.
Inter-Organizational Liaison Officers	Ensuring smooth coordination and communication.
Compliance and Risk Managers	Monitoring adherence to regulations and reporting compliance.
Monitoring and Evaluation Team	Collecting and analyzing data for governance refinement.

5.3 Stakeholder Engagement Models

Stakeholder engagement is a critical component for the DYNAMO pilot, to support the fact that governance-driven CTI exchange mechanisms are tested under real-world environment. Effective engagement fosters trust, compliance, and interoperability between public and private sector entities, regulatory bodies, and cybersecurity experts (CISA, 2024). Figure 3 illustrates the Stakeholder Engagement Model, which highlights the essential elements required to establish a structured, inclusive, and collaborative CTI exchange environment. These stakeholder roles are engaged across the phases in Table 1, from preparation to refinement.

The modules shown in Figure 3 mean the following:

- **Identifying Key Stakeholders** – Ensuring participation from sector-specific organizations (Healthcare, Energy, Maritime), regulatory bodies, and cybersecurity experts who will contribute during the pilot and CTI exchange implementation.
- **Building Trust and Collaboration** – Establishing formal agreements (MOUs, NDAs) and fostering Public-Private Partnerships (PPPs) to create a reliable governance environment.
- **Continuous Communication** – Enabling structured feedback loops, communication channels, and reporting mechanisms that support transparency, policy refinement, and stakeholder coordination.

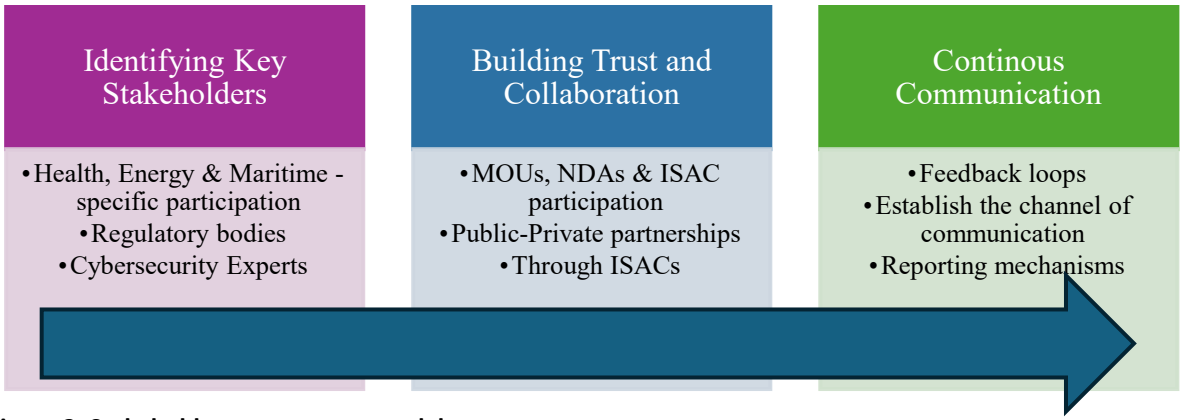


Figure 3: Stakeholder engagement model

Stakeholder engagement within the pilot also facilitates knowledge transfer, ensuring that governance policies are not only tested but also actively refined based on sector-specific insights. By documenting governance interactions, challenges, and best practices, the pilot supports a continuous learning cycle that strengthens governance adoption across different critical infrastructure sectors. This engagement model supports stakeholders actively contribute to governance policy formation, enabling a resilient, well-integrated, and governance-compliant CTI exchange framework.

6. Sector-Specific CTI Governance Adaptations

During the pilot, each critical infrastructure sector requires tailored governance mechanisms to address sector-specific operational challenges, regulatory constraints, and cybersecurity threat landscapes. Effective CTI exchange must accommodate these variations to support the threat intelligence sharing is secure, efficient, and compliant with sector-specific policies. The governance adaptations for each sector reflect the distinct threat environments and organizational structures that impact CTI exchange. Table 3 outlines governance adaptations for key critical infrastructure sectors.

Table 3: Governance adaptations for critical infrastructure sectors

Sector	Key Actors	Threat Vectors	Governance Elements
Energy	SCADA Engineers, IT & OT Security Teams, Regulatory Bodies	SCADA malware, DDoS attacks, phishing campaigns	Compliance such as NERC-CIP , emergency response protocols, SCADA data protection
Healthcare	IT Security Teams, Medical Device Manufacturers, Data Privacy Officers	Ransomware, phishing, medical device vulnerabilities	HIPAA compliance, data anonymization, ISAC partnerships
Maritime	Port Authorities, Coast Guard, Shipping Companies	GPS jamming, AIS spoofing, cyberattacks on navigation	IMO cybersecurity compliance, secure vessel communication, data-sharing agreements

By recognizing these sector-specific needs, the proposed governance-driven pilot ensures that CTI exchange is not a one-size-fits-all approach but a flexible model that can be adapted based on each sector's challenges and requirements. This sectoral governance alignment improves the effectiveness and reliability of cyber threat intelligence sharing, strengthening overall cybersecurity resilience.

7. Evaluation Metrics and Refinement Process

To evaluate the effectiveness of the governance-driven pilot, it is essential to define a set of measurable indicators. These metrics support that governance principles are properly integrated into CTI exchange and allow for continuous refinement of the governance model. Table 4 presents the key evaluation metrics that have been identified.

Table 4: Identified key evaluation metrics

Metric	Example
Governance Adoption Rate	If 8 out of 10 organizations implement CTI-sharing policies, adoption is high.
CTI Sharing Effectiveness	If a simulated threat alert is shared within 3 minutes instead of 5, effectiveness is high.
Regulatory Compliance Score	Full compliance with audit results indicates strong governance adherence.
Incident Coordination Success	If an incident response occurs within the predefined time frame while adhering to governance-defined escalation protocols and data-sharing restrictions, coordination is effective.
Stakeholder Trust Index	If 85% of participants express confidence in CTI sharing procedures, trust is strong.

7.1 Refinement Process

The pilot implementation must be continuously refined based on the evaluation metrics outlined above. A structured feedback loop will be established to capture insights from pilot participants, regulatory bodies, and technical evaluators. The refinement process includes:

- Data Collection and Monitoring – Regular assessment of governance adoption, stakeholder engagement, and technical interoperability.
- Stakeholder Feedback Analysis – Identifying operational challenges, legal concerns, and usability issues in CTI-sharing governance.
- Governance Policy Adjustments – Refining governance mechanisms based on pilot findings, ensuring compliance with regulatory standards and industry best practices.
- Technical Enhancements – Improving automation of CTI-sharing workflows, streamlining compliance enforcement, and enhancing threat intelligence dissemination.
- Final Pilot Assessment – A comprehensive evaluation after the pilot phase to validate governance model effectiveness and identify areas for further improvement before wider implementation.

By systematically applying these evaluation metrics and refining governance models accordingly, the pilot support that CTI exchange remains secure, compliant, and scalable across different sectors.

8. Discussion

As this paper presents a proposed framework rather than an executed pilot, the discussion focuses on the anticipated challenges, expected benefits, and strategic importance of governance-driven CTI exchange implementation. A governance-driven pilot is essential to bridge the gap between theoretical governance models and real-world application. The governance-driven pilot serves as a controlled environment where governance principles can be assessed, refined, and validated before broader implementation. Unlike a traditional technical pilot, this approach ensures that compliance, trust, and collaboration mechanisms are tested in real-world settings to enhance policy effectiveness. By piloting CTI exchange within the DYNAMO project, organizations can better understand how governance mechanisms operate in practice, allowing for incremental refinement. The key advantage of this approach is that it supports compliance with regulatory requirements while fostering trust and interoperability among stakeholders.

However, implementing such a pilot is not without challenges. A major concern is organizational resistance to information sharing, often due to security risks, liability concerns, and a lack of trust in third-party entities. The key challenge would be to bring the organizations to participate in the piloting activities. Additionally, ensuring regulatory compliance across different jurisdictions poses complexities, as data protection laws vary significantly between sectors and regions. Another challenge is technical integration, where participating organizations may have differing levels of CTI-sharing capabilities, leading to interoperability issues.

Despite these obstacles, the proposed framework provides a structured approach to piloting governance principles in CTI exchange. By defining clear stakeholder roles, establishing sector-specific governance adaptations, and setting evaluation metrics, the pilot will allow stakeholders to assess governance adoption in a controlled environment before full-scale implementation. The inclusion of evaluation mechanisms supports that governance effectiveness can be measured, making it possible to refine governance policies iteratively.

Beyond governance validation, the pilot serves as a structured mechanism for knowledge transfer. Lessons learned from CTI-sharing policies, regulatory compliance challenges, and stakeholder collaboration will inform future iterations of governance models. By ensuring that pilot outcomes are systematically documented and shared, this approach enhances the scalability and long-term effectiveness of governance-driven CTI exchange frameworks.

The key outcome of this governance-driven pilot is expected to be an empirically validated framework that enables scalable and secure CTI exchange. Future research will be required to validate this framework in practice, identify any unforeseen challenges, and refine governance mechanisms based on pilot results. Ultimately, this framework serves as a foundation for long-term cybersecurity resilience across critical infrastructure sectors.

9. Conclusion and Future Directions

This paper presents a governance-driven pilot framework for CTI exchange within the DYNAMO project. By aligning governance models with practical tool deployment, the pilot supports compliance, security, and sector-specific adaptation. The proposed framework offers a structured approach to integrating governance principles into CTI exchange, facilitating improved collaboration across industries.

Future work should focus on expanding governance piloting to additional sectors to test scalability. Incorporating AI-driven compliance monitoring to automate governance enforcement is also essential. Additionally, conducting empirical validation through real-world CTI exchange pilot programs will provide valuable insights. Strengthening trust-building mechanisms is crucial to encourage broader participation in CTI sharing.

By ensuring governance remains the foundation of pilot testing, this work lays the groundwork for scalable, secure, and compliant CTI exchange frameworks. The insights gained will help refine governance models, optimize threat intelligence collaboration, and strengthen cyber resilience across multiple industries. As the cybersecurity landscape evolves, continuous refinement of governance principles will be necessary to address emerging challenges and support sustained effectiveness in CTI exchange.

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Ethics declaration: Ethical clearance was not required for the research.

AI declaration: AI models have been used to summarize and extract insights from literature, as well as to correct language and grammar.

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From Human Experts to AI Agents: Agentic AI for Knowledge-Intense Problem-Solving in Logistics?

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Abstract: Logistics planning is a complex and complicated problem solving process requiring a wide range of knowledge and competence. A planning person or team represents a particular set of knowledge, skills, experience and personal attitudes. His, her or their level of competence decides about success or failure of the planning and about the quality of its results. With this, logistics planning is knowledge-based and knowledge-creating. Because of this, Knowledge Management can provide tremendous support to the planning person. Even though, there is a wide variety of (software) tools applicable to solve specific sub-problems throughout the planning process, human expertise is the key to develop creative planning solutions so far. Latest developments with regard to Artificial Intelligence (AI) might change this picture. AI is one of the most promising technological advancements, but also one of the most ambivalently discussed topics these days. It has surpassed humans at a number of tasks already and continues in doing so at new tasks in an increasing rate. Because of this, AI is capable to assist humans in many different ways. The latest boost of development moved AI application from those sophisticated communicators or task-oriented AI to intelligent agents or agentic AI allowing for autonomous, goal-driven decision-making. Hybrid approaches combine those advanced AI capabilities with human oversight, offering context-aware adaptability without full autonomy. In this way, artificial intelligence and human intelligence join forces in teams, for example, to solve complex problems creatively. Against this background, the paper analyses agentic AI with regard to its potential to support creative problem solving in a knowledge-intense field like logistics planning. Will AI agents become co-workers in logistics planning teams or can agentic AI design logistics solutions autonomously? With this, the paper focusses on chances and challenges coming with the highly dynamic evolution of AI within a complex, knowledge-intense application area where human experience, problem-solving capability and creativity is decisive. It contributes to discussions about necessary adjustments in how organizations manage their knowledge considering artificial and human intelligence.

Keywords: AI agents, Agentic AI, Problem-solving, Logistics planning, Knowledge management, Knowledge sharing

1. Introduction

Knowledge Management has been on the agenda of logistic companies since the mid-1990s, but has not realized its full potential in organizational practice yet. Even worse, it lost a lot of its credibility in logistics practice because of the wrong focus. However, knowledge is a strategic resource in logistics, too (Tomé and Neumann, 2014):

- *Whether or not a supply chain operates successfully* does not only depend on the intensity and quality of material and information flows in a supplier-customer relation. As generally recognized, the kind and quality of the collaboration between human resources involved on both sides of the partnership heavily affects the success of a supply chain as well. Knowledge, understanding, and trust form the basis of this collaboration.
- *The number and variety of methods and software tools* available to support logistics planning is permanently increasing. Unfortunately, those tools quite often dominate the planning person and prevent him/her from creative problem solving instead of purposefully giving personalized support.
- *Team building to master complex problems* in logistics planning and operation can be successful only if the team consists of the right mix of knowledge, experience and competence stakeholders, that is adequate to the problem to be solved. Within those well-balanced teams, combined individual strengths overcome a range of individual weaknesses in order to perform jointly better at a higher level.

Consequently, knowledge management can tremendously contribute to improving logistics planning and performance, i.e. problem solving in the logistics context (Neumann, 2003). Throughout the entire problem-solving process as well as in each problem-solving step in the planning, there are bidirectional links between activities for problem solving and knowledge management (see Figure 1). On one hand knowledge available with persons, inside organizations and in the form of technology is (re-)used to solve a particular problem. On the other hand, knowledge about the problem's final solution and the chosen mode of action for its generation characterizes the increased scientific basis and additional experience of the planning person, team or organization. Usually, these links mainly depend on the persons involved in the planning process. It is quite common to make use of own experience, but to benefit from knowledge, experience and lessons learned of

other parts of the organization that is not the usual procedure. To overcome this and to make knowledge of a successful or even unsuccessful planning process available to future planning tasks that is the challenge for knowledge management and its integration into personalized problem solving.

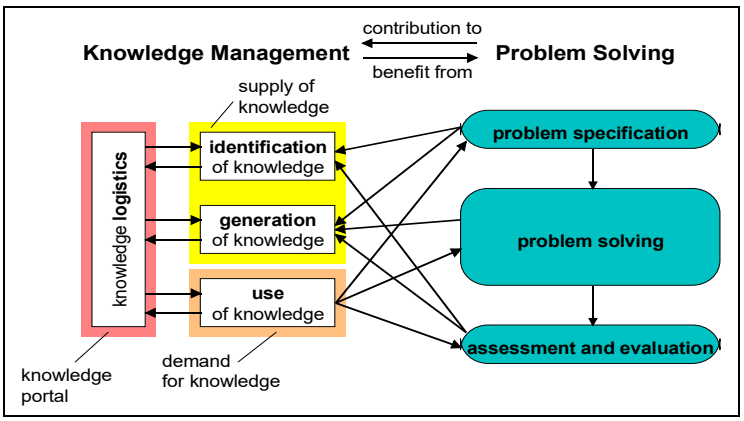


Figure 1: Knowledge management and problem solving in logistics planning

Traditionally, employers gave their planning juniors about three to five years for learning and growing before they became responsible for a planning project. Nowadays and because of increased economic pressure and competition at the market, companies are neither able nor willing to invest this amount of time anymore (Neumann and Masurat, 2016). Instead, they seek for directly recruiting employees with sufficient expertise in project-based professions who are able to take responsibility in complex engineering, design and planning projects more or less immediately. However, this becomes more and more difficult as the number of well-experienced planning experts available at the labour market shrinks. In the end, companies might lose many of their experiences and with this eventually even a part of their competitive advantage due to an ongoing exodus of long-time employees (e.g. because they retire) who cannot hand down their knowledge, networks and skills to any successor. Here, user-friendly designed tools can help to manage, distribute and provide access to knowledge on one hand and to solve problems on the other hand. They take over routine jobs and deal with those problems the planning person had converted into algorithmic tasks beforehand. In addition to this, intelligent systems can work with sub-problems if they had respective knowledge and suitably distributed processes based on a sophisticated human-computer dialogue. The advent of Artificial Intelligence (AI) with generative Artificial Intelligence (genAI) being the preliminary peak leads to even higher expectations towards computer-based planning support using intelligent agents. Following a hybrid approach artificial and human intelligence might join forces in teams to solve complex planning problems creatively.

Against this background, the paper analyses AI agents and agentic AI with regard to their potential to support creative problem solving in a knowledge-intense field like logistics planning. Will AI agents become co-workers in logistics planning teams or can agentic AI design logistics solutions autonomously? When answering this question, the future role of knowledge and experience management in such environment is in focus. The following sections will introduce into agentic AI and its potential in general (Section 2) and analyse problem solving in logistics planning with regard to challenges concerning experience-based knowledge management (Section 3). Findings from both sections are brought together in order to discuss the potential role of AI agents in logistics planning identifying current state-of-development and needs for further action (Section 4). Section 5 summarizes discussions and draws conclusions on both, the use of agentic AI for knowledge-intense problem solving in logistics and the future role of human experts in logistics planning.

2. Agentic Artificial Intelligence

Artificial Intelligence (AI) is one of the most promising technological advancements, but also one of the most ambivalently discussed topics these days. The latter starts with its definition already, as there are two different perspective, a psychological and a computational one. Gignac and Szodorai (2024) elaborated operational definitions of both artificial intelligence and human intelligence (HI). They differentiate artificial from human intelligence just by referencing to an artificial system and computational algorithm instead of a person and his/her perceptual-cognitive processes for completing a novel standardized task. The latter is a task (or test) with limited chances for preparation, as it neither was introduced before nor awareness was risen that this type of questions should be solved. Those kind of standardized tasks are used to evaluate intelligent capabilities, such as vision and language, of systems and humans. This is particularly effective for discrete

tasks, e.g. image classification or answering multiple-choice questions. To benchmark AI its performance is put in competition to HI performance when dealing with the same tasks. The AI index report 2025 (Maslej et al., 2025) uses different benchmarks to monitor technical progress of AI systems over time. Results show that AI systems continuously improve exceeding human performance at many previously challenging tasks already (see Figure 2). However, authors also point on limitations of those benchmarks in areas of AI with, for example, human-AI interaction as variability in human behaviours and the sheer diversity of correct answers provide additional challenges in performance measurement. This need for benchmarks beyond the traditional ones, which were designed to measure human performance, to ensure reliable AI evaluation is another indicator of the rapid progress of AI systems.

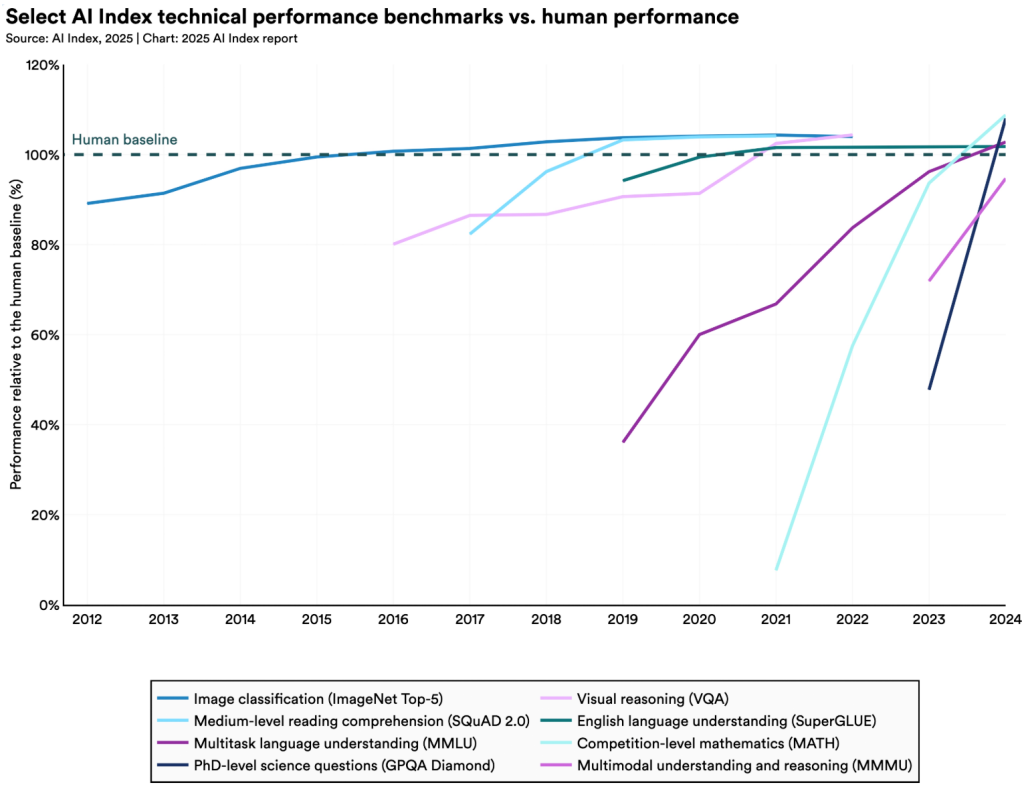


Figure 2: State of AI performance (Maslej et al., 2025, p. 94)

In recent years, *generative AI (genAI)* and open access AI tools like ChatGPT, Gemini, DeepSeek, or CoPilot provided a more common user interface moving the use of AI from an expert's competence to an almost everyday tool. Schneider (2025) characterizes genAI as an AI system based on a foundation model that generates and transforms content based on specific user interactions. In other words, genAI can generate new data similar to the training data it has seen. Generative models learn the underlying probability distribution of the (enormous amount of) training data and can then generate new samples from this learned distribution (Baum, 2024). *Large Language Models (LLMs)* are specific applications of genAI designed to understand human language and to generate intelligent, creative responses similar to human-produced content when queried. Because of the ability of processing natural language, AI is capable already to assist humans in many different ways:

- AI-powered *translation systems* use artificial neural networks to translate texts in various languages at high quality of language.
- GenAI tools create *new content* as text, image or video usually in response to human prompts.
- AI chatbots simulate *human-like conversation* through text or speech interfaces to help in customer service, manage appointments, or support travellers in booking trips.

Those chatbots are *AI agents*, i.e. autonomous single-entity systems enhancing LLMs by perceiving their environment, making decisions, and taking actions to achieve specific goals. They can be seen as *virtual assistants* that can interact with users, systems, or the real world in a task-oriented way (with regard to specific tasks) or in a general-purpose way (capable to deal with a wide range of tasks). The integration of LLMs with retrieval mechanisms enhances their response generation to answer precise questions from large

databases or address customer queries using information from different company documents. This *Retrieval Augmented Generation (RAG)* is another increasingly common capability of AI combining the strengths of information retrieval and genAI (Maslej et al., 2025): The model first retrieves relevant information from databases, files or documents and then combines them to generate a response tailored to the user's query based on retrieved content. Because of using those (relevant) external sources instead of training data purely, responses are more accurate and up-to-date. The latest boost of development moved AI application from those sophisticated communicators or task-oriented AI to agentic AI allowing for autonomous, goal-driven decision-making. With this, AI evolved from prompt-driven content generation (genAI) via tool-based task execution (AI agents) towards orchestration of full-fledged workflows (agentic AI). *Agentic AI* represents a significant advancement over traditional AI agents by incorporating features such as self-learning, real-time adaptability, and multi-agent collaboration (Hosseini and Seilani, 2025). This constitutes a paradigm shift in AI enabling to act independently, pursue broad objectives rather than isolated decisions, and carry out complex tasks that require reasoning elements such as planning and reflection (Sapkota et al., 2025; Schneider, 2025).

An AI system's capability of planning is of particular interest within the context of this paper. Maslej et al. (2025) describe planning as an intelligent task that involves reasoning, i.e. the ability to draw logically valid conclusions from different forms of information, about actions that alter the world. It requires considering hypothetical future states, including potential external actions and other transformative events. Here, human experts still outperform frontier AI models (LLMs) in solving planning problems when given enough time (Maslej et al., 2025): The best AI systems achieve scores four times higher than human experts do in short time horizon settings, e.g. with a two-hour budget. If given an eight-hour budget, human performance slightly exceeds AI already. It achieves a factor of two with a 32-hour budget. To generalize, in certain situations AI agents already demonstrate planning expertise comparable to humans, but they can deliver results significantly faster and at a lower cost. On the other hand, human expertise is still of value from an economic perspective, too, if problems show a certain level of complexity requiring creative approaches to find high-quality solutions.

As in various other disciplines, the potential from applying latest AI advancements is subject to scientific research and practical case studies in logistics and supply chain management, too. Potential application areas are manifold including market research or trend analysis, automating tasks in human resource or customer relationship management, and accelerating basic coding by use of genAI (IBM, 2023). Global sharing of AI-generated intelligence across ecosystems and industries might be of particular relevance for value creation from genAI application. At the same time, increased risks associated with data privacy, data provenance, and data integration must remain in focus; policies and controls must protect the individual and the integrity of the operation.

3. Problem-Solving Processes in Logistics Planning

Logistics planning aims at the planning of logistics processes and systems in general and at both levels the strategic one and the operational one. For this, different procedures are underlying and different methods are used. Planning of logistics processes and systems is a complex and complicated, usually ill-structured problem, since it is subject to a large number of many and diverse influences (Neumann, 2003). This is true not only to the problems to be solved but also to the planning processes for solving those problems. To act purposefully and expediently in this dynamic scenario, specific planning competencies are required. To date, the planning person was and is key problem solver, knowledge holder and knowledge user in the planning process. Hence, his or her level of competence decides about planning success or failure and about the quality of its result. Well-developed planning competencies do not only include the need for detailed declarative knowledge about logistics planning and procedural knowledge about how to do planning in logistics, but also distinctive problem solving competencies and social skills for team working and communication. The planning (i.e. problem-solving) person needs to be able to learn, to be curious and interested in gaining new experience and acquiring additional knowledge. Competence levels reached in this process might range from novice to expert, from amateurs to professionals. The main difference between them is their knowledge and skills base leading to more or less effective and efficient problem-solving strategies (Neumann et al., 2016). Developing a person's problem-solving competence is a longer-lasting process requiring the use of appropriate methods and means, like purposefully using appropriate planning tools, building well-balanced planning teams, or initiating and supporting learning processes in learning-about-planning or learning-by-planning scenarios.

With regard to planning support, there is a permanently increasing number and variety of *methods and tools*. They range from simple deterministic methods for calculation to complex and complicated tools like CAD,

simulation or virtual realities providing the planning person with an enormous functionality to take over routine jobs and – in a certain amount – also to participate in the creative phases of problem solving. Apart from the challenge to choose the appropriate tool for a particular task, the planner often faces the problem to cope with the tools' increasing complexity. This often leads to a kind of "trust in God" when being confronted with the solution produced by the tool: Since knowledge and methods embedded in these tools are often hidden the critical distance to what the tool is doing and what is resulting from this is getting lost. Because of this, experience from using tools are mainly moved into more perfect operational skills, but only seldom contribute to a lasting improvement of generalized planning knowledge. In the end, those tools cannot really be creative; they are of most benefit when being purposefully used by a knowledgeable planning person.

Well-balanced planning teams combine a range of individual strengths to overcome a range of individual weaknesses for better performing at a higher level. As pointed out by Rump (2000) teamwork might be advantageous especially in those situations requiring the effective collection and use of knowledge out of many minds. As many experience show, teams need to form the right mix of capabilities according to the individual planning competencies from the subject matter, social and methodical points of view. They need to unite different personalities, such as doers (the dynamic type who just gets on with things),

- realisers (who aim at putting things into effects),
- presenters (who market and sell ideas, concepts, solutions),
- finishers (who go over work and complete it) or
- combiners (who link persons, opinions, knowledge, ideas etc. from different sources),

representing the appropriate set of knowledge, skills, information, and authority to solve difficult problems quickly and easily. Here, the individual level of knowledge and experience in planning represents just one aspect; another one can be defined as ability to recognise, structure and solve problems as well as assess, evaluate and even implement a problem's solution (see Figure 3). Every new situation requires new team building, because the same team that worked very well in the previous context does not necessarily need to work well again in a future context. The challenge is to identify personalities and individual strengths and weaknesses for an appropriate team building.

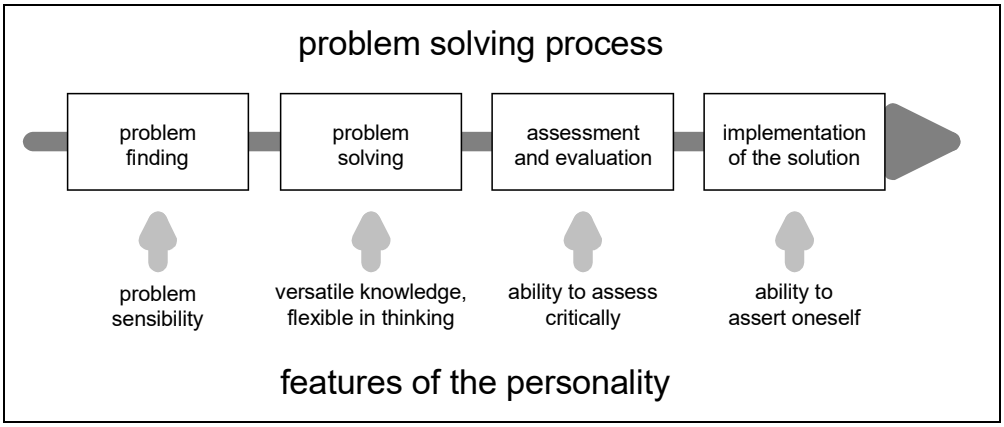


Figure 3: Problem-solving steps and problem-solving personality

4. Agentic AI in Logistics Planning

To integrate AI support into logistics planning it must build upon knowledge-management-based approaches. Against this background, a framework to support logistics planning in a customized, sophisticated way must enable the effective, efficient and purposeful use of the right method in the right problem-solving step. Furthermore, it should provide the respective knowledge specifically required in a particular step within a social environment encouraging creativity. To offer this kind of functionality the framework must contain planning methodical, knowledge-based and software technological components (see Figure 4).

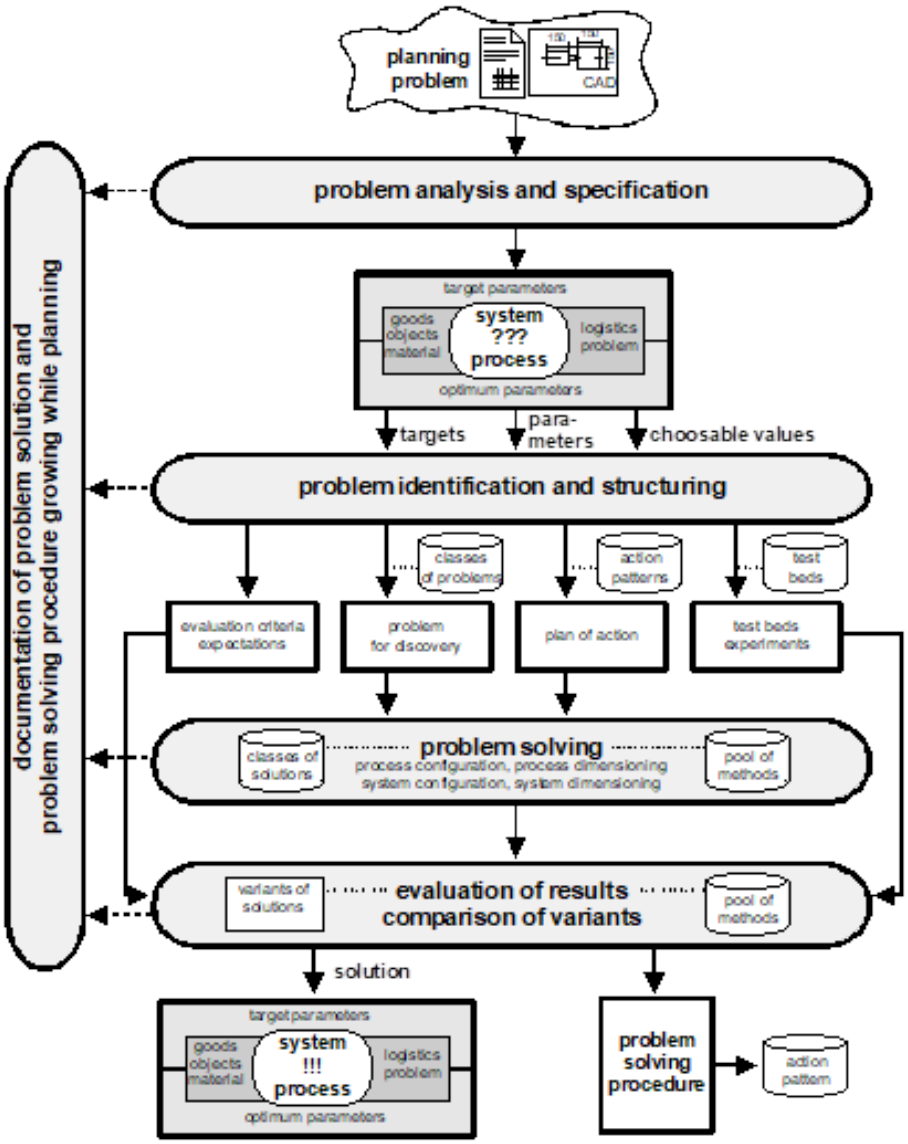


Figure 4: Framework to provide knowledge-based support in logistics planning

Among them, knowledge elements representing logistics as well as planning knowledge are of special importance:

- A *catalogue of principal planning problems and system performance* requirements supports the analysis, specification and classification of the planning problem.
- A *pool of planning solutions* providing classes of alternative variants of logistics systems and processes of varying level of detail and complexity enables the framework to suggest possible, suitable, appropriate solutions taking parameters and conditions into consideration as defined by the planner.
- By use of a *pool of problem solving procedures* of varying level of detail and complexity the framework can recommend tried and tested problem solving strategies of high effectiveness or suitable, applicable planning methods and tools for solving a particular problem situation.
- *Target and optimum parameters and a pool of testbeds* for model-based functional tests enable to evaluate selected, newly developed or modified solutions according to suitability, appropriateness and performance measures.

These knowledge elements result from theoretical and research findings as well as from prior planning experience. They are completed by a set of rules for grouping and classifying planning problems, selecting favourite solutions (i.e. relating problems and solutions) and suggesting modes of action (i.e. relating problems and problem solving procedures). To define these rules major research and development work needs to be

undertaken, since they can hardly be derived from experience and generalization due to missing standards for describing problems and solutions as well as a lack of general problem solving procedures and test beds.

Obviously, identifying existent knowledge, explicating and integrating it into a knowledge base that allows easy access to the right (portion of) knowledge in the right way matching requirements of the current problem or sub-problem to be solved or task to be accomplished, that is the challenge in implementing a knowledge-based approach. Brandt et al. (2001) present of a case-based approach to gain experience-based knowledge on project management in the field of software engineering and make it available for re-use in future projects. For this, all kinds of experiences, e.g. templates of documents, guidelines, observations, problems and their solutions, proposals for improvements and lessons learned, are gathered from interviews with project team members and stored in a central repository, the experience base. As this causes many extra efforts not always seen as beneficial within a planning project with hard time constraints, agentic AI might find a promising application area, here.

Disselkamp et al. (2024) investigated this with regard to factory planning. Similar to logistics planning existing factory planning methods often involve labour-intensive and time-consuming processes that require significant human expertise and manual input at every stage. Because of tis, challenges are comparable. GenAI-supported factory planning is expected to show potential in:

- *streamlining planning processes* by providing integrated and cohesive planning tools that enhance collaboration and ensure that all relevant factors are considered simultaneously;
- *providing dynamic and real-time scenario analysis* allowing planning persons to quickly adjust layouts and workflows to meet evolving needs;
- *being able to explore a vast number of design permutations* and identify optimal configurations that maximize space utilization, minimize material handling costs, and improve overall production efficiency;
- *providing advanced decision-support* by processing and analysing complex data sets, providing actionable insights, and recommending data-driven decisions.

From exploring ChatGPT in various use cases alongside the entire factory planning process, authors conclude on genAI being particularly beneficial for retrieving and providing initial information or suggesting, comparing and recommending workplace locations. In contrast to this, trials to generate ideal (technical) layouts were not successful. With regard to logistics and supply chain management, an IBM Think Circle (IBM 2025) identified a number of use cases despite implementation challenges:

- *Document retrieval and analysis*: Intelligent agents search unstructured data in documents such as product documents, sales documents, contracts and identify what is the best document to choose.
- *Complex data querying*: Code models are used to create SQL queries.
- *Proactive outlier detection*: Intelligent agents look at sets of data, scan them, run and find outliers overnight. They send back results as a morning briefing.

These examples and first use cases underline the potential proper AI integration might have. In logistics planning, AI might enrich the knowledge-based framework assisting the planning expert at different stages.

Bots are the simplest form of AI assistance. These automated systems are typically rule-based and designed to carry out predefined tasks without human intervention. Bots can manage repetitive tasks, answer basic questions, and execute straightforward functions. They follow scripts and rely on if-then-else logic, meaning their responses are limited to the scenarios they have been programmed to handle (Alosious, 2024). Repetitive tasks in logistics planning might be related to calculations, but also to completeness or plausibility checks concerning required input data and information. In terms of chatbots they might guide a planning person through the first stage of the problem solving process which is problem specification. The bot asks questions according to a checklist and formalizes natural language responses by the planning person. In the other way round, chatbots integrated into a planning software tool might provide an intelligent help system. Here, the user can ask the help system for support concerning a specific functionality of the software or a proposal for how to master a certain challenge.

Co-pilots represent a collaborative approach between AI and humans. Acting as assistants, they provide real-time, contextually aware support, allowing users to complete complex tasks more efficiently. Co-pilots excel in roles requiring decision support and act as an “extra set of hands” that brings data-driven insights and recommendations directly into workflows. This way, they enhance human judgment enabling more nuanced

and strategic decision-making (Alosious, 2024). In logistics planning, there is a permanent need for making decisions on next steps and candidate solutions within a phased process of loops aiming to develop variants and versions concerning both the logistics process and the logistics system. There are analysing steps and creative, evaluating steps for synthesis by turns with partially changing cognitive problems and views. Here, logistics planning co-pilots might help in evaluating variants and versions comparatively enabling the planning person to consider more candidate solutions in the same amount of time. For this, the co-pilot can search in and combine scattered documents related to previous projects (i.e. experiences), current problem descriptions, or customer requirements concerning the solution.

Agentic AI enables autonomous decision-making, automates processes, and enhances efficiency though transition from assisted (co-pilot") to autonomous (autopilot) models (Hosseini and Seilani, 2025). Agentic AI systems composed of multiple, specialized agents that coordinate, communicate, and dynamically allocate sub-tasks within a broader workflow to achieve a common goal are comparable to human experts working in teams. Those Agents, i.e. more advanced AI applications with a degree of autonomy and cognitive capability beyond that of a bot, can interpret data, learn from interactions, and make independent decisions within set parameters. They are crucial for tasks that require context-awareness, data analysis, and ongoing adaptability (Alosious, 2024). In logistics planning, agents might coordinate bots fulfilling tasks proposed above, but also work autonomously to identify and structure problems, find suitable process or system configurations from purposefully matching operational steps or materials handling technology, or optimize candidate solutions based on results from model-based simulations to test their functionality and performance. The open question here is how much of the overall planning process can or should be subject to such kind of automation in order not to lose curiosity, care, collaboration, and critical thinking – the crucial elements humans still can (and should) bring in despite of AI implementation. Implementing a hybrid approach with human experts and intelligent agents collaborating in a team enriches the challenge of building well-balanced planning teams by an additional facet.

5. Conclusions

Supply chain technologies proceeded from automation and AI assistants to autonomous AI agents or agentic platforms (IBM 2025): Process automation implies that human intelligence programs a very well-defined logic of actions that happen consequently, one to another. In contrast to this, human intelligence provides an agent with capabilities, but the intelligent agent decides how to fulfil a request and take advantage of these capabilities. Unlike assistants that support human decision-making, intelligent agents can handle complex, multi-step processes autonomously. Logistics planning is such a complex and complicated process requiring a wide range of competencies with all players involved: the individual planning expert, the planning team, the planning organization, and even the organization the planning solution will be implemented in. As discussed in this paper, AI application will not be suitable, purposeful, and valuable everywhere. Because of this, next steps need to focus on identifying and evaluating promising use cases to deploy the transformative potential of these technologies from a human-centred approach, i.e. thoughtful implementation preserving human capabilities and judgement while using technology to address increasingly complex and volatile business environments. Hosseini and Seilani (2025) see agentic AI as basis for shaping a Smart Future. A *Smart Future* refers to an era where AI-driven automation, intelligence augmentation, and autonomous decision-making systems contribute to optimized operations in various industries. By leveraging agentic AI, businesses and governments can enhance efficiency, reduce operational costs, and improve service delivery. However, this transition also raises significant concerns regarding ethical AI deployment, data security, and workforce displacement. Understanding these challenges is crucial for ensuring responsible AI adoption in logistics planning, too. Even though human intelligence still is and continues to be the key problem solver, knowledge holder and knowledge user in logistics planning, particular training is required for planning experts to understand AI and its proper (and improper) use.

Ethics declaration: For this research, ethical clearance is not required.

AI declaration: This paper was created without any use of AI tools.

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Green Status Threatens an Emerging Telework Regime?

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Abstract: The evolution of work regimes has been a central topic of discussion in organizational studies, particularly in the post-pandemic era. Telework, once considered an alternative work model, has become a strategic organizational practice, reshaping business dynamics and leadership approaches. The COVID-19 pandemic and the state of emergency in Portugal accelerated the adoption of telework, transforming it into an emerging work regime. In subsequent years, many organizations recognized its positive impact, integrating telework into their long-term operational strategies. Advancements in digital technologies have demystified telework, enabling employees to perform tasks remotely without compromising organizational efficiency. However, a paradigm shift is underway, with companies reconsidering telework policies, favoring hybrid or fully in-person models. Some researchers argue that this transition reflects organizational control mechanisms, potentially influencing voluntary turnover and employee autonomy. This study aims to examine the correlation between leadership competencies and organizational needs, assessing how telework influences business dynamics and innovation. Using a mixed-methods approach, we conducted research within a Portuguese-Angolan business group, employing critical incident techniques to analyze telework's viability and future implementation. The findings provide valuable insights into leadership adaptation, organizational restructuring, and the sustainability of telework as a long-term strategy

Keywords: Teleworking, Leadership adaptation, Organizational innovation, Digital transformation, Workplace flexibility

1. Introduction

The evolution of work regimes has been a major topic of debate within organizations and academia, especially in the post-pandemic context. The government-mandated telework policy during the state of emergency in Portugal triggered mixed reactions among companies. Many organizations approached this shift with reluctance, lacking full awareness of the necessary adaptations for maintaining operational continuity. However, the forced implementation of this work model proved to be a significant milestone in organizational transformation and the way work is perceived.

ith technological advancements and the increasing digitization of processes, teleworking has moved beyond being a temporary alternative to becoming a structured and viable practice across various businesses. This new reality required deep adjustments in supervisory methodologies, communication strategies, activity coordination, productivity standards, employee well-being, and corporate culture. Additionally, issues such as workplace flexibility, trust in teams, and the redefinition of professional values and habits have become central to organizational discourse.

The analysis of telework's impact on organizational contexts raises fundamental questions about leadership and internal dynamics. The success of this model largely depends on leaders' ability to adapt strategies to the new reality, ensuring balance between employee needs and corporate objectives. Thus, this study aims to explore the correlation between leadership competencies and organizational needs, investigating how they influence business dynamics within the telework framework.

o achieve these objectives, a case study was developed within a company operating in Portugal and Angola, employing a mixed research paradigm and the critical incident technique for data collection. The findings of this study will allow for a deep reflection on the viability and sustainability of teleworking, analyzing whether the recent trend toward a return to in-person or hybrid work models represents a setback or an adaptive evolution in organizational management.

2. Literature Review

Olson (1983) describes teleworking as the computerization of the office, thus introducing the concept of remote work, carried out beyond traditional time and space constraints, supported by technological advancements. Over the decades, teleworking has evolved from a niche practice to a mainstream organizational strategy, particularly accelerated by the COVID-19 pandemic.

The adoption of a teleworking regime requires organizations to restructure methodologies, communication channels, and coordination mechanisms. This transformation often necessitates a flattening of hierarchical structures, fostering autonomous work teams with delegated authority, thereby enhancing information flow and decision-making efficiency (Nunes, 2021). Additionally, telework demands a shift in leadership approaches, emphasizing digital communication skills, emotional intelligence, and adaptability (Bravo-Duarte et al., 2025).

Leadership plays a crucial role in the success of teleworking environments. Pontes (2008) highlights that leaders act as change agents, motivating teams to achieve organizational goals, which directly impacts company performance. In remote settings, leadership must transition from traditional oversight to a results-oriented approach, where employee accountability and trust become central pillars (Bonome, 2008). Recent studies reinforce this perspective, identifying transformational leadership, participative leadership, and supervisor support as key factors in maintaining employee engagement and well-being in telework settings (Boccoli et al., 2024).

Furthermore, e-leadership competencies have emerged as essential for managing remote teams effectively. These competencies include digital communication proficiency, goal management, and work-life facilitation, all of which contribute to reducing virtual distance and fostering a positive telework experience (Alkhayyal & Bajaba, 2023). Leaders who exhibit high emotional intelligence and adaptability can better support employees, ensuring productivity and job satisfaction in remote work environments.

The paradigm shifts in telework leadership underscores the need for continuous adaptation and innovation. Organizations must invest in leadership development programs that enhance digital skills, trust-building strategies, and effective remote collaboration techniques to sustain long-term telework success.

3. Methodology

The research follows the premise that teleworking significantly impacts employment relationships, shaping how participants perceive themselves as actors and promoters of organizational innovation. Given the increasing relevance of this topic, we designed a case study to explore participants' perceptions of teleworking, its influence on business dynamics, and managerial behaviors in this evolving reality. The central research question guiding this study is: “How does the use of teleworking influence organizational dynamics and leadership capabilities, with a view to innovation?”

To address this question, we adopted a mixed-methods approach, which allows for a comprehensive understanding of processes and phenomena implicit in telework research. This methodological choice aligns with previous studies (Pacheco et al., 2024; Simões et al., 2012), which highlight the advantages of case studies in capturing the complexities of telework, particularly in pandemic and post-pandemic contexts.

3.1 Research Design and Data Collection

The study was conducted within a Portuguese-Angolan business group operating in the food retail sector, employing over 1,000 professionals. Data collection was structured across three distinct phases, each targeting different participant groups at different moments:

Phase 1: Focused on identifying technical limitations, communication challenges, and adaptation strategies in teleworking. A closed-ended online survey was administered to employees of Angolan nationality to assess their experiences.

Phase 2: Examined functional changes resulting from telework implementation. A mixed online survey (closed and open-ended questions) was distributed to Portuguese employees to capture their perspectives on organizational shifts.

Phase 3: Investigated past, present, and future perceptions of teleworking from a leadership standpoint. A semi-structured interview was conducted with senior management to analyze leadership strategies and organizational needs.

3.2 Data Analysis Approach

To ensure robust analytical insights, we employed a three-tiered data analysis strategy:

Descriptive Statistics – Used to quantify survey responses and identify trends.

Content Analysis – Applied to open-ended survey responses and interview transcripts to extract thematic patterns.

Comparative Analysis – Cross-referenced findings from different participant groups to establish correlations between telework, leadership, and organizational innovation.

Recent studies emphasize the importance of digital leadership competencies in telework environments, including adaptive communication, trust-building, and technological proficiency (Stoian et al., 2022; Yorulmaz et al., 20232). Additionally, bibliometric analyses suggest that telework governance remains an underexplored area, requiring further research into its long-term strategic implications (Kurland, 2002).

By integrating quantitative and qualitative methodologies, this study aims to provide a holistic understanding of teleworks impact on organizational dynamics, offering insights that contribute to future leadership strategies and innovation frameworks.

4. Analysis and Discussion of Results

The study was conducted within a Luso-Angolan business group, where daily cross-border information exchanges are integral to operations. To ensure a comprehensive analysis, the study was presented—without obligation—to all employees holding managerial positions in Angola, whose communications with Portugal were frequent, as well as to Portuguese employees and senior management. This approach resulted in a sample of 110 employees, providing a diverse perspective on teleworking dynamics.

4.1 Teleworking in Dialog between Portugal and Angola

The first phase of the study focused on Angolan managers who regularly interact with Portuguese employees. Their initial reaction to the study revealed surprise at the formalization of teleworking in Portugal, as they had not perceived significant operational changes within the organization.

Despite being familiar with the concept of teleworking, most Angolan managers were unaware of its formal adoption within the company, as process execution remained unchanged, and there was no perceived negative impact on workflow efficiency. This suggests that teleworking, in this context, did not introduce significant operational disruptions, reinforcing findings from previous studies that highlight the adaptability of telework models in cross-border business environments.

4.2 Integration or Disaggregation Changes

The second phase of the study examined Portuguese employees, both those working in Portugal and those stationed in Angola. Their responses indicated that teleworking had a minimal impact on their ability to perform work tasks. The primary challenge cited was communication difficulties due to physical separation from colleagues, yet they also noted greater availability for addressing issues outside of standard office hours.

Interestingly, employees reported higher productivity levels, attributing this to the ability to minimize workplace distractions and focus on tasks without frequent interruptions. This aligns with research suggesting that teleworking enhances concentration and efficiency, particularly when employees have autonomy over their work schedules. Overall, Portuguese employees viewed teleworking as more beneficial than detrimental, reinforcing its positive impact on work performance.

4.3 Perception of Change in the Context of Teleworking

The third phase involved senior managers, who were asked to reflect on teleworking's impact on organizational dynamics, innovation, and productivity. Their responses revealed a mixed perspective:

Productivity Gains: CEOs acknowledged that employees produced more in less time, validating teleworking efficiency.

Challenges in Implementation: Some employees misinterpreted teleworking as a form of extended leave, highlighting the need for clear organizational policies to maintain accountability.

Future Outlook: While CEOs now recognize teleworking as a valid work model, they still favor physical presence, viewing telework as an experiment rather than a long-term strategy.

This perspective reflects traditional leadership models, where physical oversight remains a key factor in managerial decision-making. Despite teleworking's proven benefits, leadership preferences for direct supervision may hinder its widespread adoption.

5. Conclusion

The findings of this study underscore the transformative potential of teleworking, particularly in organizations that traditionally rely on physical presence for supervision and control. While teleworking has demonstrated clear advantages, including increased productivity, enhanced flexibility, and improved work-life balance, its adoption remains limited in Portugal due to deep-rooted managerial practices that prioritize direct oversight.

The COVID-19 pandemic served as a catalyst for telework experimentation, forcing organizations to reassess their operational models. However, despite the positive outcomes, many companies still perceive teleworking as a temporary or alternative arrangement, rather than a long-term strategic shift. This reluctance stems from classical leadership structures, where decision-making is centralized, and physical control over employees is deemed essential.

Our research highlights that leadership adaptation is critical for teleworking to be fully integrated into organizational frameworks. The transition from traditional hierarchical leadership to liberal leadership models, which emphasize autonomy, trust, and results-driven performance, is key to overcoming resistance. Additionally, the implementation of agile methodologies, such as daily check-ins and structured review processes, can help bridge communication gaps and maintain accountability in remote work environments.

The study also reinforces the importance of innovation in shaping future work models. Organizations that embrace teleworking as a strategic tool rather than a temporary necessity can enhance their competitive edge, foster employee satisfaction, and drive long-term organizational success. However, this requires a fundamental shift in leadership mindsets, moving away from control-based supervision toward trust-based collaboration.

Ultimately, the research confirms that teleworking has the potential to redefine organizational dynamics and leadership capabilities, paving the way for more adaptive, innovative, and resilient workplaces. As businesses continue to navigate post-pandemic realities, those that embrace telework strategically will be better positioned to thrive in an increasingly digital and globalized economy.

This study provides valuable insights into the challenges and opportunities of teleworking, offering a foundation for future research on leadership evolution, digital work environments, and organizational innovation. The findings suggest that teleworking is not merely an experiment but a viable, sustainable work model—if organizations are willing to adapt and evolve.

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Assessing Digital Intelligence: Validation and Insights from a Law Enforcement Pilot Survey

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Abstract: Digital transformation is integral to optimising business processes, driving greater efficiency and productivity. However, the success relies on effective knowledge management, which ensures that organisational knowledge is harnessed and applied throughout the transformation journey. Digital transformation fundamentally reshapes how organisations operate, demanding not only new technological tools but also new competences, attitudes, and a flexible working environment. As organisations adopt digital technologies, they must develop and manage digital competencies across. Knowledge management systems become essential for capturing, sharing, and updating this rapidly evolving knowledge base, ensuring that workforces can access the latest digital innovations. Digital intelligence is a comprehensive concept that encompasses digital competence— confident and responsible use of digital technologies—and a positive digital attitude, which influences how individuals engage with these technologies. These elements form a holistic understanding of digital intelligence, enabling individuals to effectively navigate and contribute to the digital landscape. An eight-dimensional model served as the measurement tool in our Digital Intelligence pilot study. The initial quantitative phase of scale validation centered on one of the Hungarian Law Enforcement Organisation, facilitating subsequent measurements on the same cohort. In 2024, the online pilot survey was conducted using the LimeSurvey system. The questionnaire is completed by employees of the chosen Hungarian Law Enforcement Organisation in Hungary (n=180). The aim of the research is to evaluate the level of Digital Intelligence within the participants by establishing a comprehensive assessment framework, and analysing the differences in Digital Intelligence across various groups based upon individual characteristics. Each dimension was evaluated using nine statements (3 attitudes, 3 skills, 3 knowledge), assessed across three levels (basic, advanced, and expert). Correlation analysis indicated a strong relationship between the model components, suggesting the instrument's ability to measure digital intelligence as a cohesive and multifaceted construct. Among the target group, age showed no correlation with digital intelligence. Paired t-tests revealed the largest discrepancies in digital dialogue (interacting with others in the digital space) and digital literacy (evaluating, synthesising, and adapting information in the digital space). The scoring mechanism indicated that at least half of the respondents scored in the advanced category across all eight dimensions.

Keywords: Digital attitude, Digital competence, Digital intelligence, Digital transformation, Knowledge management

1. Introduction

The rapid development of digital technologies has fundamentally transformed the way people learn, work and interact in society and in workplaces. Navigating in this complex environment requires not only technological skills, but also the integration of digital competence and a constructive digital attitude. These interlinked concepts are increasingly seen as essential for personal, educational and professional success in the digital age. Achieving and maintaining a competitive edge is increasingly linked to the adoption of digital technologies and the rise of Knowledge Management Systems (KMS) within organisations (Sivathanu and Pillai, 2018). These systems and technologies facilitate KM processes by enabling the codification and sharing of knowledge, establishing organisational knowledge directories, and building both internal and external knowledge networks (Alavi and Leidner, 2001; Savickas and Užienė, 2024). The ability to effectively create, store, and share knowledge is now a key predictor of organisational success. Digital technologies are transforming how knowledge is gathered, stored, and transferred (Ediz, 2018). This shift is altering the roles of human workers, redefining qualification requirements, and fostering new forms of collaboration. Advanced knowledge management (KM) functionalities—such as instant access to information and seamless knowledge sharing among employees through digital platforms — are inevitable (Obermayer et al., 2022). As a result, knowledge management is poised to become a crucial factor in ensuring organisational sustainability (Bratianu et al., 2020). By strategically combining knowledge management with digital technologies, businesses can accelerate their digital transformation (DT), drive innovation, and build a sustainable competitive edge in the digital age. However, the mere implementation of digital technologies is insufficient; their effective utilisation cannot be achieved without an adequate level of digital competencies, which may limit the potential for economic growth (Yoo et al., 2018). Another important factor is digital attitude, which refers to individuals' disposition towards digital technologies.

A Hungarian study has highlighted that employee attitudes represent one of the most significant barriers to DT as people often perceive digitalisation and automation as threats. They fear that machines will take over their jobs, which leads to resistance (Obermayer et al., 2022). This may be due to the fact that employees do not have sufficient and adequate knowledge about digital technologies. Machines relieve human workers by taking over monotonous, repetitive, and exhausting tasks, while people perform the value-creating, challenging, and creative activities. Therefore, it becomes necessary to retrain and up-skill the workforce and to develop digital competencies so that individuals can effectively utilise the opportunities provided by technology (Hungarian Central Statistical Office, 2020; Obermayer, 2020). Therefore, for successful DT a holistic view of digital intelligence (DQ) towards digital technologies is essential.

2. Theoretical Background

2.1 Digital Transformation and Knowledge Management

Organisations are re-evaluating their strategic plans to ensure they are prepared and agile in response to changes in business processes through digital technologies (Verhoef et al., 2019) and developing entirely new, innovative approaches (Khilji et al., 2024). They believe that this approach is essential to successfully protect DT initiatives, which are shaped by knowledge management (KM), and to maintain a competitive edge in the market (Lehmann et al., 2022). It is also crucial for organisations to have digitally-skilled and well-trained staff who can effectively manage change and drive innovation, thereby maximising opportunities and minimising risks with greater agility for growth and expansion (AlNuaimi et al., 2022). According to research by Verhoef et al. (2019), organisations undergo DT through three distinct progressive phases, each building upon the previous one to create increasingly sophisticated digital capabilities. The initial stage - digitisation - involves converting analog information and traditional paper-based systems into digital formats (Tekic and Koroteev, 2019), the second stage - digitalisation - encompasses a broader integration of digital technologies throughout business processes and the final phase - DT - represents the most comprehensive and impactful digital change involving fundamental business model innovation enabled by extensive digital capabilities (Verhoef et al., 2019).

According to Nguyen et al (2019), the adoption of digital technologies offers many opportunities, but in many cases the process is challenging and risky for organisations, whether it is "just" the digitisation of simple business processes or a complete DT, i.e. the development of a new business model. DT is significantly shaped by KM and strongly driven by digital technologies. High DQ is essential for employees in KM processes because it enables them to effectively use digital tools and platforms that are fundamental for capturing, sharing, storing and utilising organisational knowledge (García-Holgado et al., 2015). Workforces with strong digital competence can quickly access and manage large volumes of information, collaborate efficiently across digital channels, and contribute to centralised knowledge bases, which are all critical for organisational learning and innovation. It is crucial for organisations to assess and measure their employees' digital skills to quickly identify any gaps and address them through targeted development programs. This proactive approach ensures the workforce remains adaptable and competitive in a rapidly changing digital environment, supporting both organisational growth and effective knowledge management. Workforces who lack digital competence can limit an organisation’s ability to capture, share, and use knowledge, ultimately threatening its productivity, innovation, and long-term success (Zheng, 2024).

2.2 Digital Intelligence

This digitalised, modern world requires new skills and attitudes not only at organisational level but also at individual level. On the one hand, there are difficulties with workers' digital competences, which include the use of digital technologies, understanding the opportunities and threats generated by the internet and communicating through online media; on the other hand, there are challenges related to the responsible use of available information and interactive media, and to the interaction with smart technologies, which can be linked to workers' behaviour and digital attitudes. In the era of digitalisation, the availability of information and communication technologies (ICTs) has increased exponentially, and their use requires a critical attitude towards the responsible use of available information and interactive media. DQ is a complex concept, defined by the DQ Institute (2019, p. 12): "Digital Intelligence is a comprehensive set of technical, cognitive, meta-cognitive and socio-emotional competencies grounded in universal moral values that enable individuals to face the challenges of digital life and adapt to its demands. Thus, individuals equipped with DQ become wise, competent and future-ready digital citizens who successfully use, control and create technology to enhance humanity."

DQ Institute (2019) identified 25 different digital literacy, skills and readiness frameworks from the public and organisational sectors, and based on these, developed the DQ Framework. The DQ Framework includes 8

dimensions that cover all aspects of individuals' digital personal and professional lives, and defines 3 levels of maturity. Thus, the model essentially outlines 8×3, that is, 24 competencies, each of which can be further broken down into knowledge, skills and attitudes. This framework has since become one of the most recognised models and has been acknowledged by two major international actors in the fields of research, knowledge dissemination, and standardisation: the Organisation for Economic Co-operation and Development (OECD) and the Institute of Electrical and Electronics Engineers (IEEE). The DQ Institute framework forms the basis of the most DQ measures, and these scales are designed primarily for workforces (Li et al., 2024). Na-Nan et al. (2019) developed a DQ scale for Thai SME employees, while Kulworatit et al. (2021) created an Internet Risk Assessment Scale. Subsequent researchers have applied and adapted the DQ framework in various contexts, including Saputra's (2023) examination of leadership agility, Marnewick and Marnewick (2021) identification of important DQ competencies for South African program managers.

The study presented in the following sections is also based on this framework and represents a pilot survey with a selection of a specific target group.

3. Research Framework

The aim of the research is to measure the DQ of the Hungarian law enforcement organisation using our own - protected by a trade mark - measurement scale based on the framework developed by the DQ Institute. The study aimed to answer the following research questions:

RQ1: *How can the level of DQ among law enforcement personnel be assessed based on the eight-dimensional model?*

RQ2: *To what extent are the dimensions of the DQ measurement tool in strong correlation with each other?*

RQ3: *Are there significant differences between the individual dimensions of DQ?*

3.1 Measurement Scale

Based on the previously described DQ framework, the Digital Intelligence Profile (DIP) has been developed. It defines 8 dimensions (digital personality, digital harmony, digital risk, digital protection, digital emotional intelligence, digital dialogue, digital literacy, digital rights), each assessed at 3 levels (basic, advanced, and expert), built upon the triad of knowledge, skills, and attitudes. In total, the 24 areas of competence are evaluated using 72 statements (8×3×3). Participants are asked to rate each statement on a 6-point Likert scale, indicating how accurately each statement describes them.

3.2 Data cCllection - Quantitative

The empirical research was based on primary data collected through an online questionnaire administered in August 2024 via the LimeSurvey survey platform. One of the main advantages of this system is its open-source nature, which allows for high variability in survey design and question formats. Respondents completed the questionnaire anonymously. The average response time was approximately 15–20 minutes, as participants were asked to evaluate 72 statements related to DQ. The data collection was conducted within the framework of a national social innovation project, which enabled collaboration with a Hungarian law enforcement organisation. As a result, the target group of the study consisted of law enforcement officers. The selection of this institutional partner provided an additional advantage: participants can be easily reached again in future phases of scale validation, due to a formal cooperation agreement established between the researchers and the organisation. The sampling technique can be classified as non-probability purposive sampling, as the respondents were intentionally selected from a specific occupational group within the public sector to meet the research objectives. The questionnaire was distributed by sending a unique survey link directly to the participating organisation, and employees voluntarily completed the survey based on this invitation.

The analysis was based on the DQ Framework developed by the DQ Institute, which provides a structured model for comprehensively evaluating digital knowledge, skills, and attitudes across eight dimensions. In the first phase of the study, aggregated indices were constructed for each of the eight dimensions, enabling the DQ level of the examined law enforcement organisation to be quantified and compared across dimensions. Subsequent research questions focused on assessing the validity of the measurement tool. The aim was to examine the extent to which the model functions as a coherent system, including the degree of correlation between its various dimensions and the potential presence of redundancy or overlap. Relationships between the dimensions were analysed using Pearson's linear correlation, while differences between dimensions were assessed through two-sample t-tests. The use of these statistical methods was justified by the high level of measurement of the

variables involved. As the aggregated indices were constructed on interval scales, it was methodologically appropriate to compute means and examine differences between them. Furthermore, Pearson's correlation requires metric-level variables, a condition that was met in this case, thus ensuring the validity of the applied statistical procedures. These analytical approaches provide a basis for evaluating whether the future consolidation of certain dimensions is warranted, or whether refinement of the measurement tool is needed to more accurately reflect the complex structure of DQ.

4. Results

A total of 182 individuals participated in the survey, of which 180 responses were considered valid (n=180). The vast majority of respondents were engaged in intellectual (white-collar) work (81.1%), while only 1.1% were performing manual (blue-collar) tasks. Mixed types of work were reported by 17.8% of the participants. All respondents were employed in subordinate positions, with no external or freelance workers included in the sample. In terms of organisational hierarchy, 21.9% held leadership positions, while 78.1% were non-managerial staff. The gender distribution was nearly balanced: 49.4% of respondents were male, and 50.6% were female.

The age distribution covered a wide range, with the youngest participant being 21 years old and the oldest 64. The median age of the sample was approximately 45 years, with the majority of responses concentrated between the ages of 40 and 57. Regarding place of residence, most respondents lived in small towns (32.8%) or medium-sized towns (38.9%). A smaller proportion resided in villages (15.6%) or communes (10.0%), while only 2.8% lived in large cities. This pattern may reflect the geographic coverage or service area of the law enforcement organisation involved. Based on self-reported net monthly income, there was substantial variation. The lowest declared income was approximately €370, and the highest reached around €2,080. The most frequently reported income range fell between €1,300 and €1,560. However, income data were not provided by 42.3% of the respondents, which may be attributed to the sensitive nature of the question.

4.1 Descriptive Statistics

To answer the first research question, the study applied an index-based approach. Each of the eight dimensions of DIP was measured across three levels (basic, advanced, and expert) through three statements per level: one targeting attitude, one skill, and one knowledge. These items were rated on a six-point Likert scale. As a result, the maximum achievable score per level was 18 points, and each dimension had a maximum total score of 54 points. The analysis relied on the calculation of mean values to express the general level of DQ and highlight differences between dimensions (Table 1.).

Table 1: Mean values of DQ dimensions. Source: Own editing

Level / Dimension	Personality	Harmony	Risk	Protection	Emotional	Dialogue	Literacy	Rights
Basic	15,070	14,227	12,0121	13,812	13,899	16,349	13,821	15,458
Advanced	12,6608	12,293	13,445	11,122	14,416	12,527	8,465	12,722
Expert	11,005	10,131	13,066	10,131	13,161	13,041	8,136	10,013
Dimension means	38,736	36,651	38,523	35,065	41,476	41,917	30,422	38,193

The aggregated results clearly demonstrate a descending trend across levels: in all dimensions, average scores were highest at the basic level, lower at the advanced level, and lowest at the expert level. This pattern indicates that the instrument functions appropriately, as it differentiates clearly between degrees of proficiency, with participants scoring higher on foundational digital competences and lower on complex or expert-level digital behaviours. Such a structure supports the internal coherence and gradation capacity of the measurement tool.

In terms of dimensional performance, the highest average basic-level scores were observed in dialogue (16.35), rights (15.46), and personality (15.07), suggesting that participants feel most confident when engaging in digital dialogue, understanding digital rights, and managing their online personality. Emotional intelligence (13.90) also scored relatively high at the basic level, reflecting strong self-reported ability in emotional regulation and empathy in digital interactions. At the advanced level, the highest scores were recorded in emotional intelligence (14.42), risk (13.45), and personality (12.66), indicating a moderate extension of these competences beyond

basic tasks. In contrast, dimensions like literacy (8.47) and dialogue (12.53) showed more modest average scores at this level, suggesting lower self-confidence or less routine use of these skills in more complex contexts.

At the expert level, all dimensions show a marked decline in mean values. Risk (13.07) and emotional intelligence (13.16) remain relatively strong, possibly due to accumulated professional experience, while literacy (8.14) and rights (10.01) register the lowest averages, which may point to knowledge gaps or less familiarity with these specific digital domains at a strategic or expert level. Considering the dimension-level averages (combined across the three levels), dialogue achieved the highest mean score (41.92 out of 54), followed by emotional intelligence (41.48) and personality (38.74). These results highlight the relative strength of interpersonal and self-regulatory competences within the target group. Meanwhile, digital literacy (30.42) and protection (35.07) emerged as the lowest scoring areas, identifying key domains where further training and capacity development would be most beneficial.

Overall, the findings reflect a digitally active but unevenly prepared workforce. Participants demonstrate strong engagement and confidence in relational and emotional aspects of digital life, but more advanced cognitive and protective digital competences remain underdeveloped. This suggests a need for targeted interventions aimed at strengthening digital literacy, protection, and strategic awareness.

4.2 Relationship Analyses

The second and third research questions serve to support the validation of the questionnaire, focusing on the construct validity of the measurement instrument. As a first step, internal consistency was examined using the Cronbach's alpha coefficient, which indicates the extent to which the items within a given scale measure the same underlying construction (Tavakol and Dennick, 2011). The results show that Cronbach's alpha values across the eight dimensions ranged between 0.800 and 0.885, which, according to conventional interpretation guidelines, can be considered very good. These values suggest that the items within each dimension form a coherent and internally consistent scale, thus providing a reliable foundation for further statistical analyses. The strength of these coefficients reinforces the appropriateness of the measurement tool for capturing the components of DQ in a valid manner.

In the next step of the validation process, a Pearson correlation analysis was conducted to explore the relationships between the eight dimensions of the DIP model. Table 2 presents the results of this analysis, highlighting the pairwise linear correlations between all constructs.

Table 2: Correlation analysis on dimensions of DQ. Source: Own editing

	Personality	Harmony	Risk	Protection	Emotional	Dialogue	Literacy	Rights
Personality		0,687	0,577	0,514	0,592	0,615	0,615	0,603
Harmony	0,687		0,706	0,575	0,485	0,516	0,58	0,587
Risk	0,654	0,706		0,67	0,611	0,639	0,707	0,749
Protection	0,577	0,575	0,67		0,611	0,639	0,707	0,749
Emotional	0,514	0,485	0,611	0,369		0,683	0,403	0,595
Dialogue	0,592	0,516	0,639	0,556	0,683		0,548	0,641
Literacy	0,615	0,58	0,707	0,794	0,403	0,548		0,715
Rights	0,603	0,587	0,749	0,667	0,595	0,641	0,715	

The correlation coefficients (r) range between 0.514 and 0.749, indicating consistently moderate to strong positive associations across all dimension pairs. Importantly, all correlation values were statistically significant at the $p < 0.05$ level, confirming that the observed relationships are unlikely to have occurred by chance. The strongest correlations were found between Risk and Rights ($r = 0.749$), Risk and Literacy ($r = 0.707$), and Protection and Literacy ($r = 0.707$), suggesting that these constructs tend to be perceived and developed

together. The lowest correlation was observed between Emotional Intelligence and Harmony (r = 0.485), which, while still acceptable, may reflect a relatively weaker conceptual connection. Overall, the correlation analysis revealed that the model components are strongly interrelated yet do not exhibit excessively high interdependence. The fact that no correlation exceeds 0.75 helps to rule out construct redundancy, while the consistent strength of associations across all pairs reinforces the interpretation that the scale captures a single, complex construct—DQ. These findings support the structural validity of the model and the coherence of the underlying measurement framework.

To address the third research question, the study investigated whether there are statistically significant differences between the aggregated scores of the various dimensions of DQ. Since each respondent received a score for all eight dimensions, paired sample t-tests were applied to compare the mean values within subjects. The purpose of the analysis was to determine whether the observed mean differences between dimensions are statistically significant across the sample. The results are summarized in Table 3.

Table 3: Results of the paired t-test along the dimensions of DQ. Source: Own editing

	Personality	**Harmony**	**Risk**	**Protection**	**Emotional**	**Dialogue**	**Literacy**	**Rights**
Personality		t=4,147 p<0,05	t=0,432 p>0.05	t=6,7 p<0,05	t= -3,836 p<0,05	t=-5,072 p<0,05	t=12,662 p<0,05	t=1,009 p>0,05
Harmony	t=4,147 p<0,05		t= -3,342 p<0,05	t= 3,513 p<0,05	t= -7,026 p<0,05	t= -8,317 p<0,05	t=9,520 p<0,05	t= -2,176 p<0,05
Risk	t=0,432 p>0.05	t= -3,342 p<0,05		t=7,053 p <0,05	t= -3,836 p<0,05	t= -4,960 p<0,05	t=14,448 p<0,05	t= 1,570 p>0,05
Protection	t=6,7 p<0,05	t= 3,513 p<0,05	t=7,053 p <0,05		t= -8,384 p<0,05	t= -10,810 p<0,05	t=8,079 p<0,05	t= -5,744 p<0,05
Emotional	t= -3,836 p<0,05	t= -7,026 p<0,05	t= -3,836 p<0,05	t= -8,384 p<0,05		t= -0,610 p>0,05	t=13,615 p<0,05	t=5,197 p<0,05
Dialogue	t=-5,072 p<0,05	t= -8,317 p<0,05	t= -4,960 p<0,05	t= -10,810 p<0,05	t= -0,610 p>0,05		t=16,282 p<0,05	t=6,256 p<0,05
Literacy	t=12,662 p<0,05	t=9,520 p<0,05	t=14,448 p<0,05	t=8,079 p<0,05	t=13,615 p<0,05	t=16,282 p<0,05		t=12,846 <0,05
Rights	t=1,009 p>0,05	t= -2,176 p<0,05	t= 1,570 p>0,05	t= -5,744 p<0,05	t=5,197 p<0,05	t=6,256 p<0,05	t=12,846 <0,05	

The findings indicate that nearly all dimension pairs exhibit statistically significant differences ($p < 0.05$), suggesting that participants evaluated their digital competences differently across the dimensions. The largest mean differences were observed between digital literacy and other dimensions, as indicated by the highest t-values (e.g., Literacy–Dialogue: t = 16.282; Literacy–Emotional: t = 13.615; Literacy–Protection: t = 13.615). These findings are consistent with the previously reported mean scores, where the literacy dimension

consistently showed the lowest means. Significant differences also emerged in pairs such as Harmony–Risk (t = –3.342) and Emotional–Protection (t = –8.384), further highlighting variation in self-perceived competencies.

It is also important to note that beyond statistical significance, the magnitude of the t-values reflects the extent of the differences. The highest t-values correspond to the largest mean discrepancies, particularly in comparisons involving the dimensions of communication (Dialogue) and literacy. These results suggest that participants do not perceive their digital skills uniformly across domains. While the instrument measures DQ as a single construct, these findings reinforce the interpretation that its dimensions vary in terms of development within the examined sample.

5. Discussion

This research presents a valuable contribution to the understanding and measurement of DQ. The findings offer important insights into the digital competencies of law enforcement officers. The high Cronbach's alpha values (ranging from 0.800 to 0.885) across all eight dimensions indicate excellent internal consistency, confirming the reliability of the measurement instrument. This robust reliability suggests that the Digital Intelligence Profile (DIP) effectively captures the intended constructs and can be considered a valid tool for assessing DQ. The correlation analysis reveals moderate to strong positive associations between all dimensions (r = 0.514 to 0.749), supporting the conceptualisation of DQ as a coherent yet multifaceted construct. This finding aligns with the DQ Institute's framework that presents DQ as an integrated set of competencies rather than isolated skills.

The dimensional analysis reveals particular strengths in digital dialogue (highest overall mean of 41.92), emotional intelligence (41.48), and digital personality (38.74). This pattern suggests that law enforcement officers prioritise and have developed stronger capabilities in interpersonal digital communication and self-regulation aspects. This emphasis on communicative and emotional competencies may reflect the nature of law enforcement work, which often requires strong interpersonal skills and emotional management even in digital contexts. Conversely, the notably lower scores in digital literacy (30.42) and digital protection (35.07) highlight potential areas of vulnerability. These findings reveal a critical gap in the ability to evaluate and synthesise digital information and to implement adequate protective measures in digital environments. This gap may present operational risks for law enforcement organisations, particularly as they increasingly rely on digital evidence and must protect sensitive information.

5.1 Practical Implications

The findings reveal important insights for digital skills training and workforce development. While participants show strong confidence in digital dialogue, emotional intelligence, and online personality management, there is a notable disparity when it comes to higher-level cognitive and protective digital competences. This uneven skill profile has practical implications for organisations, educators, and policymakers aiming to support digital readiness. Organisations that neglect digital up-skilling face missed opportunities for growth, wasted resources, and a higher risk of technology implementation failures. This skills gap becomes a strategic liability, reducing competitiveness and the ability to adapt to market changes. DT efforts depend on workforces 'readiness and ability to use digital technologies. Without sufficient digital intelligence, investments in digital tools and systems fail to deliver their intended benefits. To address these challenges, organisations must prioritise targeted digital intelligence training and foster a culture of continuous learning and adaptability. This not only bridges the digital competence gap but also ensures that KMS are fully utilised and future-ready. Digitally competent employees can leverage KMS to store, retrieve, and share knowledge efficiently. Without these skills, employees struggle to use digital tools, leading to information silos, knowledge loss, and inefficient workflows.

Targeted interventions are therefore necessary to strengthen digital literacy, especially in relation to timely information access, accurate data processing, and effective communication. Digital literacy is directly linked to process innovation and the ability to adapt to technological change. Workforces without digital competence are less able to contribute to innovation, making the organisation less agile and competitive. Given the law enforcement context, enhancing knowledge of digital rights and cybersecurity protocols is particularly critical—not only for operational effectiveness but also for safeguarding institutional integrity and public trust. In practice, capacity-building efforts should offer role-specific digital training, combining foundational skills with practical case-based learning for higher-level competence development. Leadership programs should incorporate digital strategy and risk communication, equipping decision-makers with the tools to guide DT initiatives. Strengthening digital intelligence holistically will better equip law enforcement personnel to meet the evolving demands of modern policing in a digital society.

5.2 Limitations and Future Research

A limitation of our research is that the survey was conducted in a single organisation in Hungary as a pilot.. We are preparing a large sample survey in Hungary, involving hundreds of companies, and we plan to involve specific target groups (secondary school students, retired people, etc.) as a second stage.. Negotiations are also underway with partner institutions abroad, with the possibility of conducting the survey in English in several countries, in the framework of potential cooperation.

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Exploring the Interplay Between Civil Liberty, Technological Innovation, and Human Capital

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Abstract: While existing research has focused on analysing the relationship between democracy and innovation, they fall short on the conditions under which the effect works. We draw insights from the institutional and human capital theories to develop and test a simple theoretical model to examine the conditions under which civil liberty impacts technological innovation. Our empirical model based on a sample of 47 sub-Saharan African countries for the period 1990–2022 using the conditional fixed effect Poisson regression. The empirical results revealed that civil liberty positively influences technological innovation. We further found that human capital negatively influences technological innovation. Finally, we found that the effect of civil liberty on technological innovation conditional on human capital is higher for low values of human capital and diminishes for high values of human capital. The results are robust when we include additional control variables. The study has important implications for technological innovation in sub-Saharan African countries in the context of civil liberty and human capital development.

Keywords: Civil liberty, Technological innovation, Human capital, Institutional theory, Sub-Sahara Africa

1. Introduction

Technological innovation serves as a catalyst for change, driving advancements across various spheres of human endeavour, from communication and healthcare to transportation and beyond. Technological innovation is influenced by micro- or firm-level factors such as engaging in research and development and macro-level factors such as institutional-related conditions and policies (Riaz & Cantner, 2020). Micro-level and macro-level factors have been examined independently (Skare & Porada-Rochon, 2022), but innovation performance cannot be fully explained by micro-level or macro-level factors alone since innovation is a complex and multilayered notion in which the interaction of events occurring both inside and outside of a firm's borders is important (Odei, 2024). Civil liberty, encompassing fundamental freedoms such as freedom of speech, expression, and assembly, forms the bedrock of democratic societies, empowering individuals to voice their opinions, challenge existing norms, and shape the course of collective action. At its core, civil liberty provides the fertile ground upon which technological innovation thrives, fostering an environment of openness, transparency, and accountability conducive to the free exchange of ideas, collaboration, and experimentation. Sub-Saharan African countries are known to have weaker democracy and institutions (Gossel, 2018), which could affect the continent's drive for technological innovation.

Few existing studies have focused on analysing the direct relationship between democracy and innovation (see Forson et al., 2021). A study by Najam et al. (2023) concluded that civil liberties enhance innovations. However, the mechanism through which democracy (civil liberty) works to impact innovation has received less scholarly attention. We focus on civil liberty as a component of democracy to analyse its impact on technological innovation. We also examine the contingent effect of human capital on the relationship. The moderation effect of human capital suggests that the direct association between civil liberty and technological innovation could vary depending on the level of human capital. Higher levels of human capital could amplify the positive effects of civil liberties on innovation by enabling individuals to fully use their freedoms through education, skills, and knowledge. In environments where human capital is high, civil liberties are likely to have a stronger positive impact on technological innovation. Individuals with higher levels of education, skills, and knowledge will therefore be better equipped to capitalise on civil liberties (freedom of speech, access to information, and intellectual property rights) to innovate. This study contributes to the literature by drawing intuitions from the institutional and human capital theories to analyse the relationship. Our main findings demonstrate that human capital diminishes the positive effect of civil liberty on technological innovation. Policymakers in sub-Saharan African countries should prioritise investments in education and training programmes to improve human capital; this could amplify the positive impact of civil liberties on technological innovation.

The research is structured as follows: The ensuing section focuses on the methodology and data. Section 3 describes the results in relation to existing studies. The final section concludes the paper.

2. Theoretical Review and Hypotheses Development

We used the institutional theory to explain how the democratic environment in sub-Sahara Africa function within structured environments to influence technological innovation. According to North (1990) institutions can be defined as rules, norms, and structures that influence social behaviour as well as organisational practices. This theoretical frame emphasises how institutions which could be both formal (laws, regulations, policies) and informal (norms, cultural practices, social expectations) impact economic and social development. The institutional theory suggests that rules, norms, and structures influence how societies adopt and adapt to changes, including technological progress and human capital development. They provide frameworks that guide human interactions and shape decision-making. Organisations and economic agents are inclined to conform to prevailing institutional expectations to gain legitimacy. From the institutional theory perspective, we anticipate that strong civil liberties could provide the foundation for technological innovation. Civil liberties in the form of freedom of expression, access to information, privacy rights, and the rule of law (Balkin,2017; Czuryk, 2022), can create an enabling environment that promotes innovation, creativity, and the development of new technologies. Open societies that allow unrestricted exchange of ideas, could create knowledge diversity which fuels R&D activities which is vital for innovation. When citizens are able to able to contribute to knowledge-sharing and global collaboration enhanced by open internet policies could result in technological advancements. We summarise the understanding that civil liberties can contribute to technological innovation by fostering an environment where knowledge sharing and protection can thrive. Based on the aforementioned analysis, we propose our first hypothesis as.

Hypothesis 1: Civil liberty has a significant positive influence on technological innovation

2.1 Moderating Role of Human Capital

In our second hypothesis we predict that human capital will strengthen the positive relationship between civil liberty and technological innovation. We draw insights from the human capital theory which posits that investment in individuals' education and skills enhances their productivity and economic value (Sweetland, 1996). This framework considers human knowledge, skills, experience and capabilities as a form of capital, akin to physical or financial capital, that can be utilised to contribute to individual and economic growth as well as development. Education advances critical thinking and political awareness, resulting in stronger calls for democracy, freedom of expression, and digital rights. Human capital plays a moderating role in the relation between civil liberties and technological innovation by improving the absorptive capacity. Countries with high human capital resources are better positioned to capitalise in institutional support for innovation, which is frequently stronger in democracies that uphold civil liberties (Kwan & Chiu, 2015). This suggests that the effectiveness of civil liberties in promoting technological innovation is contingent upon the existing level of human capital present in a country. When individuals possess the requisite skills and knowledge, they stand a lofty chance of utilising the freedoms provided by civil liberties to carry out innovation and its associated activities, thereby amplifying the positive effects of civil liberties on technological innovation. Based on this discussion we anticipate that human capital will play an essential role in reinforcing the relationship between civil liberty and technological innovation which aligns with the human capital theory. We provide our second hypothesis as.

Hypothesis 2: human capital strengthens the relationship between civil liberty and technological innovation.

3. Data and Methodological Approach

Table 1 below provides the sources of data for the empirical estimations spanning the period 1990–2022. For the methodological approach, we used the conditional fixed-effects Poisson regression. This statistical method models count data, specifically outcome variables that are non-negative integers, while addressing unobserved heterogeneity based on the conditional likelihood estimation (Correia et al., 2020).This statistical technique was used because our dependent variable thus patent is count by nature as well as has panel or longitudinal data structure (Verdier, 2018). We provide the formula for the conditional fixed effects Poisson model as.

$$E(Y_{it} \mid X_{it}, \alpha_i) = \exp(X_{it}\beta)\alpha_i \qquad [1]$$

Where.

Y_{it} = represents the count-dependent variable (thus number of patents)

Xit = denotes the vector of independent variable namely civil liberty

β = represents the coefficient' vector

α_i = is the fixed effect (removed via conditioning)

4. Results and Discussion

Table 1 presents the summary statistics, the average patents applied is about 118. After standardisation, the difference GDP per capital is large, indicating that there are huge variations across the sampled countries in terms of economic growth. The mean for human capital is 8.457 which is low. The mean for civil liberty is 4.210, there are huge variations between and across the sample. The mean for ICT penetration is 79.100. Also, the result in Table 2 shows the correlations of the variables which are very low indicating that there are no issues of multicollinearity. The results of the moderated analyses are shown in Table 3. In Model 2, we see that there is a positive and statistically significant association between civil liberty and technological innovation ($\beta = 0.390$, $P < 0.001$). This results means that any increase in civil liberty increases the likelihood of technological innovation, suggesting that societies with stronger civil liberties provide a conducive environment for innovation to thrive by fostering creativity, risk-taking, and entrepreneurship. This result contradicts with the findings of previous studies in developing countries that found an insignificant association Ahmed et al. (2024), and Najam et al. (2023) who found a negative relationship. The result also shows that the direct relationship between human capital and technological innovation is negative ($\beta = -0.043$, $P < 0.001$), indicating that any increase in human capital reduces the likelihood of technological innovation. This result could be possibly explained as the educational systems may not necessarily equip students with the practical knowledge and skills needed for successful innovation (Habiyaremye et al., 2022), particularly in fields like STEM (Science, Technology, Engineering, and Mathematics). This skillset mismatch could therefore play a key role in hindering the development of a workforce with the skills necessary for high-level needed for innovation. This result contradicts the finding of a related study in sub-Saharan African countries by Danquah & Amankwah-Amoah (2017) who found an insignificant relationship. However, studies in developed countries found that human capital has a positive influence on radical innovation (Delgado-Verde et al., 2016).

Table 1: Descriptive Statistics and variables sources

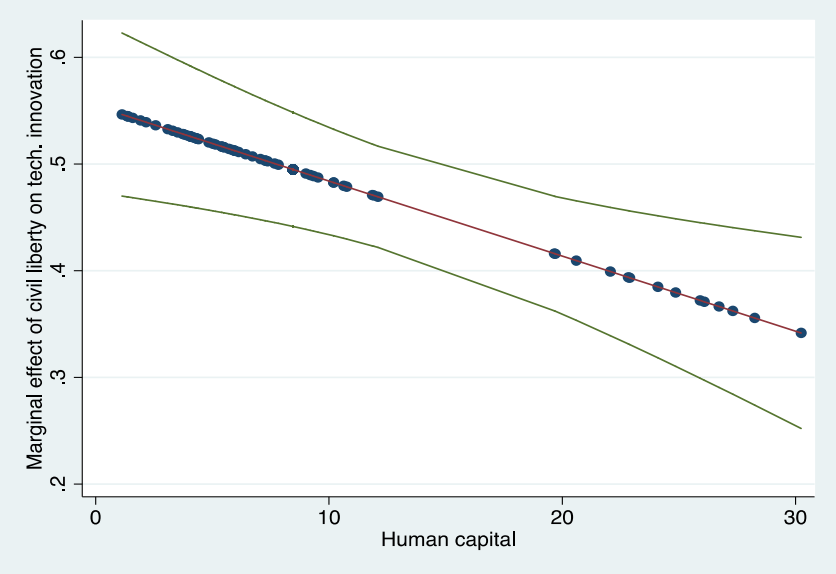
Variable		Mean	Std. Dev.	Min	Max	Sources
Patents	overall	117.873	245.740	1	1003	World Intellectual Property Organization
	between		162.420	1	800	
	within		74.605	-140.127	360.373	
GDP per capita	overall	7.120	0.954	5.542	9.748	World Bank
	between		0.948	5.676	9.515	
	within		0.1651	6.311	7.723	
Political stability	overall	-0.557	0.917	-3.310	1..280	World Bank
	between		0.849	-2.681	1.023	
	within		0.369	-2.075	0.752	
Regulatory quality	overall	-0.713	0.638	-2.550	45323,00	World Bank
	between		0.617	-2.198	0.794	
	within		0.185	-1.736	0.119	
ICT	overall	79.100	211.233	1	1706	International Telecommunication Union
	between		136.271	1	849.2	
	within		143.610	-767.101	986.394	
Property rights	overall	35.986	15.070	5	90	Heritage Foundation
	between		12.080	15.130	67.957	
	within		8.479	7.160	91.160	
Civil liberty	overall	4.210	1.542	1	7	Freedom House
	between		1.176	1.905	6.545	

Variable		Mean	Std. Dev.	Min	Max	Sources
	within		1.010	0.210	7.305	
Human capital	overall	8.457	7.603	0.350	44.39	UNESCO
	between		5.633	1.504	30.558	
	within		4.330	11.070	22.290	

Note: UNESCO= United Nations Educational, Scientific and Cultural Organization

Table 2: Correlation matrix (1081 obs.)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Patents	1.000							
(2) GDP per capita	0.476	1.000						
(3) Political stability	-0.054	0.481	1.000					
(4) Regulatory quality	0.280	0.430	0.648	1.000				
(5) ICT	0.621	0.206	-0.014	0.197	1.000			
(6) Property rights	0.203	0.429	0.519	0.732	0.224	1.000		
(7) Civil liberties	0.467	-0.015	-0.317	-0.320	0.071	-0.319	1.000	
(8) Human capital	-0.232	0.279	0.217	0.370	0.029	0.208	-0.058	1.000



Source: Own estimation

Figure 1: Effect size of the moderation

Our second hypothesis anticipated that human capital would improve the relationship between civil liberty and technological innovation. The result in Table 3 shows that the simple slope coefficient is significant but negative (β = -0.015, P < 0.001). This result means that we didn't find support for our hypothesis 2. As shown by the descriptive statistics in Table 1, the human capital potential in the sampled countries is low and resonates with the findings of previous research (Ogundari & Awokuse, 2018), hence the possible reason why it has a negative direct influence on technological innovation. This result is contrary to the widely held view that human capital is essential for innovation, in the case of sub-Saharan African countries our result has demonstrated that human capital hinders technological innovation. This result contradicts the findings of a related study in China by (Liu et al., 2017), who found a positive association between human capital and innovation. Since using the simple slope coefficient to interpret a moderation effect is considered not intuitive enough because it does not show the trend of the moderation effects (Meyer et al., 2017). We followed the literature (Meyer et al., 2017) and used the effect size approach. This approach allowed us to estimate the confidence intervals for interaction effects

over the significant range of the independent variable (Meyer et al., 2017). Another important benefit of this approach is that it provides detailed information that allows us to ascertain the magnitude and nature of the contingent effect. The result of the effect size is shown in Figure 1 above. Although the simple slope coefficient revealed a significant moderation effect, the effect of the interaction varies according to the level of human capital. Lower levels of human capital have the highest marginal effect on the relationship between civil liberty and technological innovation. But as human capital increases, the marginal effect of civil liberty on technological innovation decreases. This result means that lower levels of human capital improve the relationship between civil liberty and technological innovation compared to higher levels. This can be explained through the lens of the law of diminishing marginal returns. At lower levels of human capital, marginal improvements in education, skills, or access to knowledge have a disproportionately large impact on technological innovation. As human capital increases, the additional impact of civil liberties on technological innovation decreases because civil liberties create a conducive environment that allows the free flow of new knowledge and ideas, but it is highly skilled capital who turn these ideas into innovations. As a country accumulates or increase their human capital base, the direct impact of civil liberties on technological innovation diminishes, because well-educated workers can drive innovation regardless of political freedom.

Table 3: Results of the moderated analysis

	(1)	(2)	(3)	(4)
	Patents	**Patents**	**Patents**	**Patents**
GDP per capita	1.568***	1.020***	3.069***	3.005***
	(11.20)	(6.97)	(11.77)	(11.41)
Political stability	-0.091	-0.422***	-0.615***	-0.653***
	(-1.77)	(-6.91)	(-6.25)	(-6.53)
Regulatory quality	0.524***	0.287***	-0.179	-0.024
	(7.84)	(3.64)	(-0.82)	(-0.11)
ICT	-0.000***	0.000***	-0.000	-0.000
	(-6.37)	(7.74)	(-1.51)	(-0.58)
Property rights	0.014***	0.014***	0.014***	0.015***
	(10.79)	(10.03)	(5.83)	(6.13)
Civil liberty [CL]		0.390***	0.291***	0.416***
		(16.91)	(4.41)	(5.65)
Human capital [HC]			-0.043***	0.035
			(-5.09)	(1.68)
CL*HC				-0.015***
				(-3.96)
Year-fixed effects	Yes	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes	Yes
N	1081	1081	1081	1081

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.1 Further Robustness Test

We reevaluated the model and confirmed the validity of the main research findings using other estimating techniques to examine the robustness of the empirical results mentioned above. We incorporated an alternate set of control variables that have been shown by the innovation literature to influence technological innovation for the model reassessment into the models, in accordance with the literature (see Meyer et al., 2017). We included the new variables namely government effectiveness and voice and accountability. The results of the reassessed models are shown in Table 4. Government effectiveness was shown to positively influence technological innovation (β = 0.913, P < 0.001), while voice and accountability demonstrated to negatively influence technological innovation (β = -0.260, P < 0.05). The results in Models 2, 3, and 4 show that the

directions and significance of the of the variables of interest remain unchanged after including other control variables. Based on these unchanged results, we draw the conclusion that our findings are robust.

Table 4: Robustness test with additional controls

	(1)	(2)	(3)	(4)
	Patents	**Patents**	**Patents**	**Patents**
GDP per capita	1.513***	0.975***	3.724***	4.125***
	(9.44)	(5.83)	(11.27)	(11.74)
Political stability	0.126*	-0.231***	-0.424***	-0.402***
	(2.54)	(-3.60)	(-3.84)	(-3.60)
Government effectiveness	0.913***	1.187***	2.585***	2.707***
	(13.03)	(14.85)	(17.23)	(17.30)
ICT	-0.000***	0.001***	0.001***	0.001***
	(-6.02)	(13.26)	(3.33)	(3.30)
Property rights	0.012***	0.012***	0.005	0.004
	(10.03)	(10.03)	(1.87)	(1.72)
Voice and accountability	-0.260*	-0.081	-0.196	-0.120
	(-2.51)	(-0.69)	(-1.01)	(-0.62)
Civil liberty [CL]		0.418***	0.213**	0.335***
		(17.61)	(2.70)	(4.07)
Human capital [HC]			-0.039***	0.099***
			(-4.25)	(3.93)
CL*HC				-0.024***
				(-5.75)
Year-fixed effects	Yes	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes	Yes
N	1081	1081	1081	1081

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5. Conclusion and Policy Implications

This research investigates the relationship between civil liberty and technological innovation in sub-Saharan African countries, considering the contingent effect of human capital. The empirical results revealed that civil liberty positively influences technological innovation which is in line with the institutional theory. However, human capital demonstrated to have a negative relationship with technological innovation, which aligns with the human capital theory. The result further demonstrated that human capital diminishes the positive impact of civil liberty on technological innovation. However, the result of the effect size estimation revealed that lower levels of human capital strengthen the relationship compared with higher levels. Our results have implications for policy. First, to make sure that people have the skills and knowledge needed to effectively use civil liberties for technological innovation, governments and policymakers need to prioritise investments in education, training, and skill development. Second, the descriptive statistics result shows that human capital in sub-Saharan African countries is low, the possible reason for the negative moderation. Policies should focus on improving and shifting the focus of education to technical and vocational training. Finally, policies should be designed to maximise the impact of civil liberties and human capital investments to accelerate technological innovation. Policy makers should crackdown on internet shutdowns and censorship that impede access to new ideas and knowledge.

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Ethical consideration: Ethical approval was not sought for the present study because the research involves non-human subjects.

AI declaration: This research paper did not use AI tools at any stage of its development. All analyses, writing, and conclusions were done manually by the authors.

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Leveraging Social Capital to Enhance Knowledge Sharing in Mature Enterprises

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Abstract: The aim of the paper is to examine the role of social capital in the knowledge sharing (KS) process in an enterprise, with particular emphasis on its three dimensions: structural (SSC), relational (RSC) and cognitive (CSC). The paper analyses how these three dimensions of social capital contribute to the adoption of KS behaviours, which in consequence can lead to increased innovation, competitiveness and efficiency of the enterprise. Understanding the role of social capital in the knowledge sharing process provides valuable information for practitioners and decision-makers, helping them to create favorable conditions for cooperation and innovation. The contribution to science and the novelty of the current research are based on an empirical approach that focuses on mature enterprises. Analyzing social capital in the context of those organizations that have an established position on the market will allow for the discovery of unique dynamics and challenges related to KS. This research fills a research gap in the literature, focusing on mature enterprises, which are often omitted in knowledge management research. Hence, the empirical part of the article was prepared based on a questionnaire survey among 280 mature enterprises in Poland. In the study of the impact of social capital dimensions on KS, a regression model was used, which allowed us to determine the extent to which each of the dimensions of social capital affects the KS process in a mature enterprise. The regression model confirmed that among the three predictors of social capital, SSC and CSC (had significant positive effects on KS, however, RSC was not statistically significant, suggesting it does not contribute meaningfully to the prediction of KS. The assessment of the strength and direction of these relationships provides valuable information for practitioners in the field of knowledge and social capital management strategies. The current research approach also creates the possibility of continuing the research, by expanding it to include factors mediating this relationship. The research limitation is primarily the simplification in the form of defining mature enterprises only by the period of operation on the market, which should be clarified in future studies.

Keywords: Knowledge sharing, Knowledge management, Social capital, Mature enterprises

1. Introduction

Due to the rapidly changing economic environment and globalization, companies must constantly fight to maintain a competitive advantage. Currently, the condition for this is to have an effective knowledge management strategy and systems, which will become essential to increase the ability of companies to continuously create, transfer and use knowledge. Knowledge is considered the life force of organizations and has been identified as a key element of organizational survival and allows companies to differentiate themselves from competitors (Tran Pham, 2024). From this perspective, knowledge sharing (KS) is one of the most significant knowledge-related activities since it serves as the link between individual knowledge and organizational information, so successfully improving the ability to absorb and innovate (Lin & Huang, 2023). The process of KS is determined by many internal and external factors, among which researchers very often analyze social capital, both as a holistic construct and its three dimensions: structural, relational, and cognitive.

Although the relationship between social capital and knowledge sharing in organizations has been the subject of much empirical research, there are still many areas and aspects that have not been sufficiently explored. The novelty of the study results from focusing on the identification of the impact of social capital, as a multidimensional construct, on knowledge sharing in mature enterprises. So, the contribution of the paper creates a reference to mature companies and their KS behaviour. Mature enterprises are characterized by more formalized and optimized intra-organizational processes that ensure operational stability and efficiency. They have clearly defined management structures, decision-making hierarchies, and operational procedures, which promote predictability and risk minimization. At the same time, despite their stability, mature companies must maintain flexibility and the ability to adapt to the changing market environment, which is often achieved through innovation, automation, and development of employee competencies. Thus, the aim of this article is to examine the role of social capital in the knowledge sharing (KS) process in an enterprise, with particular emphasis on its three dimensions: structural (SSC), relational (RSC) and cognitive (CSC).

The paper is structured as follows. After the introduction in Section 1, the author presents a literature review in Section 2. Section 3 discusses the research methodology. Section 4 presents the empirical results. The author concludes in Section 5 by highlighting the limitations and suggesting directions for future research.

2. Literature Review

2.1 Knowledge Sharing

Knowledge sharing encompasses the behavior of individuals to share their information or knowledge with others (Berraies, Lajili & Chtioui, 2020), which enhances both individual and organizational performance. According to Wang and Noe (2010), KS is a group of actions that include exchanging social and task-related knowledge with others and cooperating to resolve problems, create new ideas, or execute organizational procedures. Knowledge is regarded as the essential foundation of a business, recognized as a vital component for its existence and enabling firms to differentiate themselves from competitors. Knowledge is socially produced, and its worth increases when disseminated, and this is why KS is one of the most fundamental activities in organizational operations (Tran Pham, 2024).

KS is problematic and controversial because it is handled by individuals who are sometimes reluctant to share knowledge that they perceive as valuable and important, which makes KS difficult to implement as a process in an organization (Alajmi & Al-Qallaf, 2022). KS behavior is not only influenced by personal motivation but also by KS opportunities. It refers to the knowledge transfer across individuals and organizations, storage in and retrieval from a knowledge base, and the process of behaviors becoming the routine and practices of organizations (Hassan et al., 2016). In addition, KS is one of the most important behaviors in knowledge-related behaviors. As a necessary link for the transformation of individual knowledge into organizational knowledge, it can effectively enhance the ability to absorb and innovate. It is also a prerequisite for knowledge creation and plays a key and indispensable role in the application and integration of organizational knowledge (Ritala & Stefan, 2021).

Previous studies have emphasized the benefits of knowledge sharing, including cost reduction, increased customer satisfaction, improving individual skills, nurturing the intellectual capital of the organization, and improving innovation and performance capabilities (Wang & Noe, 2010).

2.2 Social Capital

Many fields have examined social capital, including sociology, politics, economics, and management. Companies in the knowledge-based economy have realized how crucial social capital is to their success (Tran Pham, 2024). As Bourdieu (1985) stated, social capital implies resources accumulated through social relationships. Human relationships and interactions gave rise to the idea of social capital, which has since been associated with both people and societal institutions (Dageid & Gronlie, 2015). It is characterized by social organization features, including networks, conventions, and trust that promote action and collaboration for the advantage of both parties (Putnam, 1995). According to Donate et al. (2020), social capital is the collection of resources individuals possess and have accumulated from their networks. In turn, Ganguly, Talukdar and Chatterjee (2019) stated that social capital is the total of the real and potential resources that are a part of, derived from, or accessible through relational networks.

For organizations, social capital enhances interorganizational relations and organizational reputation and also helps them with strategic and advantageous positions for new ideas or risk protection (Oh et al., 2023). According to Bourdieu and Wacquant (1992), it refers to the resources that either individuals or organizations may mobilize or access through long-lasting relationships and networks. Social capital relationships represent the quality of the connection between individuals, including the degree of mutual trust or cooperation in the relationship (Lin & Huang, 2023). Through social connections, it makes it more feasible for individuals to obtain information and resources, creating value through useful and consoling interactions. It additionally assists in their strategic positioning in the market by utilizing networks to identify opportunities, reduce risks, and negotiate challenging situations (Coleman, 1990). Strong social ties give individuals and companies access to important information, resources, and opportunities that boost productivity, creativity, and competitive advantage in the rapidly changing environment of today (Han, Oh & Kang, 2022). According to Allameh (2018), social capital fosters the development of a social foundation that stimulates collective intelligence and fosters a sense of solidarity, which in turn strengthens an organization's knowledge base and enables individuals to execute their jobs effectively and possess important information. According to social capital theory, social networks can be strengthened through network links and are significant resources for people or social entities. At the same time, a large portion of information gain comes from social interactions. Accordingly, social capital encompasses both the resources and expertise found in networks as well as how they are applied in interactions (Lee & Han, 2024).

Nahapiet and Ghoshal (1998) perceived social capital as a triangle that could be broken into three sections: structural, relational, and cognitive capital in order to assess its type and quality. Structural capital is the overall

design of social networks that give members the chance for interaction with other individuals. Such elements as respect, trust, norms, and cooperation are all components of relational capital, which reflects the essence of interpersonal relationships (Nahapiet & Ghoshal, 1998). According to Zhang et al. (2017), cognitive social capital is the shared knowledge of social actors through similar objectives, visions, cultures, or languages. Individuals are encouraged to act collectively and share information by these dimensions, which also foster understandings, interactions, and collaboration (Polyviou, Croxton & Knemeyer, 2019).

2.3 Hypotheses Development

Many previous studies have confirmed the relationship between social capital and KS in organizations (Peng, 2022). Liu and Meyer (2020) indicated that social capital should even be treated as a driving force of KS. Since the structure of social capital indicates the strength of the relationship or the frequency of interactions between an individual and other stakeholders (Sheng & Hartmann, 2019), a higher level of social capital in an organization means that interactions between employees will be more frequent, creating an environment conducive to KS, including when members directly contact and exchange explicit knowledge, as well as when there is an opportunity to share tacit knowledge (Foss & Pedersen, 2019). Therefore, the structure of social interactions can encourage individuals to KS in a cost-effective way and improve the intensity, breadth, and frequency of knowledge sharing (Chowdhury et al., 2020). Considering the dimensions of social capital, Hau et al. (2013) indicated that social capital at the structural, relational, or cognitive level has a positive impact on individuals' KS behavior. Similarly, Peng's (2022) research confirmed that employees' social capital has a positive impact on employees' KS behavior, and a strong correlation is seen between all dimensions of social capital and KS.

The structural dimension of social capital refers to informal and formal meetings among team members (Lin, Liu & Chan, 2022) and reflects the pattern of structural connections or ties among members of a work team (Tsai et al., 2014). People in a team who have a high level of social interactions or interpersonal relationships can obtain emotional support and positive experiences, which helps reduce emotional conflicts and develop positive feelings in a collective way, facilitating knowledge sharing as a consequence (Lin & Huang, 2023). The relational dimension of social capital refers to the trust and willingness of team members to increase mutual reliance on each other within the team (Baruch & Lin, 2012). Trust helps to shape a rich, positive emotional space with enduring social and affective resources (Jahanshahi, Maghsoudi & Nawaser, 2020), in which employees are likely to exhibit better work mood and positive feelings of participation in team activities and thus be more willing to share knowledge with each other (Lin & Huang, 2023). The cognitive dimension of social capital refers to a shared vision, which is a set of beliefs and assumptions about team goals and processes that are widely accepted by team members (Tsai et al., 2014). A shared understanding of values and purpose through frequent communication events is likely to elicit a positive affective tone to a large extent, ultimately increasing knowledge sharing (Baruch & Lin, 2012).

Based on these arguments, the following hypotheses were developed:

H1: SSC has a positive effect on the KS in mature enterprises.

H2: RSC has a positive effect on the KS in mature enterprises.

H3: CSC has a positive effect on the KS in mature enterprises.

3. Methods

To test the research hypotheses, data was collected from a sample of 280 mature enterprises in Poland. Mature enterprises were considered to be those operating on the market for more than 5 years. In this group, 24.7% of companies had been operating on the market for 6-10 years, 28.9% for 11-20 years, and 46.4% for more than 20 years. The selection of the research group was random. The respondents expressed their opinions using a 5-point Likert scale. All variables were prepared as the average (arithmetic mean) of their component items.

The questionnaire survey was prepared based on a literature review. The items of structural (SSC), relational (RSC) and cognitive (CSC) social capital were prepared based on previous research (Hau & Kang, 2016; Chow & Chan, 2008; Chiu, Hsu & Wang, 2006) as a variable consisting of 4 to 5 items. The seven items that make up the KS variable were developed from the literature (Luu, 2021; Stock et al., 2021; Imam & Zaheer, 2021). The following tools were used for statistical analysis of the primary data: descriptive statistics, Kendall's Tau correlation coefficient (as a coefficient used for nonparametric variables) and multiple regression to examine the influence of independent variables on the dependent variable.

The reliability analysis using Cronbach's alpha indicates a high level of internal consistency for all variables (Tab. 1). RSC (α = 0.926) and CSC (α = 0.921) demonstrate excellent reliability, suggesting strong internal coherence among their items. SSC (α = 0.848) shows good reliability, though slightly lower than the others, but still well above the commonly accepted threshold of 0.70. KS (α = 0.902) also exhibits excellent reliability, indicating that the scale effectively measures a consistent construct. Overall, the results confirm that all scales used in the study are highly reliable, ensuring consistency in the measurement of the constructs.

Table 1: Cronbach's alpha reliability test

SSC	RSC	CSC	KS
0.848	0.926	0.921	0.902

4. Results

First, descriptive statistics for each variable were provided in order to diagnose the disparities in respondents' views in established businesses. The social capital variable, consisting of three sub-variables, was rated relatively high by the respondents, as the overall mean of the response was 4.13, however, referring to the individual dimensions of social capital, there are significant differences. The descriptive statistics for SSC, RSC, CSC indicate that all variables have relatively high mean values, with SSC (4.280) being the highest, followed by RSC (4.154) and CSC (3.948). It is visible that the structural dimension was rated the highest, and the relational dimension slightly lower. The cognitive dimension received the lowest mean response, i.e. below the value of 4.0 on a 5-point Likert scale (Fig. 1). It should be noticed that all variables exhibit negative skewness, meaning responses tend to be skewed toward higher values, with SSC (skew = -1.176, kurtosis = 2.021) and RSC (skew = -1.139, kurtosis = 1.795) displaying sharper peaks and more extreme values, suggesting a more leptokurtic distribution. In contrast, CSC (skew = -0.863, kurtosis = 0.806) has distributions closer to normal.

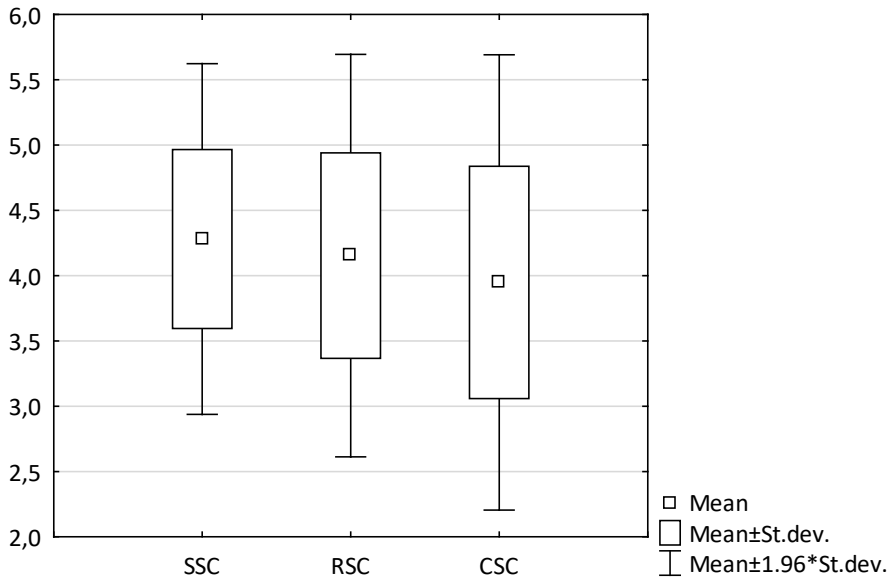


Figure 2: Box plot for the structural, relational and cognitive social capital variables

Descriptive statistics for the KS variable are presented graphically in Fig. 2. The mean value for the KS variable is 4.045, with a standard deviation of 0.76. KS variable exhibits negative skewness (skew = -0.735, kurtosis = 0.397), which suggests distribution closer to normal.

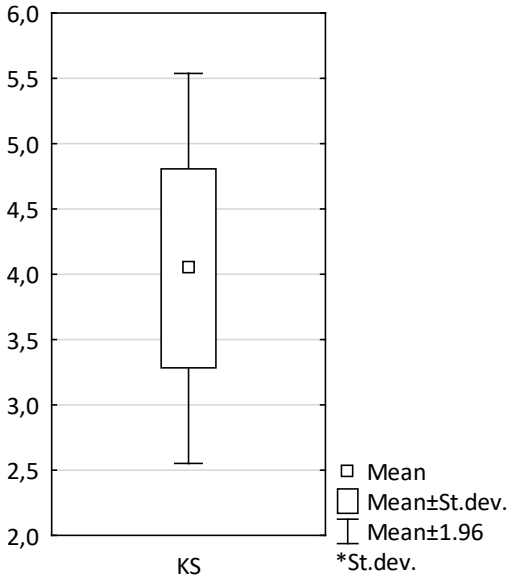


Figure 2: Box plot for the knowledge sharing variable

For all variables, medians are close to the means, suggesting relatively symmetrical distributions (Tab. 2). In terms of variability, CSC (SD=0.890) shows the highest dispersion, while SSC (SD=0.685) has the lowest, indicating more consistent responses. Overall, the results indicate that participants generally provided high ratings, with SSC and RSC showing strong internal consistency, while CSC exhibited more response variability.

The correlations between variables were calculated using the Kendall Tau correlation coefficient. The test results show a statistically significant correlation ($p<0.05$) with the moderate strength and positive direction.

Table 2: Correlation analysis (n=280; p<0.05)

	Mean	Median	S.D.	SSC	RSC	CSC	KS
SSC	4.280	4.500	0.685	1.000			
RSC	4.154	4.200	0.786	0.560	1.000		
CSC	3.948	4.000	0.890	0.569	0.656	1.000	
KS	4.045	4.000	0.762	0.481	0.437	0.433	1.000

The multiple regression analysis examined the impact of SSC, RSC, and CSC on the dependent variable KS. The model was statistically significant ($F(3,276) = 73.856$, $p < 0.000$) and explained 44.5% of the variance in KS indicating a strong relationship. Among the predictors, SSC and CSC had significant positive effects on KS, with SSC being the strongest predictor. However, RSC was not statistically significant, suggesting it does not contribute meaningfully to the prediction of KS. The model's standard error of the estimate was 0.5704, indicating a reasonable level of prediction accuracy.

Table 3: Summary of Regression Analysis for Dependent Variable KS

R	R^2	Adjusted R^2	F-statistic (df = 3,276)	p-value (F-test)	Standard Error of Estimate
0.667	0.445	0.439	73.856	<0.000	0.5704

Variable	Standardized Coefficient (β)	Unstandardized Coefficient (b)	Std. Error	t-value	p-value
Intercept	–	0.971	0.222	4.364	<0.001
SSC	0.390	0.434	0.074	5.861	<0.001
RSC	0.091	0.088	0.071	1.233	0.219
CSC	0.252	0.216	0.064	3.380	0.001

Overall, the results of regression analysis suggest that SSC and CSC play important roles in influencing KS, while RSC does not have a meaningful impact as the p-value is 0.219.

5. Conclusion

Many researchers have studied inter-organizational knowledge sharing from the perspective of social capital due to its social nature and resources embedded in relationships. An appropriate level of social capital creates an appropriate context for knowledge sharing among co-workers, which, in the case of high-quality social ties, employees are more willing to share their knowledge with other employees (Lee & Han, 2024).

The contribution of the present research is visible in the confirmation of the impact of the social capital, as a multidimensional construct, on KS level in mature organizations. The regression analysis confirmed that structural and cognitive dimensions of social capital have an impact on KS of mature firms. Therefore, it was possible to confirm hypotheses H1 and H3. At the same time, it was not possible to confirm the influence of the relational dimension of social capital on KS, which necessitated the rejection of hypothesis H2.

Within the research process, several limitations could be identified. First, we used a simplification in the form of defining mature enterprises only by the period of operation on the market, which should be clarified in future studies. Moreover, the use of the Likert scale in the study raises problems with the interpretation of questions and the bias of respondents, which can lead to ambiguous results. In addition, respondents often tend to choose extreme values, which can distort the actual attitudes.

Research on the impact of social capital on knowledge sharing in mature companies can provide management practitioners with important information on how to optimize internal processes. In the context of mature organizations, which often struggle with stagnation and limited innovation, the results of this research can indicate how strengthening relationships between employees and promoting open communication contribute to effective knowledge transfer. Practitioners can apply these findings to implementing strategies that encourage cooperation between departments, creating interdisciplinary teams, and developing mentoring programs. In addition, the research can highlight the importance of an organizational culture that is conducive to knowledge sharing, which allows mature companies to better leverage the experience and skills of their employees. As a result, these companies can become more flexible and adaptable in a dynamically changing market environment, which is crucial for their long-term success.

AI declaration: I confirm that no AI tools were used to the creation of this paper.

Ethics declaration: I declare that ethical clearance was not required for the research.

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The Role of Regional Technology Observatories in the Creation of a Regional Knowledge Management System

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Abstract: The main purpose of this article is to present the concept of a regional knowledge management system (RKMS) and the role of regional technology observatories in creating such a system. The commencement of conceptual work on an RKMS results from the need to practically embed the functioning of regional technology observatories in the Silesian Voivodeship in the broader context of managing the development of the region. The formal role of regional technology observatories in the Silesian Voivodeship in shaping the RKMS can be indicated since 2013, when the Network of Regional Specialist Observatories (NSRO) was established. The method used in the article was case study. Based on analyses of the literature, the characteristics of RKMS were identified and then, using data from 2010 to 2024, the NRSO was described and the characteristics of RKMS that NSRO met were identified. The article identifies the directions of development of RKMS and indicates the conditions favourable to endogenously rooted specialisations in the region, which have development potential in a global perspective. As an example of the scope of knowledge acquired by observatories, the results of research in the materials production and processing sector regarding innovation management and business models in this sector were presented. The example uses a quantitative analysis in which data was collected during direct surveys of companies. The research sample covered n=50 companies in the manufacturing and materials processing sector.

Keywords: Knowledge management system, Region, Technology, Technology observatories

1. Introduction

The regional knowledge management system (RKMS) has different features than the enterprise system. The region can be treated as a specific organisation that implements all management functions (planning, organising, motivating, and controlling) for its stakeholders: businesses, scientific institutions, cities, and other organisations (Zhao&Ordoñez de Pablos, 2011).). The nature of knowledge management processes in RKMS remains the same as well-known SECI model (Nonaka&Takeuchi, 1995) but the knowledge transfer takes place between different people in different organisations. The regional authorities are not the only recipients of knowledge created and used in the region. Regional businesses, scientific institutions, and local authorities are actors in this system by actively participating in knowledge exchange processes.

The purpose of the paper is to present specific features of the RKMS using the example of the system operating in the Silesian Voivodeship and the role of Regional Technology Observatories operating under the auspices of the regional authorities.

2. Literature Review

Knowledge management involves identifying, acquiring, collecting, storing, and sharing knowledge. The definitions of knowledge management emphasise the process of its flow and transformation, and management is especially about conscious and purposeful processes (Probst et al., 2000; Davenport and Prusak, 2000; Wallace, 2007; Jashapara, 2004). As part of the knowledge management process in an organisation, we take into account processes that go beyond the boundaries of the organisation (knowledge acquisition, knowledge sharing) as well as processes of informal knowledge flow. This is a significant challenge for knowledge management systems and is even more pronounced in the case of regional knowledge management systems.

Knowledge management systems (KMS) are often reduced to ICT systems that support the management of explicit knowledge, while they should facilitate the natural process of transferring both explicit and tacit knowledge. In the literature, we can indicate examples of KMS implementations for the public sector (Nor'ashikin et al., 2024).

RKMS should have a specialisation that strategically defines what knowledge it concerns and who is the most important end-user of this knowledge. Sardjono et al. (2024) present the evaluation model of RKMS for addressing natural disasters in Indonesia. The main recipient of knowledge in this case is the National Disaster Management Agency (BNPB) in Indonesia. Similarly, Calvani (2010) describes the need for the creation of RKMS in the area of new threats and methods to limit these risks. The Interregional Crime and Justice Research

Institute of the United Nations (UNICRI) established regional knowledge management systems with the objective of facilitating the flow of information among states, using existing knowledge and data to develop common strategies and response mechanisms. In this case, the term "regional" refers to the global region of eastern Europe.

There are many similarities between the regional knowledge management system (RKMS) and the regional innovation system (RIS). Ph. Cooke described the essence of the regional/national innovation system that serves to provide knowledge to entities in the region/country. Of particular importance is the problem of transferring knowledge from scientific units to enterprises, which has been discussed for decades (Cooke, 2004). It should also be noted that, in addition to the knowledge management system, RIS also includes innovation infrastructure, i.e., innovation support entities administered by local and regional authorities. The core of the regional innovation system is the creation, transfer and application of scientific and technological knowledge to promote the regional knowledge innovation, technological innovation, knowledge dissemination and application among the regional entities.

Zhao and de Pablos (2011) present the theoretical assumptions of RKMS from the point of view of core management functions: planning, organising, leadership, and control. According to the authors, there are the following activities that the RKMS fulfils, linked to the core management functions.

1. Planning

- *Basic scientific research programme*
- *Technology foresight programme*
- *R&D programme*
- *Science and Technology Cooperation Programme*

2. Organising – stimulating and coordinating cooperation between actors of the regional innovation system
3. Leadership – Governing role in regional knowledge flow by establishing infrastructure for regional knowledge creation, diffusion, and storage
4. Control

- *identifying failure issues within the region in terms of main knowledge production and knowledge market exchange;*
- *Identifying failure issues of knowledge exchange*

The role of the government is to provide a good learning and innovation environment, build an innovative atmosphere, and create systematic conditions for regional innovation. We are therefore dealing with real aspects (objects) and ephemeral phenomena such as knowledge transfer. To describe the processes that take place between tangible and intangible creations, Czarniawska's concept of ‘action net’ is the best one (Czarniawska, 2004). RKMS is thus an action net that involves the creation, transfer, storage, and sharing of knowledge to create value in the region. S. Olko described action nets in creative clusters, identifying the main interrelated activities and the relationships between them (Olko, 2023).

One of the valuable instruments providing knowledge about technological development is the technology observatory. The Technology Observatory on the regional level is the undertaking, the purpose of which was to win and deliver knowledge on development of technology to the major stakeholders of regional development: regional authorities, companies established within a given region, and institutions cooperating with companies. The organisational form of technology observatory may correspond to differentiated configuration of entities composing the regional innovation system: it may be hierarchical, heterarchical (network form), polycentric, and it may also have dual nature, i.e. have some hierarchical and heterarchical features (Cooke et al. 1997).). The concept of technology observatories comes from the European Key Enabling Technology (KET) observatories (European Commission, 2015).

3. Network of Regional Specialist Observatories as an Instrument of Regional Knowledge Management System

The Network of Regional Specialist Observatories (NRSO) was established on 13 March 2013 as part of the system project of the Marshal's Office of Silesian Voivodeship entitled 'Management, implementation and monitoring of the Silesian Voivodeship Regional Innovation Strategy' (3rd edition) carried out from 2011 to 2013 in partnership with the Silesian University of Technology in Gliwice, the University of Economics in Katowice, the

Central Mining Institute and the TECHNOPARK Gliwice Science and Technology Park).). NRSO operates on the basis of an agreement between the Regional Government of the Silesian Voivodeship and the Partners responsible for the individual technological areas of regional specialisation identified in the "Technology Development Programme for the Silesian Voivodeship". This has created a permanent platform for cooperation between key participants in the region's innovation ecosystem, enabling the implementation of activities to build and strengthen innovative potential. The leader of the network is the self-government of the Silesian Voivodeship, which ensures continuity and effectiveness of activities undertaken within the NRSO.

The following tasks were identified during the development of the NSRO, which the partners will be required to carry out:

- Gathering information and data necessary for the region's authorities to diagnose the potential in a given technological area.
- Monitoring and evaluating the impact of public interventions on the development of a technological area.
- Acting as an animator and advisor for enterprises, units supporting the technological development of the region.
- Organising/co-organising events and meetings.
- Involvement in cooperation with other national and foreign observers.

Figure 1 shows the structure of the NRSO with each observatory not being a separate organisational entity, but an activity assigned to an observatory leader. The Marshal's Office is the Leader of the whole network, coordinating the activities of the network and acquiring projects to ensure its continuity. At the core of the network are three coordinating bodies: Steering Committee, Silesian Innovation Council, Programme Council of the Observatory Network.

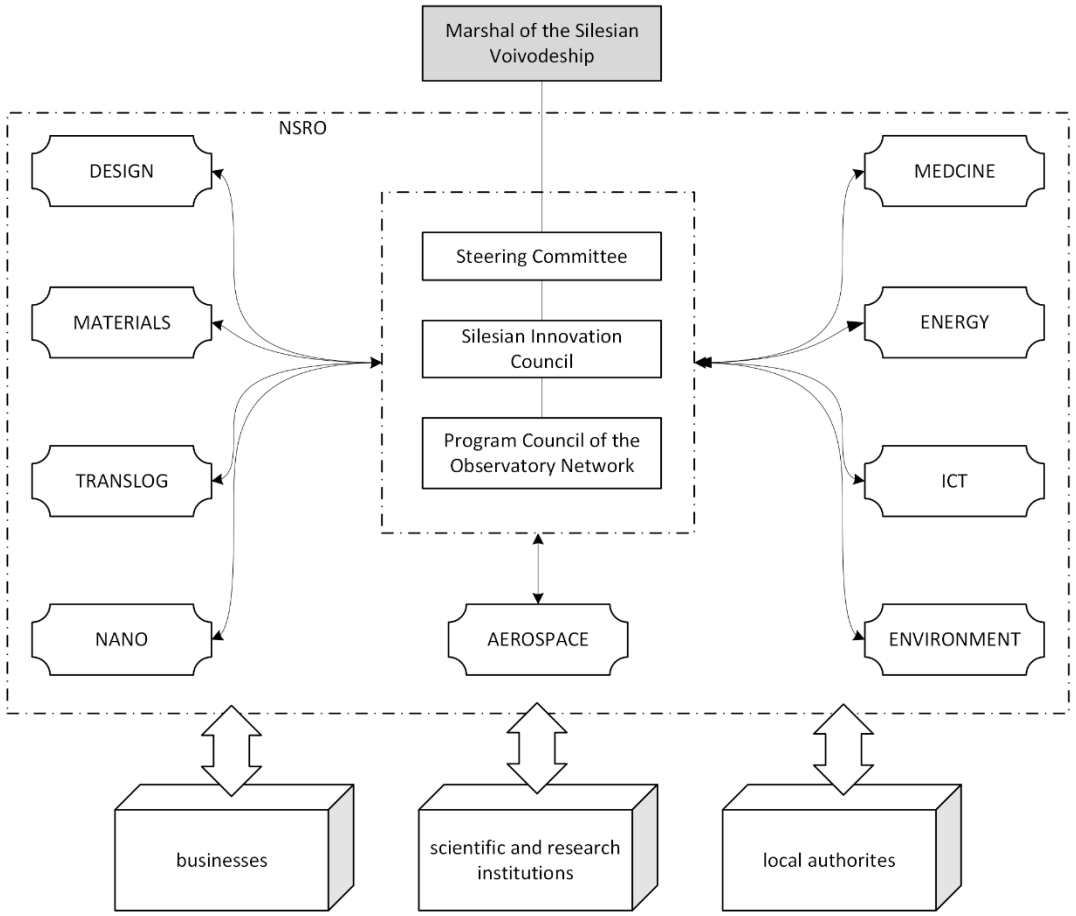


Figure 1: Structure of the Regional Knowledge Management System – example of the Network of Specialist Regional Observators. Source: Own elaboration

The Steering Committee is made up of 32 people representing all the institutions involved in the NSRO, led by representatives of the Marshall Office. The committee comprises representatives from eight universities, five research institutes, and three business environment institutions. Silesian Innovation Council consist of 28 members and 13 external experts. As with the steering committee, they represent the regional scientific and business environment institutions.

The network currently has nine specialised observatories in the technological areas shown in Figure 1. The observatories are consortia of partners with a separate leader, a scientific research institution or a business environment institution. Each observatory is contractually obliged to prepare biannual reports on the state of development of the technology area. This report includes, in particular, information on ongoing projects, regional scientific and research resources within the technology area, identification of regional trends, and recommendations for further development of the technology area. This information is obtained from the business sector and scientific institutions.

4. Knowledge Gained by NSRO - Research in Environments Where Technologies are Used

One of the main objectives of the NSRO is to gather information related to broadly understood innovation management models, the state of innovativeness of enterprises and the needs for support in gaining and implementing innovations, mainly from the public sector. Each of the nine observatories presented in Figure 1 prepares its scope of research in environments that use technology. As part of a project supporting the network's activities in 2023, a survey was conducted of companies operating in the technological area of materials production and processing. The research was carried out by the observatory in this technological area MATERIALS), which is run by a research team at the Faculty of Organisation and Management of the Silesian University of Technology in Gliwice. The subject of this research was innovation management, business models, innovation application, strategy and organisational structure, development of human resources, and the impact of innovation on the functioning of the company. The results of this research, i.e. the information and opinions obtained, were a component of the information resources in the regional knowledge management model enabling the creation of instruments to support innovation management and reduce the risk of innovation application. The following research techniques were used in the study:

- diagnostic survey using a research questionnaire addressed to companies in the materials sector,
- multiple case studies (4 companies),
- documentation analysis of the 4 companies under study,
- interviews with managers (4 companies).

In the case of the first method, surveys were conducted in 50 small and medium companies selected in the Silesian Voivodeship. The basic selection criterion was the business activity conducted in the field of production of one of the following: metal materials, plastics, ceramics, and composites. The survey was carried out between 4 May and 24 May 2023 and as result, n=50 completely completed questionnaires were obtained. This sample size corresponds to the minimum sample size determined by the historical method cited by G. Churchill (1995). Historical data suggests that for regional surveys conducted in institutions, with the number of subgroup analyses from 0 to 9, the sample size should be between 50 and 200 entities. According to the Central Statistical Office, the general population of companies in the manufacturing and materials processing sector in the Silesian province includes N=9 771 companies.

The questionnaire contained 32 extensive questions, open and closed, single and multiple choice, and covered the following research areas:

- **General characteristics of the company.** This area provides information on the products (leading activity), markets, ownership structure, scale of capital, revenue, and employment of the surveyed company. We also asked about the implemented management standards (ISO, HCCP, TQM). An important piece of information was the ratio of R&D expenditure to revenue in the last 3 years. The responses were obtained in the form of a constructed percentage scale.
- **Practice in innovation management.** The questions dealt with two important issues.The first was the types of innovation applied in this area: product, process, organisational, marketing, management and social innovation. Given the extended classification of innovations, these concepts were explained to respondents. The second is the sources of funding for the innovation, i.e. loans, own funds , public funds, or other funding. The answers to these questions provide information related to the applicability of innovations and the associated risks.

- **Strategy and business model.** The first part of this area focused on how the different types of innovation related to strategy and its elements, as well as to the business model. Respondents were asked to provide information on both the actual and the postulated (benchmark) state.
- **Organisational structure.** The information obtained was related to the current functioning (or planning of functioning) in the company's management system of a unit or position related to the R&D and innovation process or function. Respondents also assessed the status and intentions of cooperation in technology transfer and innovation.
- **Knowledge management.** In this area, it was important to explore the elements of knowledge management present in the company such as systems, procedures, instruments and tools for knowledge management, concepts and methods used to support knowledge creation, talent acquisition and utilisation, and management of innovative projects. Another important problem in this area was the assessment of risk management. The questions concerned the mapping of risks and the assessment of the importance of different types of risk, including in particular risks related to the impression of different types of innovations.
- **Employees.** The focus was on the aspects of human resource management related to the creation and implementation of innovation. Information was obtained on employee development in the area of research, development, and innovation, as well as on preferences for issues in this area (e.g., design, technology, quality).
- **Needs and expectations of the company towards the administration, cooperation with the environment.** In this area, information was obtained on the entities, subject and scope of cooperation with the environment related to innovation activities in the broad sense. Areas of support expected by public sector enterprises in the implementation of innovation were identified.
- **Self-assessment of innovation management.** The final element of the research questionnaire is a request for respondents to self-assess the management of innovation in their company compared to other companies in the industry researched in Poland. Factors such as cooperation with the environment and the use of public support, innovation project management, or product/process/technology development were valued.

The following section presents analyses of the responses to selected questions from the research survey. The broad scope of the survey research has allowed the acquisition of knowledge in the field of innovation in the manufacturing and materials processing sector, which is an important information feed for the RKMS.

The effects of the company's innovation policy, strategy, and management are the implementation of different types of innovation. Their structure illustrates the specific preferences of the company in the implementation of innovations, which results from the competitive position as well as the possibilities (including financial) of the organisation. Figure 2 presents the answers to the question 'What type of innovations has the company introduced in the last 3 years?' which shows that by far the most common innovations introduced were product process innovations, which dominated in 80% and 66% of the surveyed enterprises, respectively. The primacy of product innovations results from the frequent use by SME enterprises of strategies to distinguish themselves with products meeting customers' expectations, used by them for further processing. The need to implement product innovations is also influenced by the requirements set by corporations in cooperation chain systems. The importance of using process innovations is justified by the nature of the sector (production of materials), where new technologies enable the creation of innovative products but also affect cost competitiveness by reducing direct costs, i.e. materials, raw materials, energy, and labour.

Interest in process innovations is also influenced by the requirements and principles of a sustainable economy. Marketing and organisational innovations were implemented to a lesser extent, reaching the same level, that is, 36% of the companies surveyed implemented this type of innovation. Even taking into account the fact that 24 % of enterprises use management innovations, the share of this type of innovation, i.e. directly related to the market (customers) and management, is not satisfactory. A positive phenomenon is the relatively moderate interest in social innovations, reaching 20% of the surveyed enterprises. This situation is a signal for a broader recognition of the potential of this type of innovation, the importance of which in the development of a sustainable economy is constantly growing.

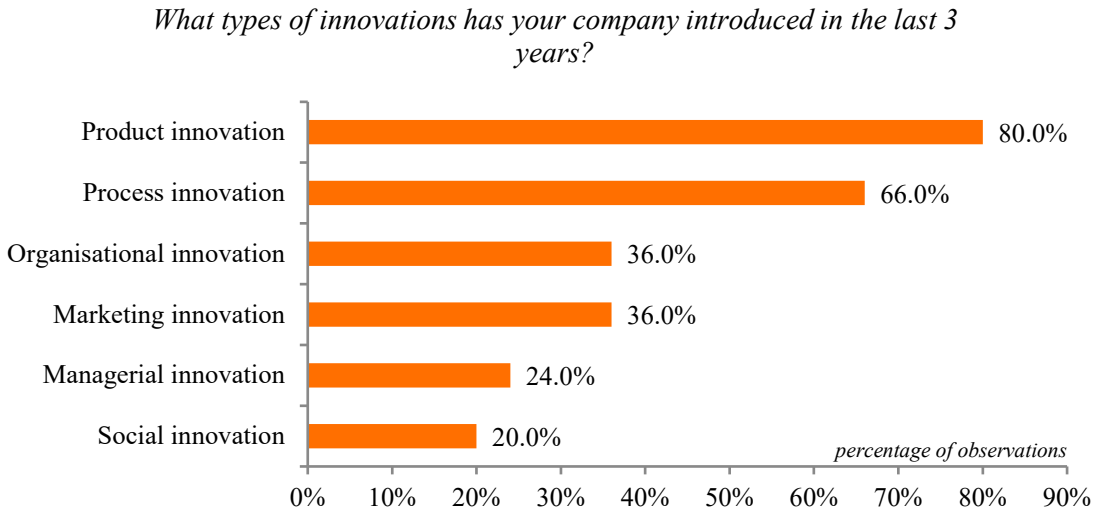


Figure 2: Types of innovations introduced by companies in the material production and processing sector (more than one indication possible, n=50). Source: Own elaboration

The issue of the relationship and direct reference of innovations to different areas of the company's operation arises from the very nature of innovations and the use of innovations in management. Information on this phenomenon is included by referring both to the actual state and the preferred state. Therefore, Figure 3 shows the responses of the respondents to the question 'In what areas of the company's activity are there direct references to innovation?' while Figure 4 shows the answers to the question *'In which areas of the company's activity should there be direct references to innovation?'*. In the first case, the vast majority (26 to 33) of respondents considered important the links between innovation and strategic management, i.e., goals, mission, vision, strategic analyses, and the company strategy itself. Fewer than half of companies see references to innovation in business models (22). In addition, less than half of the companies refer to business models (22), procedures, process maps (24) and organisational structures (25), i.e. elements of operational management. Relatively few respondents (14) see links between innovation and the use of key performance indicators (KPIs).

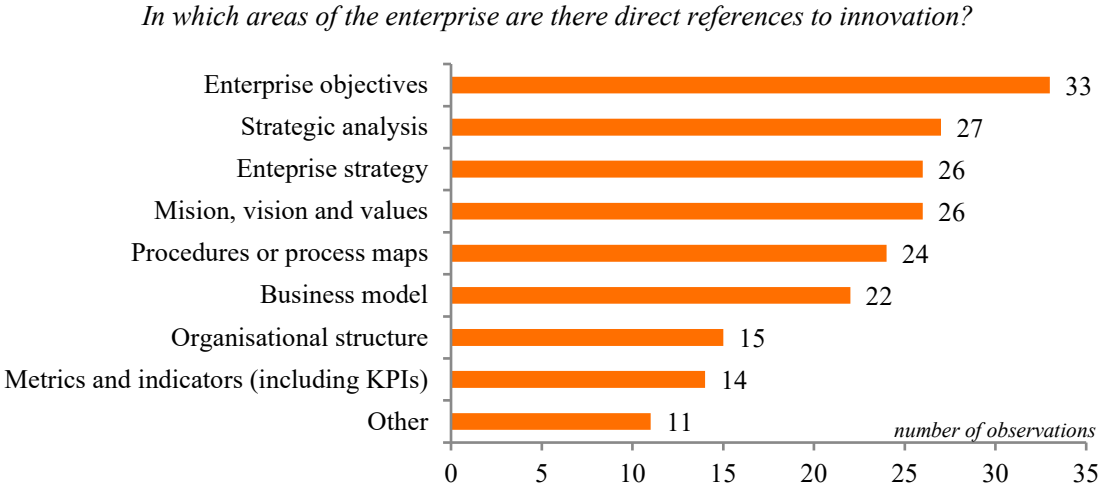


Figure 3: Business areas with direct references to innovation (n=50). Source: Own elaboration

This shows that there is little belief in companies in improving operational management, applying innovation to the construction of business models and using them as innovation vehicles. When analysing the responses related to the postulated state (benchmark), as shown in Figure 4, one can see a significant increase in the number of respondents perceiving a link between innovation and the strategic management of the company. The importance of innovation in the formulation of objectives is perceived in 40 companies, representing 80% of the entire research sample. Also, many enterprises (more than half) link innovation with strategy, mission, vision, values. The number of indications of links between innovation and process management (29), business

models, and organisational structure has also increased. Less than half (21) of the companies surveyed see links between innovation and business measures and indicators, including KPIs. This indicates an insufficient appreciation of the role of innovation in increasing organisational effectiveness and enterprise value.

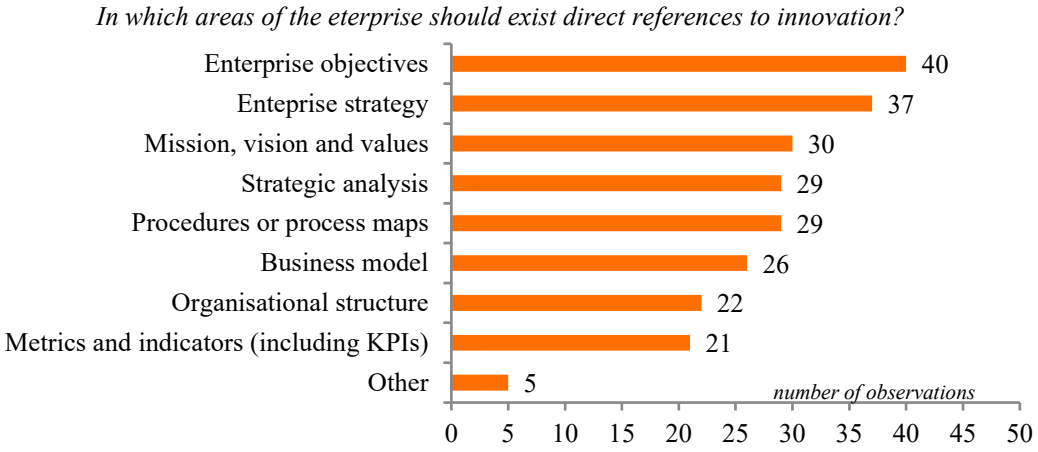


Figure 4: Areas that should have direct references to innovation (n=50). Source: Own elaboration

The issue of measuring innovation more broadly is characterised by two research questions:

- What innovation-related indicators/measures are used in your company ?
- Which innovation-related indicators/measures should be used in your company?

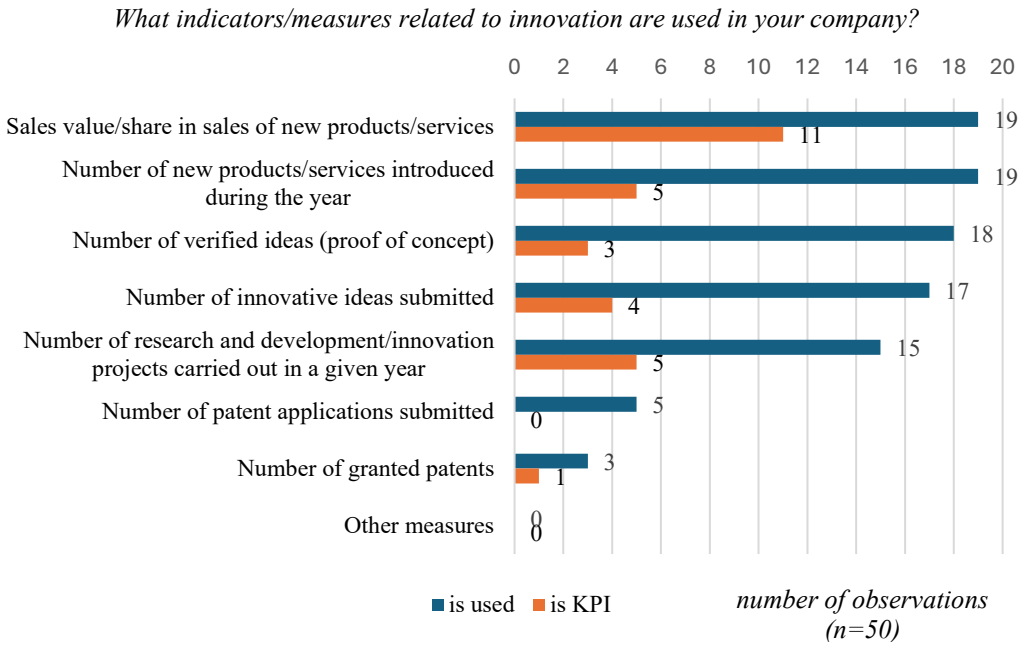


Figure 5: Areas where direct references to innovation should exist. Source: Own elaboration

The structure of the answers to the first of these questions is shown in Figure 5 and the second in Figure 6. The analysis of the answers shows that the use of outcome measurement for applied innovation is not common in companies. Among the companies that use outcome measurement of applied innovations, the most important are:

- value of sales/share of sales of new products is used by 19 companies and is considered a key performance measure by 11 companies,
- The number of new products (services) introduced during the year is used by 19 enterprises; 5 enterprises consider it as a key performance indicator (KPI).

A relatively large number (15) of companies use the number of research and innovation projects implemented to measure innovation. Analysis of the data in Figure 4 indicates a rare use of key performance measures for innovation activity. In the case of answers to questions concerning the desired state, more enterprises are in favour of using measures characterising innovation activity. More than half (29) of the companies surveyed postulate the use of sales value/share of sales of new products as a measure, but only 10 consider it as a key performance measure. Almost half (24) associate the number of validated ideas and the number of research and innovation projects carried out during the year with innovation. More than 20 companies opt for the use of the number of ideas submitted and new products introduced during the year to measure innovative activity.

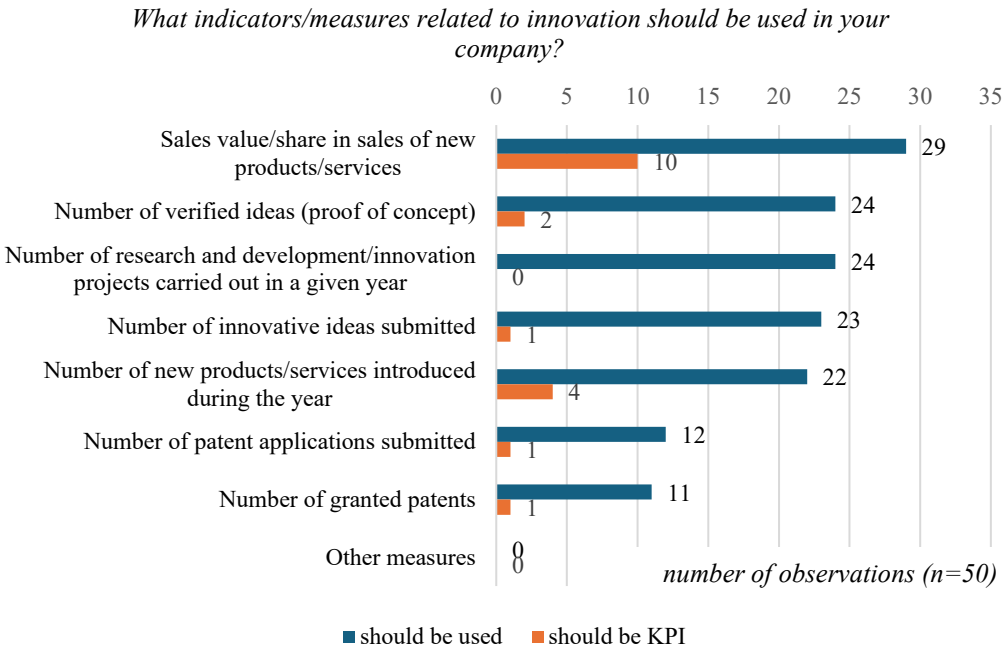


Figure 6: Indicators or measures related to innovation that should be used in investigated enterprises. Source: Own elaboration

Analysing the responses to the questions (Figure 6), it can be seen that very few respondents postulate the use of key performance indicators (KPIs) for innovation activities, indicating little interest and appreciation for innovation in corporate value management and little orientation towards motivating employees to innovate internally through the use of the Balanced Scorecard.

The problems of financing research, development and innovation activities are framed by the following research question: *'What percentage of revenue in your enterprise is allocated to research, development and innovation?'* The answers to these questions are captured in Figure 7. Nearly half (24) of the surveyed companies allocate less than 1% of their revenues to R&D&I of which 10 i.e. as many as 20% of the surveyed companies do not finance innovation in this way at all. In turn, 1% to 2% of revenues are allocated to R&D&I by 5 companies , from 3% to 5% it is 10 companies, 9% -10% are spent on this activity by 4 companies, and only one company declares financing this activity from revenues at the level of more than 10%. The results of the surveys clearly indicate a relatively low level of financing of R&D&I activity from own resources (revenues) of enterprises, which can be justified by awareness of high risk related to innovative activity. The information obtained may be used in the Regional Knowledge Management System as a premise for a policy that supports innovative activity, especially in the SME sector. It should be noted that in each technological area, the specifics of innovation activity may be different, hence the need for individualised research.

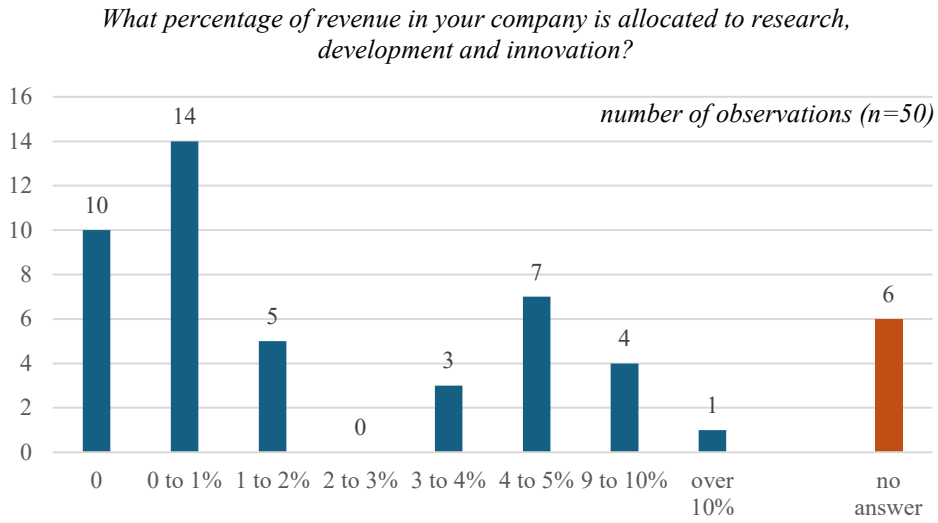


Figure 7: Percent of revenue allocated to research, development, and innovation (R&D&I) of the surveyed companies. Source: Own elaboration

5. Conclusions

Based on the analyses of the literature and the descriptive analysis carried out of NSRO operation as RKMS so far, the following conclusions may be drawn.

- NSRO meets the requirements for RKMS described in the literature, despite the fact that it concerns a narrow thematic scope, i.e. the innovation management in entities creating the regional smart specialisations.
- The most important functionality of the regional knowledge management system is to provide regional decision makers with knowledge about the needs of enterprises in the area of innovation management.
- Practical experience of the NSRO's operation indicates that it covers only a small part of regional innovation knowledge, but such systems should nevertheless be developed in order to rationalise decisions at regional level.
- The article presents an example of the knowledge collected by an exemplary observatory relating to the diagnosis of the current state of the region. Since 2024, observatories of NSRO have also been used to carry out technology foresight for selected technological areas. This is therefore a new functionality of the NSRO, which is part of the framework of the RKMS.
- Further development of the NSRO may involve improving and developing new tools for sharing knowledge with regional partners and developing tools for sharing tacit knowledge. This will also be a future research task for the authors of this article.

Acknowledgements

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Developing Business Managers' Skills for Data-Driven Decision-Making

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Abstract: The ongoing digitalisation of business operations continues to increase the amount of data available for organisations. As a result of this transformation, organisations are investing in business analytics tools and technologies to facilitate the use of this data in their decision-making. The existing business analytics literature suggests that the tools and technologies alone do not guarantee success in such endeavours, as organisations also need to have other types of resources, such as human skills and data-driven organisational culture, to form coherent set of business analytics resources that enable them to leverage data and business analytics technologies in their decision-making. While previous studies have recognized the importance of business analytics skills as the enablers of data-driven decision-making in organisations, they have focused mainly on the skills of analytics professionals who manage and run business analytics related operations, rather than the skills of business managers who use business analytics and its output to support their decision-making. Based on empirical data collected through 36 semi-structured interviews, the objective of this study is to identify the skills business managers need for using business analytics in their decision-making. Additionally, the study identifies several practices applied by organisations to help their business managers develop such skills. Contributing to the extant business analytics literature, this study highlights the importance of business managers' skills in making data-driven decisions by applying analytics-based output to support their decision-making and thereby offers new insights for both scholars and organisations concerning the prerequisites for using business analytics in managerial decision-making. Besides bringing concrete and practical ideas for organisations to develop the skills of their business managers and to seize the value from their business analytics investments, our findings also help the educational professionals to design programs for the future business managers in universities and other educational institutions by increasing their understanding on the skillset required from their students.

Keywords: Business analytics, Business managers, Skills development, Data-driven culture

1. Introduction

As a result of digital transformation, organisations have increasing amounts of data at their disposal. Business analytics (BA) consists of methods, tools and technologies organisations can use to analyse and interpret this data and to use it for making data-driven decisions (Davenport & Harris, 2007). Using BA helps organisations to leverage their data assets to better understand their operations, to identify new business opportunities, and to improve their performance (Oesterreich et al, 2022).

Extant research has established that BA-related resources such as data and technology, human skills, and specific cultural traits are integral for successful BA value creation. While data, technology, and basic resources form the backbone of BA, analytics professionals' (APs) skills are required to leverage those resources to produce analytics output, and data-driven culture ensures that this output acts as a basis for organisational decision-making (Gupta & George, 2016). However, much less attention has been given to the BA skills of business managers (BMs), who should make data-driven decisions based on analytics output (Schmidt et al, 2023).

This study contributes to the existing corpus of BA literature by identifying the skills BMs need for making data-driven decisions, and the practices organisations apply to develop such skills. We use a thematic analysis of empirical data collected from 36 interviewees in large companies to respond to two questions: 1) What kind of skills BMs need to make data-driven decisions? and 2) What kind of practices organisations apply to support the development of such skills? We start by summarising the extant literature and introducing our research methods. After that, we present our findings concerning the skills and the development practices. Finally, we discuss our findings in the light of existing BA literature and the implications they provide to scholars, organisations and educational practitioners interested in developing BMs' data-driven decision-making (DDDM) skills.

2. Theoretical Background

2.1 Resource-Based View of Business Analytics

The resource-based view of the firm (RBV) suggests that organisations should apply their resources in innovative combinations rather than in isolation to generate business value (Penrose, 1959; Barney 1991). Research has also shown that an investment into BA assumes investing into a combination of tangible resources, such as data assets, tools and technologies, and intangible resources, such as human skills and data-driven culture (Gupta & George, 2016; Mikalef et al, 2020). While financial BA investments in organisations often focus on acquiring tangible resources, the intangible resources are also crucial, as they are needed to leverage the other resources (Gupta & George, 2016).

DDDM means that data is proactively utilized to support decision-making (Davenport & Harris, 2007). In an organisation that is considered to have a data-driven culture, analytics-based insight is actively used for decision-making on different levels of the organisation (Medeiros & Maçada, 2022). Building a data-driven culture requires a collaborative approach that nourishes interaction between analytics and business (Öhman et al, 2021) but also adequate skills that enable creating and using BA output for decision-making purposes (Lamest & Brady, 2019). Organisations that invest into BA should understand its potential and applicability (Srivastava & Dixit, 2025) and plan their analytics-related activities accordingly (Narwane et al, 2021).

The skills of APs have been considered an essential enabler for DDDM (Gupta & George, 2016; Srivastava & Dixit, 2025). Besides technical skills needed to run BA and to produce analytics output, APs should possess managerial skills that enable them to manage analytics teams' work (Srivastava & Dixit, 2025). Additionally, APs should have skills that help them collaborate with their business and other stakeholders, such as communication and presentation skills (Carillo, 2017). Besides APs, also top managers have an important role in enabling BA adoption and DDDM in organisations, as they decide upon the resources dedicated to driving the related activities (Egwuonwu et al, 2024) and show commitment of using BA to support decision-making (Szukits & Móricz, 2024).

For BA adoption to be deemed successful, the organisation should use data-driven insight as a basis for organisational decision-making activities. Part of the value from BA arises from its potential to increase the share of automated decisions within organisations (Davenport & Harris, 2007), while BMs are also expected to use BA and analytics output to make data-driven decisions in those situations where automated decision-making is not a feasible opportunity (Oliveira & Handfield, 2023; Schmidt et al, 2023). Making data-driven decisions assumes BMs to possess an ability to understand analytics output and to apply it accordingly (Grandhi et al, 2021; Nasir et al, 2020). Hence, to reap the benefits of their BA investments requires organisations to equip their BMs with skills that enable them to use BA to support their decision-making activities (Lamest & Brady, 2019).

2.2 Business Nanagers' BA Skills

To make data-driven decisions, BMs should possess the ability to use BA and analytics output to support their decision-making. Whereas BA literature highlights the importance of managerial BA skills as building blocks of organisational BA capabilities (Mikalef et al, 2020), research focus has been on the organisation-level skills as well as the skills of APs and BA managers rather than BMs (Schmidt et al, 2023). What can, however, be considered as a common view within BA literature is that BMs need to 'understand analytics' and to be able to derive business impacts and plan actions based on analytics output (Lamest & Brady, 2019; Oliveira & Handfield, 2023).

Analytics understanding, referring to the ability to interpret the analytics output and use it as a basis for decision-making, is considered as a crucial skillset for BMs (Lamest & Brady, 2019). Such understanding seemingly acts as a common ground when BMs interact with APs, whereas possessing a more in-depth 'data efficacy', referring to basic skills on statistics, tools and software, technical infrastructure, experimental design as well as the development of performance indicators, would even increase their confidence on leveraging BA and collaborating with APs. Analytics understanding and data efficacy also support effective leadership in organisations. (Schmidt et al, 2023).

Some findings within the extant literature indicate that analytics understanding and data efficacy alone do not automatically lead BMs to make data-driven decisions. First, BMs should be able to balance their decision-making practices to fit the context they operate in and to explain their decision-making approach to their teams (Korherr et al, 2023). In this sense, they need to be aware of what DDDM means for the organisation but also to be able to reflect on their own behaviour concerning how they apply BA and analytics output in their decision-making, and why they do it in the way they do. Second, it seems that BMs should possess knowledge of the

latest BA tools and methods used by the organisation. BMs who aim at enhancing their DDDM skills should understand that they also need to update their skills on a continuous basis (Zaitsava et al, 2022). Hence, they need to establish an approach that enables them to do this. Third, DDDM assumes BMs to develop a positive attitude towards data and analytics, as otherwise they are not willing to apply their skills (Szukits, 2022). Besides helping them develop their skills, organisations should support them in building an attitude that encourages them to make data-driven decisions (Carillo et al, 2019).

2.3 Developing Data-Driven Decision-Making Skills of BMs

Organisations have an important role in equipping their BMs with BA skills, and they can proactively facilitate and promote using BA in decision-making (Grandhi et al, 2021). Various skills development practices, such as training programs, are important for building adequate-level skills for everyone involved with BA (Arora et al, 2022). To plan skills development for their BMs, organisations should start by identifying those factors that may prevent their BA use and thereby DDDM, such as competence gaps or information siloes (Zhan & Than, 2020).

To enable BA skills development, BMs should be supported by training activities (Merhi, 2021), but also by providing them with proper end-user assistance and making BA easily accessible (Arora et al, 2023). Knowledge sharing events about BA-related benefits can also support BA use (Economou et al, 2023). Additionally, organisations can encourage using BA and analytics output in decision-making by taking it into their strategic priorities as well as setting objectives and compensation schemes that promote such behaviour (Korherr et al, 2023).

Based on the extant literature, BMs need analytics understanding and data efficacy to use BA and organisations need to support them in developing such skills. However, previous findings indicate that a skillset enabling DDDM may also require something else. Next, we explain the methods we used for collecting and analysing data to take a closer look on what kind of skills enable BMs to make data-driven decisions and what kind of practices organisations have applied to support the development of these skills.

3. Methodology

3.1 Data Collection

The empirical data of this study was collected in the context of a two-year research project examining the development and use of BA capabilities in large companies. Qualitative inquiry (Timmermans & Tavory, 2012) was carried out through semi-structured interviews (Qu & Dumay, 2011) that were conducted between September 2022 and January 2023 for 3-5 informants selected by each of the 11 companies involved in the research project. Throughout data collection, we observed the emergence of new themes to ensure that the collected data formed a purposive sample (Constantinou et al, 2017). A third-party service provider was then used for transcribing all the 36 interviews before moving into the data analysis phase.

3.2 Data Analysis

The objective of our data analysis was to identify how the informants describe those BA skills BMs apply when making data-driven decisions, as well as how they consider their organisations to support the development of such skills. To focus on the relevant aspects within our data, we applied a thematic analysis approach that enabled inductive pattern identification and reporting for descriptive purposes (Braun & Clarke, 2006). Compared with for example content analysis, thematic analysis leans more on searching for common threads rather than specific issues and their frequency within the data, which increases the researchers' opportunities to identify patterns within the data (Vaismoradi et al, 2013).

For our analysis, we applied the six steps of the thematic analysis described by Braun & Clarke (2006, 87): 1) Familiarizing ourselves with the data; 2) Generating initial codes; 3) Searching for categories and themes; 4) Reviewing themes and creating thematic maps; 5) Defining and naming themes; and 6) Producing this research report. During the analysis, two thematic maps were created: 1) Themes concerning DDDM skills of BMs; and 2) Themes concerning the development of DDDM skills of BMs. Next, we describe our empirical findings using these thematic maps.

4. Empirical Findings

4.1 DDDM skills of BMs

Our first objective for this study was to find out what kinds of skills the BMs need to make data-driven decisions. Thematic map in Figure 1 describes the four themes and their underlying categories that, based on our data, form the DDDM skillset of a BM.

Understanding analytics value. Our analysis shows that the rationale for BMs to involve BA and analytics output in their decision-making activities in the first place is the value it can add to the decision-making process and its outcomes. Based on our data, BMs who use BA to support their decision-making consider analytics either to improve decision-making in general, or to improve their own understanding of the situation. Besides understanding the value arising from the use of BA in decision-making, also the ability to identify situations where using analytics could potentially bring additional value was considered to impact on whether it is used in decision-making situations.

Understanding and applying analytics output. Our data indicates that DDDM involves using analytics output such as reports, dashboards and analyses produced with BA tools and technologies. BMs interpret this output and apply it to their needs also without direct involvement of APs. Our observations indicate that analytics output can be used at any stage of decision-making to make it 'data-driven', whether discussing the interpretation of these reports and analyses, using this information to enrich the decision-maker's own knowledge, using the analytics output as a basis for the decisions, or leveraging it to lead people and communicate to them. Additionally, when analytics output is used for any of these decision-making related activities, the way it is applied depends entirely on the decision-maker who uses it.

Understanding analytics processes. Whereas the ability to understand and apply analytics output is where DDDM can be observed, it was also brought up by the informants of this study that BMs should understand how analytics work. Based on our data, BMs are expected to understand what kind of methods and data the analytics teams use and how, while they should also possess an understanding of which methods and data would be relevant from the viewpoint of their business. Additionally, to have a basic understanding of the time and effort required for creating different types of analytics output, they should understand how these methods and data are applied as part of the work conducted by APs.

Collaborating with analytics professionals. Although BMs were seemingly capable of utilizing analytics output without the involvement of APs, during our analysis we observed that many of the DDDM practices also involved close collaboration between these two roles. BMs have specific questions they want APs to find answers for, or they want to gain a deeper understanding of the analytics output. BMs are also seemingly proactive when collaborating with APs, expressing their needs concerning reports and analyses, participating in data and information gathering for analysis purposes, and participating in designing and validating the analysis and the output to ensure it can be used for decision-making.

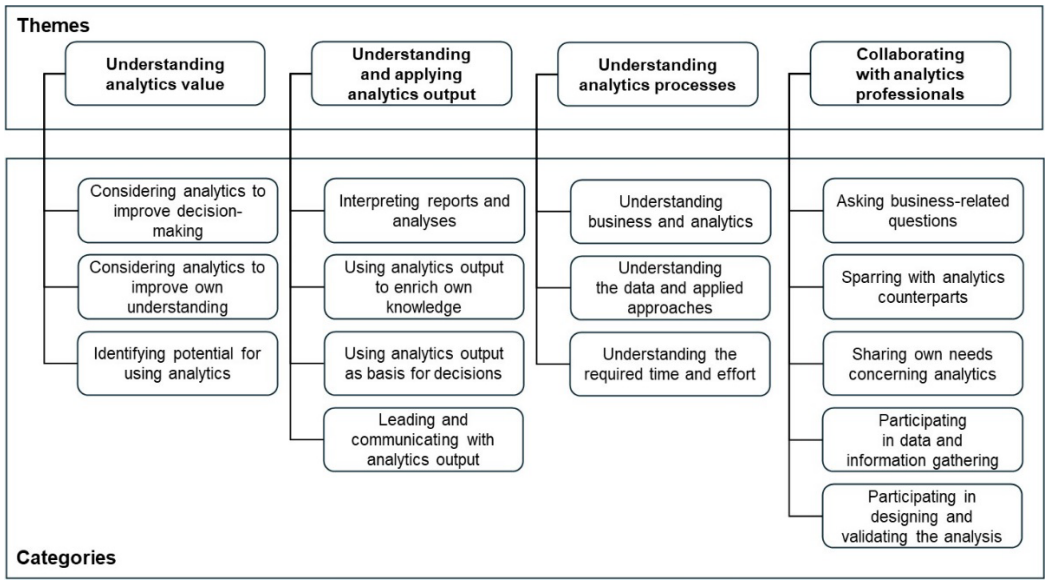


Figure 1: Themes concerning DDDM skills of BMs. Source: Authors' own work

4.2 Development of DDDM Skills of BMs

The other objective for this study was to identify practices for organisations to support their BMs to develop their DDDM skills. Thematic map in Figure 2 describes three approaches identified in our data, as well as examples of concrete practices that represent each of these approaches.

Arranging analytics training. Our data shows training-related practices form an important approach to equip BMs with skills that enable DDDM. Trainings offered by organisations vary from training programs to individual courses. While some training programs involve a curriculum or different themes and phases, other programs are tailored to serve specific needs of target group within the organisation. In some organisations, BMs can also choose from a selection of individual courses, that may either be instructed or offered as part of the organisation's self-service training offering. According to our observations training content highly depends on the organisation-specific needs identified by the APs; while some organisations emphasize the need for data utilization and data literacy, other organisations focus on teaching the use of analytics tools, reports or dashboards to their BMs. Some of the courses may also be compulsory for BMs, either due to regulatory requirements or because they are considered essential from the organisational viewpoint.

Facilitating analytics use. In addition to training their BMs, organisations also apply other practices that help develop skills for DDDM. Based on our observations, BMs get involved in DDDM as part of their daily responsibilities, and the related skills are developed through experience. Examples of this from our data include using reports and dashboards for sharing business status and learning to leverage analytics when using data as part of daily practices. Organisations facilitate the analytics use of their BMs by making the tools and reports as easy to use as possible, which may mean for example adjusting them to better fit the needs of a specific user or even letting the BMs create their own reports. BMs are also proactively supported by APs, either through dedicated support channels or simply being involved in joint activities such as projects or meetings. Some organisations also intentionally involve selected BMs into analytics use as "change agents" and use them as examples of successful analytics users as well as potential sources of peer support for other BMs who want to enhance their DDDM skills.

Sharing knowledge about analytics. Organisations apply various practices with an approach to share knowledge about analytics and how it can be used for DDDM. Whereas newsletters and information sharing events create awareness about analytics use, organisations also use them to share knowledge about analytics-related success stories and pilots that seemingly motivate BMs' DDDM. According to our data, BMs also ask APs to join in their meetings and events for knowledge sharing purposes whenever they have identified this to serve their needs. Some organisations have also established regular forums or continuous communities where BMs can get involved and hear the latest opportunities concerning analytics use and DDDM.

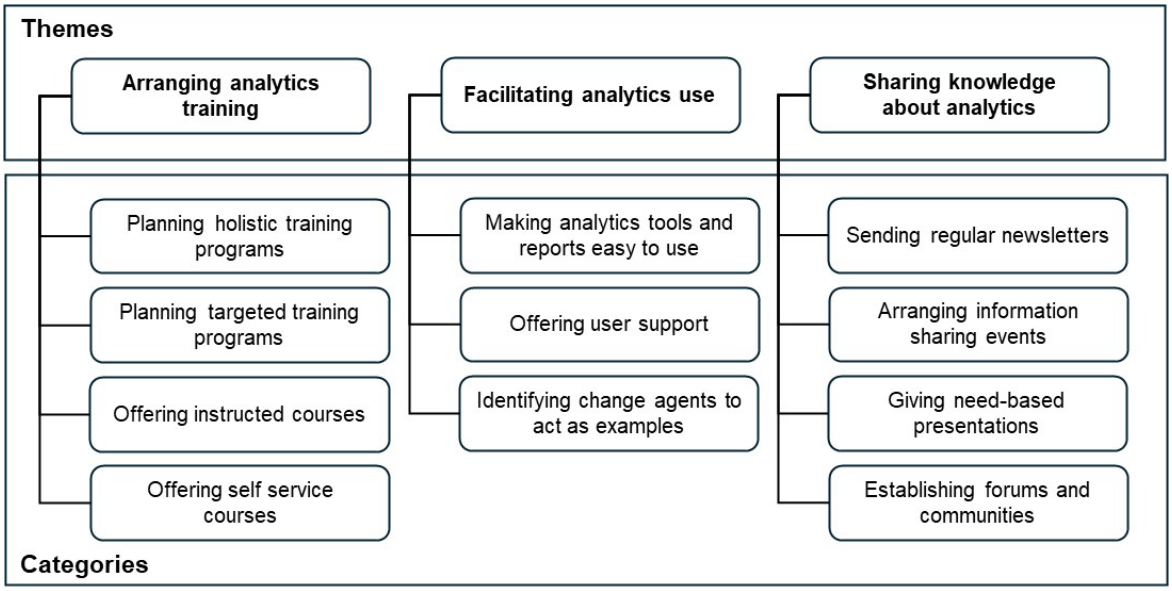


Figure 2: Themes concerning the development of DDDM skills of BMs. Source: Authors' own work

5. Discussion

To leverage the full value potential of BA, organisations should ensure that their BMs use BA and analytics output as the basis for their decision-making (Oliveira & Handfield, 2023; Schmidt et al, 2023). Our study shows that BMs need four types of skills for DDDM, and that organisations have various ways to equip their BMs with such skills.

First, to be willing to make data-driven decisions, BMs need to understand the value of analytics. Our data shows that BMs should consider BA and analytics output to improve both decision-making and their own understanding, while they also need to be able to identify where it may be used to add value. Understanding the value helps establish a positive attitude towards BA (Szukits, 2022), and organisations can support BMs in this by sharing knowledge on BA-related success stories and pilots via different channels, such as events, newsletters or communities. This is in line with previous findings stating that organisations can enhance BA use by organising events where they share knowledge about BA-related benefits (Economou et al, 2023).

Second, BMs who make data-driven decisions should be able to understand and apply analytics output. Our findings are aligned with the extant literature (Lamest & Brady, 2019; Schmidt et al, 2023), showing that this involves interpreting the output and using this to enrich BM's own knowledge and to make data-driven decisions Also in line with the extant literature (Korherr et al, 2023), BMs need these skills when leading their teams and communicating with them on the decisions they make. Whereas our data shows that skills to understand and apply analytics output are partly developed through experience, organisations also support their BMs to develop such skills through training activities. Organisations also intentionally facilitate the use of analytics output, by improving the accessibility and usability BA, as well as by tailoring its suitability for different needs BMs may have (Arora et al, 2023).

Third, understanding analytics processes, hence, how analytics work, helps BMs in DDDM. While the knowledge on analytics methods and the available data is important (Schmidt et al, 2023), also the understanding of the time and effort required for the analytics work is needed. Organisations provide various courses and training programs for their BMs to develop such skills. Whereas training for data literacy and analytics skills is considered a suitable approach, both the extant literature and our analysis show that organisations should also ensure end-user support for their BA users to enhance these skills (Arora et al, 2023). Our findings show that BMs get extensive support from APs, both as part of daily collaboration as well as through dedicated support channels.

Fourth, ability to proactively collaborate with APs is an important skill for BMs, as it helps them leverage BA and analytics output during different stages of their decision-making process. Based on the extant literature, analytics understanding and data efficacy may support such collaboration (Schmidt et al, 2023). Considering that BA methods, tools and technologies are constantly evolving, APs may also act as an important source for BMs on the new opportunities arising from this (Zaitsava et al, 2022). However, there seem to be other underlying factors that trigger BMs to reach out to APs, asking them questions, communicating their needs, and participating in data gathering and analysis design activities. Deriving from the extant research, such proactive collaboration means that both BMs and APs possess adequate skills for enabling DDDM (Lamest & Brady, 2019) and it can be considered a sign of data-driven culture as such (Öhman et al, 2021).

6. Conclusions, Implications and Limitations

According to RBV, organisations need to combine different types of resources to create value (Penrose, 1959; Barney, 1991). While BA enables organisations to create value through DDDM (Davenport & Harris, 2007), this will not take place without the DDDM skills of BMs (Lamest & Brady, 2019).

The current discourse of human BA skills emphasizes the skills of APs, paying less attention to the BMs, whose BA skills are mainly considered to consist of analytics understanding and data efficacy (Schmidt et al, 2023). This study updates this view by identifying four types of skills BMs need for DDDM: 1) Understanding analytics value, 2) Understanding and applying analytics output, 3) Understanding analytics processes, and 4) Collaborating with APs. The extant BA literature also suggests that organisations can support BA use of various end-users by, e.g., sharing BA-related knowledge through internal and interorganisational events (Economou et al, 2023) as well as providing end-users with training opportunities (Merhi, 2021) and end-user assistance (Arora et al, 2023). This study enriches these findings by offering concrete examples of those practices that organisations have applied to develop the DDDM skills of their BMs.

Extending the current view of human BA skills, this study provides scholars, organisational practitioners and educational professionals with new insight on DDDM skills and their development in organisations. Scholars can

include the findings of this study as a basis for further examination of human BA skills and the creation of DDDM culture in organisations. Whereas organisational practitioners may find it useful for evaluating the current skills of their BMs and for identifying new approaches to developing these skills, educational professionals can use our findings in curriculum planning for future BMs.

This study also involves limitations, some of which may serve as opportunities for future research. Whereas we consider our data to form a purposive sample that enables fulfilling the objectives of this study (Constantinou et al, 2017), this research still leaves plenty of room to further explore the DDDM skills and their development in other contexts and with other research methods. Our analysis also indicates that the four kinds of skills identified in this study may be interconnected, providing an opportunity for future research to evaluate these connections with other methods.

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AI declaration: No AI tools were used for developing this research paper.

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