

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

Pradipta Banerjee and Sobah Abbas Petersen

Department of Computer Science, Norwegian University of Science and Technology, Trondheim
Norway

pradipta.banerjee@ntnu.no

sap@ntnu.no

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.

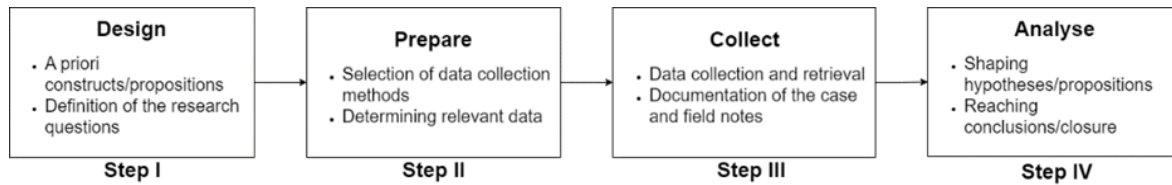


Figure 1: Overview of the case study process

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.

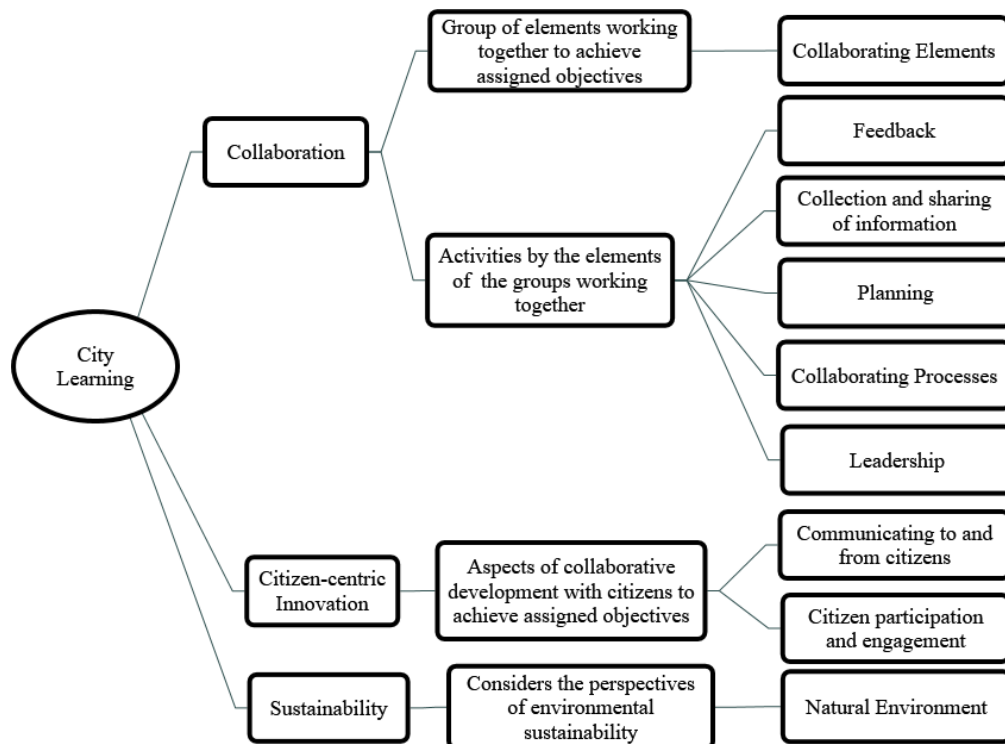


Figure 2: Themes identified in the document analysis of the selected cases

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.

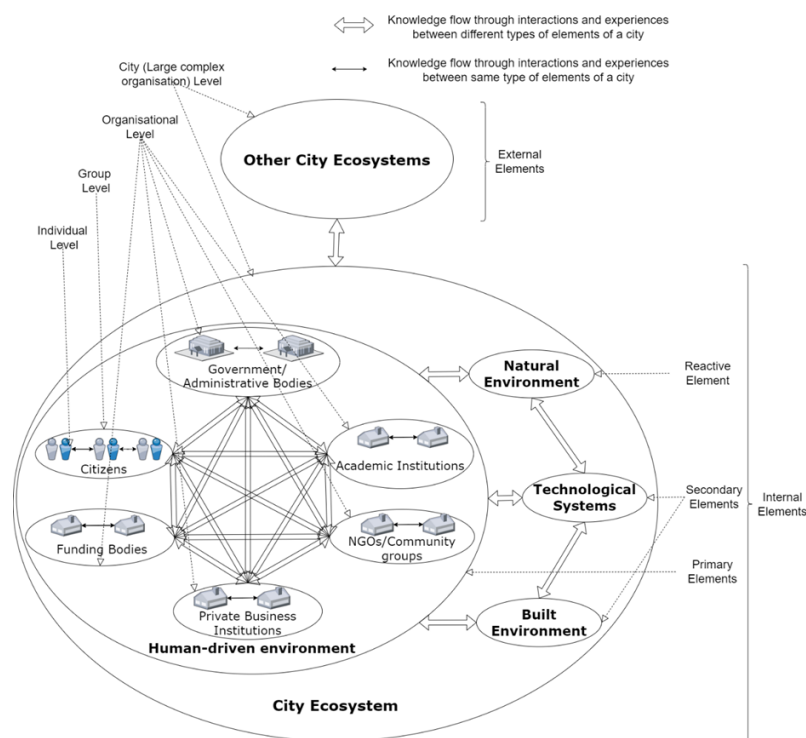


Figure 3: A conceptual model illustrating the elements of a city and its ecosystem view for city learning

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 • 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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