

# Anticipating Change and Development With Systematic Build-up of Critical Knowledge Assets: Blueprint for a Knowledge Roadmapping Framework

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**Abstract:** Organizations of today act in a volatile operating environment that 1) implies challenges for firms in adapting to the new conditions but also 2) creates opportunities that new areas of knowledge and technology offer. To succeed, companies need to embark on the journey of visionary and strategic management also concerning knowledge management (KM). They also need to simultaneously link the change and development to make a continuum with the current offerings and operations. Technology Roadmapping (TRM) by e.g., Robert Phaal et al. (2004) has been introduced as a solution to describe the process of understanding and combining what is needed (external and internal business drivers) and what is possible (technologies available). In their meta-analysis of the knowledge roadmapping literature Letaba et al. (2015) conclude that technology roadmaps have supported the process of operationalizing strategies by mapping details of future R&D programs, technology and manufacturing capability development. However, technologies *per se* do not offer a competitive advantage if they are not paired with knowledge of how (and when and where) to use the technology and how to resource the build-up of the knowledge that will be relevant for the future. Competence mapping is a common tool that links jobs and skill needs to succeed in them. Competence maps act as inventories that sum up the knowledge possessions of departments and individuals in the organization. These mappings are however cross-sectional – focusing on current needs vs. current knowledge possessions – and do not link seamlessly to the overall vision and strategy of the organization. This conceptual paper introduces aims at creation of a blueprint for a new framework and process for Knowledge Roadmapping by integrating the findings of earlier research across the fields of technology, competence and knowledge mapping. The framework is built on Technology Roadmapping structure by Phaal et al. (ibid), adding to it the layers of Critical Knowledge Assets (CKA) and Business Process Excellence (BPEx). E.g., new CKAs such as “data-drivenness” and “resource wisdom” directly affect the Product and Service offerings (PSOs) of a firm but also the effectiveness of the firm’s business processes and technologies that an organization can deploy. The framework is built by synthesizing the findings of extant literature on technology, competence, and knowledge roadmapping. The theoretical contributions of the paper add to the knowledge pool of the nascent area of knowledge roadmapping and practical contributions serve organizations by offering a planning tool that ties KM to their overall strategic foresight.

**Keywords:** Knowledge, Capability, Anticipation, Career, HRM Strategy

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## 1. Introduction

### 1.1 The Objectives and Research Question

The operational environment of organizations is knowledge-intensive, up to the point where the current tide across industries and societies can be called the knowledge economy (Powell and Snellman, 2004). To succeed, companies must be capable of creating, acquiring, protecting, and sharing knowledge.

Recently, advancements in technologies such as the Internet of Things (IoT), machine learning, and predictive and generative artificial intelligence have presented new opportunities for companies to gather, analyze, and convert data into useful information. This information can help businesses make informed decisions that can lead to short- and long-term success. *Knowledge* is an essential resource that companies need to succeed in the foreseeable future. An environment that values knowledge as an asset also means that new knowledge brings with it destructive capacity since adjusting to the new “settings” of the operational environment can cause organizational crises (Freeman and Perez, 1988). Knowledge intensity—if well mastered—has the potential to help avoid the worst impacts of those crises and create new entrepreneurial opportunities via knowledge creation and resulting differentiated offer advantage (Moore, 2000). As a result, it can be claimed that modern KM needs to be dynamic in two senses of the word: It needs to contain the (future) time element as well as depict the dynamism of KM between an organization and its business partners (Saukkonen, 2020).

Organizations have applied many ways to keep up to date with the knowledge that they possess. The need for this type of inventory or deposit –approach of knowledge is well reflected in an often-quoted expression of the

need and difficulty of mastering knowledge by then-CEO of Hewlett-Packard Lewis E. Platt: "If only HP knew what HP knows we would be three times more productive" (Atwood, 2009). On top of mapping the current competencies, educational institutions and companies have engaged in efforts to anticipate the capabilities likely needed in the changing operational landscape. Anticipation as action and mindset is close to the foresight process, a joint effort of stakeholders to explore futures and interpret them to justify the present actions (Dufva and Ahlqvist, 2014) - e.g., in knowledge management. As Poli (2014) stated, anticipation brings in both calculable risks and incalculable uncertainties. Organizations vary in their capability to utilize futures in their decision-making (ibid.).

Companies aim to cope with and anticipate the change with their long-term plans for corporate strategy and their technology and product roadmaps. From the outputs of those efforts, different corporate functions - such as Human Resource Management (HRM) and Knowledge Management (KM) - get inputs in their function-specific visions and strategic plans. As Mintzberg (1987) coins the term, strategies are made purposefully and consciously before the action they will apply.

This paper aims to synthesize the existing models of roadmapping and the aims and scope of strategic knowledge management into a new framework to facilitate change management and strategic alignment of KM efforts. The research question i.e. the quest for new knowledge set at the start of the research journey is: *"How can the current tools of science, technology, competency and product roadmapping be further improved to better facilitate strategic and dynamic knowledge management?"*

This research aligns with the practical needs of the industry, echoing the remark of (technology) roadmapping by Letaba et al. (2015): "Practitioners and scholars alike are seeking new ways on integration of this technology market planning tool with other business processes while on the other hand, there are efforts for their customisation according to the needs of managers or policy makers."

## 1.2 The Approach and Method of the Study

The research approach and method of this paper is conceptual. The authors aim to understand and structure the phenomena under study, combine the related concepts, and derive and propose a new framework for further study. Young (1995) proposed that an essential parameter of conceptual research is an attempt to give clarity to concepts systematically. Conceptual research can be used to develop new concepts and reinterpret existing ones (Leuzinger-Bohleber & Fischmann, 2006). Conceptual researchers investigate, e.g., the meanings and usage of concepts. The outcome of this study is built on existing concepts that have been combined into a proposal for a new integrative framework, "Knowledge roadmap", and a proposal for a roadmapping process that organizations can apply. In this research, the authors reviewed selected papers using Semantic Scholar, SciSpace and Google Scholar tools. The findings of the most relevant prior art studies are displayed in the literature review (Chapter 2), and elements identified in those papers as well as the elements found to be missing from current frameworks get integrated into the new framework. As is typical for conceptual research, the study also fulfils many criteria of exploratory research. Exploratory research is typically an initial investigation to clarify a problem and provide understanding and background information. It has the role of preparing for more conclusive future studies with limited prior knowledge. (Manerikar and Manerikar, 2014).

## 2. Literature Review

### 2.1 Competency and Knowledge Mapping

Competency mapping identifies and evaluates the skills and competencies required for different organizational job roles (Jaskiran et al., 2023). It may be used as a tool that supports understanding the strengths and weaknesses of individuals and directing their career development. It can also be used in talent acquisition, induction, training and development, and assessment processes in HR. Competency mapping can be visualized using knowledge or competence maps, which provide an overview of prevailing competencies in an organization. *Skill mapping* is a related concept that involves analyzing the skills and competencies required for a job position. Creating skill mapping involves analyzing the skills and competencies required for the job position, evaluating the employee's current skills and competencies, and creating skill mapping and learning activity plans based on their level (Komkrit, 2023). Competency and skill maps are cross-sectional; they are created for the current needs of competencies for job roles and map the skills (what, who, where) possessed at the time of analysis.. As Carvalho et al. (2013) commented, roadmaps that depict one or more possible routes to reach the destination have found their way into the planning in business and non-profit organizations over the recent decades.

According to Dönitz (2023), roadmapping is a flexible and practice-oriented tool for assisted strategic planning and can be used in various fields of expertise. Roadmapping has been claimed to have many affordances and claimed benefits for strategy development and innovation (Phaal & Muller, 2009). Roadmapping is a process that involves many stakeholders and is constantly evolving (Tang et al., 2011). Knowledge and competency roadmapping is a strategic approach that yields structured plans to guide organizations and individuals in assessing the needs and means of acquiring knowledge to achieve relevant competencies in a particular field of activity. The output of the process – roadmaps – serves as pathways that outline steps and milestones in time needed to reach the contents and levels of knowledge portfolio to reach a desired level of proficiency.

Numerous studies have shown the importance of knowledge roadmapping. Siebelink et al. (2021) reported that firms worldwide face challenges and need help with strategic and long-term development plans. Creating coherent plans and efficiently communicating them with employees is difficult, leading to the search for strategic development tools such as roadmapping (ibid.).

On a pragmatic level, knowledge roadmapping is a workshop-based tool that utilizes diverse knowledge from individuals to create shared knowledge in the form of a roadmap for navigating a strategic landscape (Pan, Liao & Zhang, 2023). It involves drawing on individual knowledge and transforming it into collective outcomes through shared meanings and commitment to act (Krull, Smith, & Husted, 2022). The aim is to improve knowledge sharing and ultimately achieve better strategic outcomes. Roadmapping facilitates face-to-face interactions between individuals in a neutral space, fostering knowledge sharing. Additionally, a positive disposition of individuals to share knowledge and imperatives to trigger knowledge contributions are essential factors in knowledge sharing during roadmapping. The role of the facilitator is also highlighted as crucial in promoting knowledge sharing. This multilevel approach to knowledge sharing in roadmapping provides insights into the relationship between individual knowledge and organizational-level outcomes.

## 2.2 Science, Technology, and Product Roadmapping

The process of roadmapping serves various purposes and helps in strategic planning, competence mapping, and knowledge asset planning. The study conducted by Siebelink et al. (2021) reviewed the roadmap as a strategic tool that helps companies surpass critical strategic challenges. Previous studies have shown that significant corporations such as Motorola and Philips have used roadmapping for decades to navigate product direction, anticipate potential risks, and make long-term plans. Adopting roadmapping has allowed firms to gain a competitive edge and improve their long-term planning capabilities.

Effective knowledge management is a challenge that most companies face, regardless of their industry or size. Qualitative research conducted by Sareminia et al. in 2018 shows that roadmapping for knowledge management can be a powerful solution to this challenge. The study developed a framework that offers a structural approach for organizations to efficiently manage their knowledge through visual roadmaps, opening new possibilities for effective knowledge management.

In 2015, Yee and Teoh conducted structured action research to create a unified roadmapping system that any organization could adopt. The system was designed to enhance a company's strategic capability. Unlike other studies focusing solely on technology roadmapping (TRM), this research explored knowledge management's "soft" aspects. Meanwhile, Phaal et al.'s 2009 study looked at technology roadmapping and their T-plan framework as a tool for navigating disruptive markets. Similarly, Moehrl et al. (2013) argued that technology roadmapping is an approach that can help companies address future challenges. These studies show that technology roadmapping is a valuable method for navigating change. Companies of different sizes and industries have widely used technology roadmapping to ensure their technologies align with their strategic objectives.

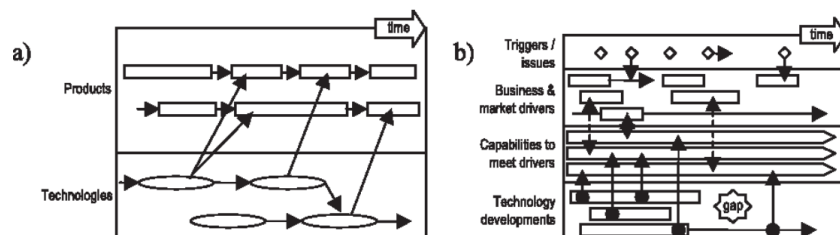


Figure 1: Examples of technology roadmapping process interim outputs in the T-plan model (Phaal et al., 2004)

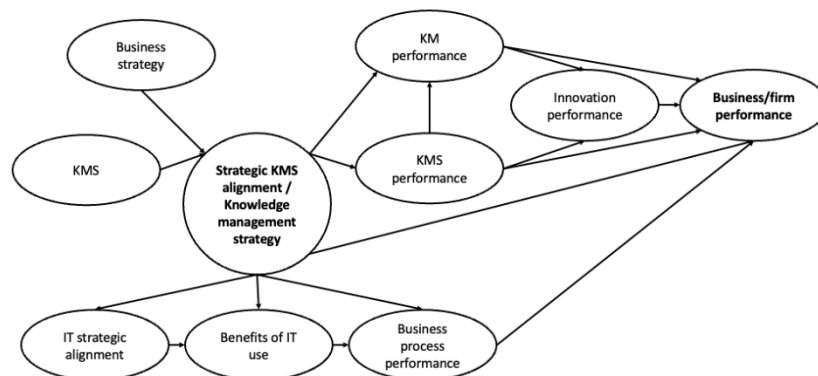
Product-technology roadmapping is an effective method to ensure that current plans align with long-term objectives and specific steps. This approach creates a visual framework that consolidates knowledge across different structures within a company. According to Raymond et al. (2007), several crucial factors must be considered when creating a roadmap. These include the scope of the roadmap, the level of detail required, and the importance of data privacy throughout the process. Involving stakeholders from different company functions as well as technology and data analysis tools can enhance roadmapping.

### 2.3 Strategic Alignment of Knowledge Management

“Competitive strategy is about being different” (Porter, 1996). It means, for example, choosing a different set of activities to deliver a unique mix of values. Today, it more and more also includes the choices of knowledge and technology. The organization can be conceptualized as an institution for integrating knowledge (Grant, 1996). The simplified production task in an organization is transforming inputs into outputs. In this organizational context, the fundamental activities include creating, acquiring, storing, and deploying knowledge. Grant (1996) studied the coordination mechanisms through which organizations integrate the specialist knowledge of their members. The emphasis was primarily on the application of knowledge and the role of the individual.

Strategic thinking can and should lead to new options in the evolution of the business. Bolisani and Bratianu (2018) emphasize the importance of aligning knowledge when creating organizational value. The scarcity of tangible assets can be balanced with the availability of intangible resources. They see “knowledge strategy planning as a continuous effort of learning and adaptation to needs and opportunities that dynamically emerge from daily practices.”

Aligning strategy with a knowledge management system improves innovation and business performance (Lai et al., 2022). Strategic knowledge management system alignment (SKMSA) has a significant positive impact on knowledge management (KM) and knowledge management system (KMS) performance (Figure 2.). SKMSA was defined in this study as the degree to which a firm’s business objectives are supported by crucial KM entities such as processes (e.g. knowledge codification), skills, tools (e.g. knowledge map), and motivation (e.g. trust, rewards). It was concluded that “firms achieve their performance goals through SKMSA instead of developing a standalone KMS or business strategy.” The study by Yoshikuni and Albertin (2020) demonstrated findings that knowledge management strategy (KMS) has significant, positive effects on IT strategic alignment, benefits of IT use, business process performance, and firm performance (Figure 2).



**Figure 2: The strategic knowledge management system (KMS) alignment / knowledge management strategy has a positive effect on business/firm performance (Lai et al., 2022; Yoshikuni & Albertin, 2020)**

Jami Pour et al. (2018) have suggested implementing KM strategic planning in practice. The main phases of KM strategic planning are review, orientation, implementation, and evaluation. The KM strategic review includes external environment analysis and internal environment. KM's strategic orientation consists of setting KM's vision, identifying the strategic knowledge gap, and prioritizing knowledge-oriented processes. KM strategy implementation includes allocating the KM resources, identifying appropriate KM mechanisms, identifying KM processes, and developing a detailed action plan. KM Strategic evaluation involves identifying key performance indicators (KPIs) and reviewing strategic priorities regarding emerging changes.

All in all, strategic alignment of knowledge management is essential, and as Prahalad (1990) put it: “Unlike physical assets, competencies do not deteriorate as they are applied and shared. They grow.”

## 2.4 Research and Tool Gap for Strategic and Dynamic Knowledge Management

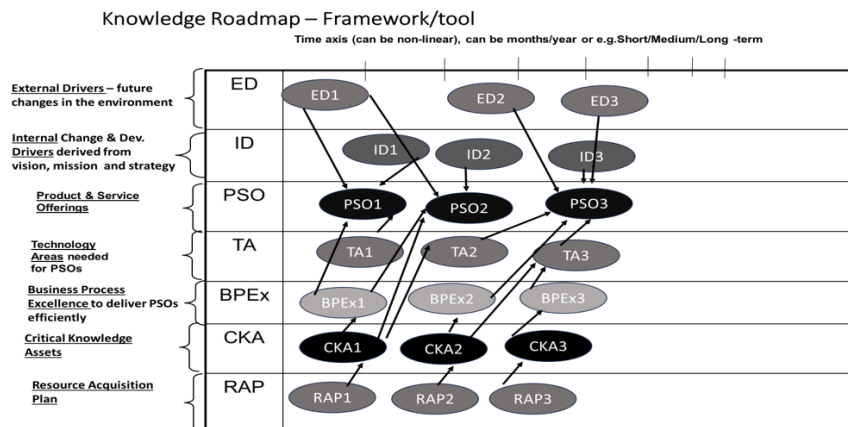
The study got its motivation from the identified gaps of knowledge. Firstly, strategic knowledge alignment with other areas of planning (technologies, product, and service offerings, and resourcing both tangible and intangible resources). Secondly, the commonly deployed process of knowledge roadmapping does not specify the knowledge areas and their acquisition that need to be paired with technologies and business processes for the organization to reach its aims. Thirdly, the current knowledge mapping process is not dynamic but cross-sectional; it creates a knowledge inventory of the firm and its stakeholder network but not the evolution needed for future knowledge inventory. Finally, doing the roadmapping by tying it into the firm's strategies and visions (Internal drivers) and changes in operative environment (external drivers) would make the choices made in knowledge roadmapping easier to justify.

The prior-art literature in the topic area is not vast: In a Google Scholar Boolean search for academic papers about the roadmapping philosophy, close to 1000 papers had "technology roadmapping", "technology roadmapping" or "technology roadmaps" in the research title. In the case of "knowledge roadmapping"/"knowledge roadmapping"/"knowledge roadmaps" in the paper title only 3 papers were identified. Thus, knowledge roadmapping is an emerging but understudied area that requires increased interest, as well as the tools and frameworks that the technology roadmapping approach already has. Combining the vast prior-art knowledge of technology roadmapping and findings of the nascent area of knowledge of roadmapping, a new framework with theoretical and practical contributions would advance roadmapping research and practice. As proposed, knowledge roadmapping -approach can enlarge the current technology-focused roadmapping approach with "soft" issues and information systems. Despite the recognized need, effort in framework development has been scarce.

## 3. Results - A Blueprint for a Knowledge Roadmapping Framework and Process

### 3.1 The Structure of a Knowledge Roadmap

This paper's evolutionary step is the proposal to expand the product and technology roadmapping process. The new model below (Figure 3) would cover the knowledge needed to meet the operating environment and strategy changes more widely and deeply, emphasizing the crucial role of knowledge and knowledge planning in achieving organizations' goals.



**Figure 3: The elements and some hypothetical interconnections of the Knowledge Roadmapping framework.**

**External Drivers (ED):** Changes in the operating environment that are foreseen, independent of the existence and action of the company doing the roadmapping. These drivers can be sourced from, e.g. Megatrend reports by institutes of futures research (e.g. SITRA in Finland, Fraunhofer Institute in Germany) and top-tier consultancy companies (Deloitte, Nielsen, etc.). The drivers can be sourced and arranged using e.g. the PESTEL framework: Political, Economic, Social, Technological, Ecological, and Legal drivers.

**Internal Drivers (ID):** The firm's strategic choices and development in the long run towards new business opportunities. The firm's vision, mission, and strategy are the main sources for the drivers. These may include targets for e.g. new market entries, growth, market shares, profitability etc.

**Product and Service Offerings (PSO):** Resembling the layer of Product Feature Concepts (PFCs) in the T-plan approach by Phaal et al. (2004), this layer depicts future offerings to chosen target market segments. The PSOs can be entirely new or development versions of existing offerings. They can be related to physical products or services offered—or a combination of the two.

**Technology Areas (TA):** On this layer, the organization maps the technology areas that have potential or are needed to bring about the PSOs mapped in the layer above. Mapping can also be done on a robust level (“location technology”) or on a specific level, naming the technology like “Global Positioning System GPS.”

**Business Process Excellence (BPEx):** The areas of operational excellence where the organization must be genuinely competitive to deliver PSOs efficiently and take the identified TAs into use. The business processes can be named according to the organizational divisions (marketing, purchasing, customer service, R&D, etc.) or on a more conceptual level (customer care, co-creation).

**Critical Knowledge Assets (CKA):** The areas of capability that the company must possess or have access to (if CKAs held, e.g. by a business network partners) to be able to excel in TAs and BPExs. Knowledge assets refer to the valuable resources and capabilities that an organization possesses in the form of knowledge. These assets can include internal knowledge developed within the organization and external knowledge acquired from outside sources. Knowledge assets can be categorized into different types, such as structural capital, relational capital, and human capital, each of which can contribute to firm performance. In today’s technology-laden operating environment, Improvement methods for knowledge acquisition include using advanced technologies like artificial intelligence and machine learning to automate knowledge extraction and analysis via “intelligent agents”.

**Resource Acquisition Plan (RAP):** This layer focuses on how and when knowledge assets are acquired or created. Ways to secure knowledge availability range from own R&D projects and strategic hiring to license acquisitions and partnerships with other organizations.

### 3.2 Blueprint for a Process that Yields the Roadmap

The framework for knowledge roadmapping, proposed in section 3.1, can be developed through a series of workshops. The workshops will produce content for the different layers of the framework, connect the items across different layers, and put them into a timeline. The table presented below organizes the steps of the process into the order and themes of the workshops, desired outcome layers, and the stakeholders involved in each step. Overall, it provides a structured overview of the roadmap development process.

**Table 2: Workshop-based process of creating a knowledge roadmap**

Workshop order and theme	Desired Outcome Layers	Stakeholders in charge
1. Driver recognition	External Drivers (ED), Internal Drivers (ID)	R&D, Business Intelligence, all functions' representatives
2. Offering and techs	Product and Service Offerings (PSO), Technology Areas (TA)	R&D, Technology/ Product Development team, Sales&Marketing
3. Business processes and knowledge assets	Business Process Excellence (BPEx), Critical Knowledge Assets (CKA)	R&D, Functional Managers (= business process owners)
4. Resourcing and charting	Resource Acquisition Plan (RAP)	R&D, Business Intelligence; HRM

During workshops, charts and diagrams can be created using whiteboards, flipcharts, or specific ICT tools for roadmapping, such as Fibery, Productboard, Miro, and more. These exercises help better understand both internal and external markets, business drivers, and knowledge management. To ensure transparency and avoid frustration, guiding all participants throughout the workshop process is essential. The first driver recognition workshop may involve outside stakeholders like business consultants or strategic advisors. The structured approach presented in the table helps companies to navigate the complexities of strategic planning systematically. This approach allows them to create a roadmap that aligns with their objectives and goals while fostering agility and adaptability in response to internal and external dynamics that may change over time. This approach enables companies to plan strategically and respond to changes effectively.

## 4. Conclusions

The research question set in the beginning of the study was: “How can the current tools of science, technology, competency and product roadmapping be further improved to better facilitate strategic and dynamic knowledge management?”

With the exploratory research approach that aimed at creating a new framework to be tested and implemented later, this paper offers an enlargement of the pre-existing frameworks of technology roadmapping, competence and knowledge mapping. The framework is the theoretical contribution of the study. Certain elements and principles of the earlier frameworks, such as the time-boundness of the framework elements, layered structure, and the role of technologies (enablers) and internal/external drivers (change agents) and resourcing layer, were kept intact. In addition to these, the model introduced layers of Business Process Excellence and Critical Knowledge Assets. On top of the framework, the paper introduces a proposal for a process consisting of a series of workshops that will yield the framework content and a full-scale knowledge roadmap to fit the company strategy and changing operation environment. The process consisting of workshops that will yield company-level understanding of the “big picture” of knowledge management needs connected with other areas of planning is the practical contribution of the paper.

## 5. Discussion

Operational excellence and strategy are essential for the firm's long-term success. The Knowledge roadmapping framework helps to consider all the essential diverse elements systematically. Systematic and dynamic knowledge management can be spread across a firm's business functions and stakeholders via roadmapping. Operational excellence can be supported and developed via a systematic knowledge roadmapping process and parallel the strategic alignment of knowledge management can be established. The proposed Knowledge roadmapping framework and the process can be reflected against Zack's (1999) framework which discusses the areas of knowledge presented in Table n. With the Knowledge roadmapping framework, we can better consider the questions "knowing why, what, when, where, how, and who?".

**Table 3: Knowledge roadmapping framework in reflection to Zack’s knowledge framework**

Knowing is made of...	Layers involved in the Knowledge Roadmap framework
Knowing WHY	External Drivers (ED), Internal Drivers (ID)
Knowing WHAT	Product and Service Offerings (PSO), Critical Knowledge Assets (CKA)
Knowing WHEN	External Drivers (ED), Internal Drivers (ID), (Resource Acquisition Plan (RAP))
Knowing WHERE	External Drivers (ED), Internal Drivers (ID), Product and Service Offerings (PSO)
Knowing HOW	Technology Areas (TA), Business Process Excellence (BPE), Critical Knowledge Assets (CKA)
Knowing WHO	Critical Knowledge Assets (CKA) and Resource Acquisition Plan (RAP)

Our conceptual paper introduces a blueprint for a new framework and process for Knowledge Roadmapping. Future research could study the implementation of the Knowledge roadmapping framework in different business contexts. A longitudinal, in-depth analysis of the outcomes of a knowledge roadmapping process would illuminate the actual outcomes.

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