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Contents

A Scoping Review on Project-Based Organization's (PBOs) Knowledge Transfer Using the Systemic Lessons Learned Knowledge (Syllk) Model as an Interpretative Structural Model (ISM)

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Abstract: Aim: A scoping review was conducted in order to systematically map the research featuring Project Based Organizations (PBOs) in relation to knowledge transfer. This scoping review considered over 50 years of research to ascertain how PBOs transfer knowledge by using an interpretative structural model (ISM) to illustrate the outcomes of the investigation via the Systemic Lessons Learned Knowledge (Syllk) Model, created by Duffield and Whitty (2015). We wanted to illustrate what knowledge transfer elements from the authors' original model outlining six key themes were sustained and prevalent in literature as representative of this knowledge transfer process. The six elements are: learning, culture, social, technology, process and infrastructure. Employing an ISM also helped identify gaps in existing knowledge. The following research questions formed the basis of our study: **Research Question 1:** How does the Syllk model help interpret and categorize knowledge transfer dynamics in PBO contexts? **Research Question 2:** What adaptations are required, if any, to the Syllk Model (Duffield & Whitty, 2015) to better facilitate knowledge transfer within PBOs? **Research Question 3:** What are the key barriers to knowledge transfer in PBOs? **Findings:** Extant literature indicated that knowledge sharing depends on the willingness of individuals to participate, without which lessons cannot be learned. The results of this scoping review illustrated how some of the elements within the original Syllk Model by Duffield and Whitty (2015) are not fully exploited by organizations. Moreover, several terms possess hazy definitions which further disadvantaged outcomes as it makes some reserch outputs open to question because concensus on the ideology for each element considered as a key theme is subject to interpretation. We propose the Aspirational Syllk (ASyllk) Model as a reconceptualized ISM that enables PBOs to systematically capture and assess experiential learning outcomes. **Methodology:** A scoping review was undertaken looking at 202 peer reviewed journal papers: Scoping reviews differ from a systematic review in that the former maps a broad body of literature on relevant topic areas and provides tabular outputs, as well as identifying gaps. Whereas the latter considers a far narrower range of research material as it possesses a dedicated synthesis. We subscribed to the scoping review protocol advocated by Bragge et al. (2011) in that we delineated our area of exploration, thereafter we conducted an extensive literature review and then we reported upon these sources to accurately assess the barriers to organizational learning and, thus, identify the gaps in literature. We also considered the antecedents that go into knowledge transfer in PBOs. **Significance:** Despite a half century of research on knowledge transfer, our findings indicated that knowledge transfer is not intrinsic to PBOs, thus illustrating the need for robust project termination processes to garner key lessons learned for subsequent organizational learning capacity. Through our extensive examination of existing literature, covering over 200 sources, we illustrated a detailed understanding of the barriers to knowledge transfer within PBOs. This scoping review serves as a powerful resource for researchers and practitioners by offering insights into an ammended model to test in future research.

Keywords: Systemic lessons learned knowledge (Syllk) model, Aspirational systemic lessons learned knowledge (ASyllk) model, Interpretative structural model (ISM), Organizational learning, Knowledge transfer, Project-Based organizations (PBOs), Scoping review

1. Introduction

1.1 Organizational Learning Model

Duffield and Whitty (2015) attempted to address the practical failures in delivering organizational learning and knowledge transfer from projects. The authors created their theoretical Systemic Lessons Learned Knowledge

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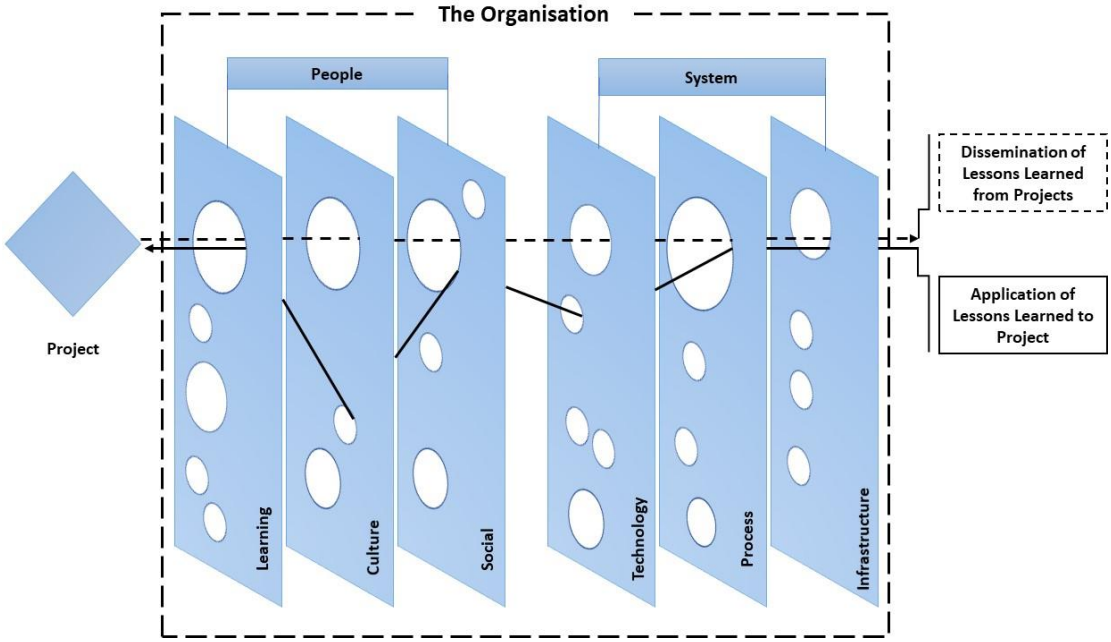
(Syllk) Model (Figure 1) through modifying the Swiss Cheese Model incepted by Reason (1997), which has been successfully applied within other research methodologies (e.g. Malik & Annabi, 2022; Wiegmann et al., 2022).

In the Syllk Model, the cheese slices, or plates, depict six elements: Learning, Culture, Social, Technology, Process, and Infrastructure. Each cheese slice is representative of the potential barriers to lessons learned for each segment, and the open holes in the Swiss cheese slices constitute the facilitators. For lessons to be learned from each project, it is necessary for that knowledge to be recorded and meaningfully transferred from the project back to the parent organization and likewise, the apertures in each cheese slice needs to permit knowledge to flow through them to have maximum impact (Duffield & Whitty, 2015).



Source: Duffield and Whitty's (2015) Syllk Model (permission to reproduce figure kindly received from the authors)

Figure 1: Systemic Lessons Learned Knowledge (Syllk) Model

The pathways through the apertures are illustrated by a dashed line and this shows the lessons learned route for projects through the facilitators, overcoming the barriers, then on towards the organization. The solid line in the opposite direction depicts the path of lessons learned from the organization to the project team. The paths are not necessarily direct, and the multifarious range of facilitators which are implicit in each slice of cheese are not used in a determined chronological pathway, hence the zigzagging characteristics of the solid line. Paver and Duffield (2019) applied the Syllk Model in their study of government entities, their adaptation of the model dealt primarily with externalities whereas our research is focused on internal processes that may collectively, or separately, impact upon knowledge transfer.

Project-based organizations (PBOs) merit a special treatment because they are often advocated as being best suited for environments where flexibility, adaptability, and collaboration are key to success (Pemsel & Müller, 2012) yet despite this there is a paucity of literature which means that this scoping review augments data by considering the wealth of literature on organizational knowledge transfer. This is consistent with approaches taken by other scholars (see Tshuma, Steyn & van Waveren, 2022). PBOs cannot be attributed a standard format, nor are they prevalent in any specific sector. Pemsel and Wiewiora (2013) considered previous research and discovered that PBOs could be referred to as 'firms', 'organizations or 'companies'. The first two terms have been exemplified in further research since that date (see Tarziján and Brahm (2014) on Project-based firms, and Miterev, Mancini and Turner (2017) relating to PBOs, although references to Project-based companies become less common thereafter. For all typologies, a PBO is considered an organization able to tackle several projects whether as a standalone institution or part of a larger organization. Arbabi, Salehi-Taleshi and Ghods (2020) highlighted the role PBOs should play in being a 'knowledge broker' between projects and the wider project organization.

2. Literature Review

2.1 Research Background

Knowledge-based economies require organizations to be innovative, creative, and incorporate learning opportunities faster and more effectively than their competitors (Serinkan et al., 2014; Crupi et al., 2021). The importance of knowledge is comensurate with a range of factors, including globalization, technological innovation happening apace, and best practice exchange requirements (Akhavan et al., 2018). The need for transparent internal knowledge sharing and open communication was illustrated during Covid 19 (Lee et al., 2021). Kirchner, Ipsen and Hansen (2021) emphasized how effective communication channels strengthened the sharing of learning outcomes during the pandemic. Transparent internal knowledge needs organizations to foster strategic learning capabilities by linking organizational learning and knowledge management (Dimitriades, 2005). This supports continuous organizational development opportunities that can be proactive during change and the need to operate in disruptive market conditions (Senge, 1990; Luhn 2016; Lee et al., 2021).

Over the decades, many studies have tackled organizational learning, knowledge management and learning organizations (e.g. Easterby-Smith, 1997; Senge, 1997; Bapuji & Crossan, 2004; Fai Pun & Nathai-Balkissoon, 2011; Argote & Hora, 2017; Odor, 2018). These disciplines have been linked with improving organizational performance and innovativeness (Du Plessis, 2007; Casprini et al., 2017) and are perceived as providing organizations with sustainable performance and competitive advantage (Almeida & Soares, 2014). For organizations to achieve these, they should target procedures aligned to capturing knowledge and creating the resultant knowledge management processes. This demands an organizational culture that can support and facilitate learning as well as the structure, infrastructures and systematic adaptability to flourish in times of dynamic change (Pemberton & Stonehouse, 2000; Balle et al., 2019).

Previous studies looked at knowledge management and organizational learning from a projectized perspective (Sense, 2011; Duffield & Whitty, 2015), focusing on knowledge management barriers (Lotti Oliva, 2014), human resource development and chaotic systems (Raidén & Dainty, 2006), leadership (Donate & de Pablo, 2015) alongside a consideration of multiple approaches (Powell & Ambrosini, 2012).

Thiry (2008) explained that PBOs conduct their primary activities as projects. However, PBOs can adopt many different forms: they can be structured as departments, matrix organizations, functional organizations alongside other less defined structural typologies.

Tshuma, Steyn and van Waveren (2022) claimed that whilst Project Management Offices (PMOs) could be used as a tool to sustain knowledge transfer between projects, this theme was not seen elsewhere in literature. Nonetheless, their study only looked at PBOs with overseeing PMOs offering moderation and mediation and concluded that hypothetically PMOs could provide both mediating and moderating roles to facilitate the transfer of knowledge between projects, without actually attesting that they did so in reality.

2.2 Distinguishing Between Individual Learning and Organizational Learning

Understanding the differences between individual learning and how organizations learn is paramount. Formative research initially linked individual learning to the parent organization's learning processes, in such a way as to indicate that there was no distinction between the two (Argyris & Schon, 1978; Shrivastava, 1983). This approach adhered to the principle that organization's learned via a humanistic cognitive-like process, thus personifying the organization and directly attributing it with learning traits similar to that of individuals: denoting both as able to acquire, analyze, store and disseminate knowledge (Lipshitz, Popper & Friedman, 2002). This view was not universal. Kim (1993) opined that although 'learning' was largely similar in both typologies, that the organizational learning itself differed in that the tasks needed to motivate individuals but it still took individuals to produce the behaviour that leads to learning (see also Mumford, 1992; Argyris, 1999; Franco & Hasse, 2009).

Essentially, for organizations to benefit from an individual's learning, organizations as an entity need to 'learn how to learn' (Schein, 1996), and to provide an effective supportive learning environment (Mumford, 2016). Individual learning is not a guaranteed pre-cursor to organizational learning (Cook & Yanow, 2011) and nor is it merely the aggregate of each group-member's learning capacity (Fiol & Lyles, 1985). Individual learning influences an idiocratic range of insights and the learning outcomes have the ability to produce changes in an individual's habits, skills, and action. This is at odds with organizational learning because that is designed to craft "changes in norms, doctrines, standard operating procedures, structures and cultures" (Naot, Lipshitz & Popper,

2004, p.93). In summary, organizational learning is essentially people orientated but it relies on an environment which is conducive to motivating and supporting individual learning. Yet, the organization needs to be able to exploit that individual learning to facilitate knowledge transfer between individuals and the organization.

2.3 Knowledge Management

Knowledge management as a business discipline began in the early 1990s and built on information management, data management, and document management. Fai Pun and Nathai-Balkissoon (2011) believed that knowledge is complex, has many dimensions and can be communicated several different ways, dependent upon the audience and technological aids available. Knowledge management can be found in an array of formats that include perceptions, routines and behaviour (Argote, 2011). The knowledge gets lodged in several different repositories within the organization. These encompass shared external memory systems and are exhibited within social networks (Argote & Ingram, 2000).

Ho et al. (2004) surmised that organizational knowledge systems depend upon constructive collaborative relationships to scaffold cooperation and a shared vision. This type of collegiality needs a platform strengthened by common consensus and trust. Social/sociable behaviour between team members is requisite for knowledge sharing. Organizations seek out and improve knowledge foundations by using training, education, research and development and communication. The knowledge management doctrine requires focusing effort in the right direction (Bhatti et al., 2021).

2.4 Knowledge Transfer and Preservation

Terzieva's (2014) research informs readers that organizational knowledge transfer and knowledge preservation approaches fall under the terminology of being either 'explicit knowledge' or 'tacit knowledge'. Her study centred on projectized learning and detailed explicit knowledge as software tools and shared project folders, reports and portfolios. Tacit knowledge was exhibited through internal social networks, specific project management training or coaching and mentoring programmes. Explicit knowledge can be easily shared across the organization, independent of the individual. In contrast, tacit knowledge mandates the individual's direct engagement with the process (Mitchell, Harvey & Wood, 2022). Knowledge management is a strategic approach that enables organizations to identify, capture, and leverage their collective knowledge to enhance productivity, innovation, and decision-making (O'Dell & Hubert, 2011). The core premise of knowledge management is that an organization's intellectual capital, which encompasses the skills, expertise, and experiences of its employees, is a critical driver of competitiveness (Rastogi, 2002; Santhose & Lawrence, 2023). Effective communication and the seamless sharing of knowledge among employees are essential components of successful knowledge management initiatives.

Knowledge management should facilitate lessons learned across an organization (Terzieva, 2014). By documenting and disseminating the insights and best practices gained from past projects, organizations empower their teams to learn from the successes and failures of their colleagues, allowing them to avoid repeating mistakes and streamline their processes (O'Dell & Hubert, 2011). The benefits of knowledge management are well-documented. By fostering a culture of collaboration and continuous learning, organizations can make use of the collective intelligence of their workforce, leading to improved problem-solving, enhanced innovation, and a competitive edge in the marketplace (Rastogi, 2002).

2.5 Knowledge Management Process

Gupta, Iyer & Aronson (2000, p.17) defined knowledge management as a "process that helps organizations find, select, organise, disseminate, and transfer important information and expertise necessary for activities such as problem-solving, dynamic learning, strategic planning, and decision making". The *process* element is echoed by Antunes and Pinheiro's (2020, p.146) view that knowledge management is the "processes of creation, storage, access and dissemination of the intellectual resources of an organization."

Barney (1991) created VRIO, which looked at resources from the perspectives of Valuable, Rare, Imitable and Organizational. The copious literature featuring the resource-based view (RBV) of a firm indicates that focus falls mostly on resources and performance. The RBV thesis is that resources which, simultaneously, are valuable, rare, imperfectly imitable and imperfectly substitutable become significant sources of competitive advantage (Barney, 1995). This explains inter-organizational performance differences (Hoopes, Madsen & Walker, 2003). The true value of VRIO is released when resources are valuable, rare, inimitable, and thereby become *irreplaceable* (Antunes & Pinheiro, 2020).

2.6 Practical Challenges to Knowledge Management

Whilst knowledge management appears as if it should be a straightforward construct, in fact there are practical challenges that incorporate a range of issues such as how accurate the knowledge is, how voluminous it may be, then how to motivate group-members to share their knowledge with others, as well as financing the IT/Technological support and ensuing maintainance that the data requires (Antunes & Pinheiro, 2020).

2.7 Culture, Structure and Infrastructure

The organizational structure teamed with the nature and expansive support/infrastructure (such as IT and communication systems) influence the effect and speed of an organization's learning (Pemberton & Stonehouse, 2000). The organizational culture determines the overall impact on an organization's capacity to learn (Bapuji & Crossan, 2004; Cook & Yanow, 2011; Lotti Oliva, 2014; Yao et al., 2020).

PBOs are defined as firms that structure their operations around temporary, client-specific projects rather than continuous, process-driven tasks (Hobday, 2000; Sydow, Lindkvist & DeFillippi, 2004). These organizations typically operate with decentralized, team-based structures and have high turnover across project teams and functions. This structural fluidity presents unique challenges for knowledge retention and transfer (Turner & Keegan, 2001; Bresnen et al., 2003). Unlike traditional hierarchical organizations, PBOs frequently "reset" their knowledge environments between projects, often leading to loss of learning, fragmented knowledge, and reduced organizational memory (Lindkvist, 2005). Knowledge transfer in PBOs is more episodic and informal, relying heavily on interpersonal relationships, embedded routines, and temporary networks (Sydow, Lindkvist & DeFillippi, 2004). As a result, standard models of organizational learning and transfer do not always apply effectively. Hassan and Annabi (2019, p.20) conducted research in the aircraft Manufacturing, Repair and Overhaul (MRO) Industry in which each repair and overhaul was project based and they reported that "there was evidence that assumptions, as opposed to knowledge, underpinned decisions".

2.8 What is a Learning Organization?

Wang and Ahmed (2003) believed that a learning organization should concentrate effort on continuously improving its performance via constructive learning channels. A learning organization also aims to direct appropriate knowledge to any requirement arising which needs an adapted response to changing market conditions (Luhn, 2016).

Literature detailed that PBOs have become increasingly common over the past 25 years (Miterev, Mancini & Turner, 2017). The International Organization for Standardization (ISO) stated that "More businesses are harnessing the power of projects to drive social and economic benefits" (ISO, June 2022). The Association for Project Management (APM) stated that projectized work had increased by 51% between 2019 and 2024 (APM, April 2024). Yet, despite the increase in project-based activities and implicit understanding that knowledge transfer is key to project success (van Waveren, Oerlemans & Pretorius, 2014; Todorović et al., 2015) an astonishing number of projects continue to fail, often in excess of half of them (Project Management Institute (PMI), 2023). Several scholars have highlighted that traditional knowledge management systems such as repositories and formal lessons-learned processes are often insufficient in PBOs unless complemented by mechanisms that support interpersonal, project-to-project and post-project learning (Bresnen et al., 2003; Ajmal & Koskinen, 2008). This creates a compelling need to examine knowledge transfer in PBOs through a tailored lens that reflects the socio-technical and temporal dynamics of project work.

In the context of PBOs, knowledge transfer is further complicated by the temporary and fragmented nature of project teams. Unlike traditional hierarchical firms, PBOs often lack formal structures for embedding learning between projects. As a result, mechanisms like *lessons learned reports* are frequently implemented in a procedural way, but without being meaningfully integrated into the organization's broader systems. The transient project environment makes it difficult for knowledge to move beyond the individual or project level, especially in the absence of sustained processes or cultural incentives for reuse. Nonetheless, it was consistently discovered that the lessons learned are rarely transferred or absorbed into organizational learning, or are even utilized beyond each project (Newell et al., 2006; Williams, 2008; Sense, 2011; Mothapo & Joseph, 2023). The optimum outcome is to transfer lessons learned by means of individuals sharing their knowledge whilst moving on to new projects or via relevant social networks (Swan, Scarbrough & Newell, 2010; Lin & Lo, 2015; Grant, 2016). If knowledge transfer is deficient for whatever reason, the result leads organizations to reinvent the knowledge and, moreover, risk repeating failures (Baloh, Uthicke & Moon, 2008; Almeida & Soares, 2014).

2.8.1 Lessons Learned

Success, failures, and near-misses all provide opportunities for effective lessons learned. The outputs from each of these three scenarios should be incorporated into the organizational operandi modus (McClory, Read, & Labib, 2017). These types of institutional 'memories' are the most effective learning tools and should prevent time wasted on making the same mistakes (Shokri-Ghasabeh & Chileshe, 2014).

The development of lessons learned tools and procedures, are exampled through the Project Management Institutes (PMI) guidelines: Project Management Body of Knowledge (PMI, PMBoK Guide, 2021 7th Edition). Indeed, it has been established by a range of empirical studies that the failure to record and transfer project learning has remained unchanged over the decades (Williams, 2008; Swan, Scarbrough & Newell, 2010; Duffield & Whitty, 2015; Argote, Lee & Park, 2021). The various iterations of the PMBoK have proferred many guidance pointers regarding lessons learned. These outputs have covered documented and variance attributes and touched upon many of the project management knowledge areas. For example in the 4th version of the PMBoK (2008) there were 54 lessons learned entries. By the 5th edition of the PMBoK (2013) 78 guidance points were included. The 6th edition PMBoK (2017) contained a section on *Manage Project Knowledge* as a component of the Project Integration Management knowledge area. The PMI (2017) advocated that this utilized existing knowledge and also created new knowledge to realize the project's targets and give rise to organizational learning. A more detailed breakdown of the nuanced differentiation is covered by Duffield (2017). The focus of PMBoK was changed for the 7th edition. Whereas all versions up to the 6th edition detailed both project phases and knowledge areas, the 7th edition moved towards a competency performance perspective in lieu of knowledge areas. In brief, the 6th edition concentrates on outputs whereas the 7th edition tries to inculcate an understanding of value-driven skills and resources to deliver outcomes.

There is a gap in organizational knowledge management and a need for more effective practices to capture and disseminate lessons learned. Researchers continue to chronicle this gap without providing the solution (Argote, Lee & Park, 2021; Zhou et al., 2022; Mothapo & Joseph, 2023). Duffield and Whitty (2015) used their Syllk Model to emphasize that lessons learned is crucial for organizational efficacy. They argued that documented and shared lessons can contribute to an organization's intellectual capital, fostering innovation and preventing mistake reptition. However, the authors also disclosed that many organizations struggle to operationalize lessons learned processes.

2.9 Further Dimensions to Project-Based Organizational Learning (PBOs)

Further dimensions significantly impact on an organization's ability to learn within PBOs. Sense (2011) was keen to emphasize the distinction between 'projects' and the every-day 'normal' work in organizations. He stated that projects were quite separate because they were temporary and task-focused with unique aims and objectives. This inpermanent project status can often culminate in knowledge leakage because at project termination the project team members are reallocated to different roles, which leads to the fragmentation of the project knowledge, unless it is collected, collated, placed in a repositary and disseminated within the organization (Lindner & Wald, 2011; Mothapo & Joseph, 2023). The transient nature of project teams poses challenges for organizational learning. As project-based work becomes more prevalent, organizations must grapple with how to effectively capture and transfer the lessons learned by these temporary, fragmented teams back to the broader organization. Traditional organizational learning processes may prove insufficient in this context (Wiewiora, Chang & Smidt, 2020). This lack of project uniformity and the fragmented end knowledge which is not captured within existing organizational structures, processes, practices, and technologies is a monumental challenge to effective PBO learning. There is a paramount need to find mechanisms to effectively share and integrate knowledge between projects and throughout the parent organization (Almeida & Soares, 2014; Zhou et al., 2022). Organizations must adapt their learning processes to become agile. This may involve implementing robust project debriefing procedures (lessons learned), designing knowledge repositories that transcend individual projects, and fostering a culture that prioritizes cross-project collaboration and learning.

Despite this, much of the literature still generalizes knowledge transfer across organizations without adequately accounting for the context of project-based structures. This review therefore contributes to the field by focusing specifically on how knowledge transfer processes are enacted, constrained, and facilitated within PBOs, highlighting a gap in how these PBOs build and sustain institutional learning. Failing to do so could result in lost lessons learned and the resultant missed knowledge transfer opportunity. Zhou et al. (2022) reported that the system dynamics model that they employed in their research illustrated that knowledge was not transferred from the PBO to the parent organization.

2.10 Linking Organizational Learning with Knowledge Management

Researching links between knowledge management and organizational learning both have interplay in the roles relating to the operation and/or creation of a learning organization (Raidén, Dainty & Neale, 2008). Additional aspects including culture, the environment, strategy and structure all influence organizational learning and contribute to efficacious knowledge management outcomes (Bapuji & Crossan, 2004; Putra et al*.,* 2020).

2.11 Reviewing Duffield and Whitty's (2015) Syllk Model

The Duffield and Whitty (2015) Syllk Model (see Figure 1) was developed from an earlier model (see Duffield & Whitty, 2012). The model offers examples of facilitators for each element but associated barriers are omitted. It is not apparent if the lack of one or more of the Swiss cheese elements would be a significant barrier to organizational learning, or just reduce optimum learning effectiveness (and if so, which of the six elements would be most impactful on the [lack of] success outcomes if they were absent?) It is unclear whether or not each element holds equal weighting with regard to the efficacy of the final lessons learned. For example, in other studies, a supportive organizational culture was said to be of higher relevance for facilitating organizational learning than either the organizational structure or infrastructure (Chen et al., 2003). Despite this, the development of supportive infrastructure significantly scaffolds organizational learning (Lotti Oliva, 2014; Yao et al., 2020).

Although the knowledge economy (KE) is not an intrinsic part of the Syllk Model, it is implicit that the dissemination and application of lessons learned when done effectively epitomize the KE principles. Roberts (2009) stated that the KE is the result of "the recognition that advanced economies derive a high proportion of their economic wealth from the creation, exploitation and distribution of knowledge and information" (p.285). Hadid (2017) synthesized several authors work and suggested that "the knowledge economy is developing continuously as a direct consequence of the increase of importance of knowledge in economic processes in all economic sectors" (p.204). She further mentions that KE is required for effective knowledge management. It is crucial to retain knowledge to feed into a successful KE (Mubarak et al., 2024).

2.12 People Matter

The Syllk Model has broad similarity to the organizational elements noted in Pemberton and Stonehouse's (2000) *Organizational Learning and Knowledge Management Environment Model*. However, there is one noteworthy addition in the inclusion of *Social* under the heading of *People*. Its addition clearly indicates research findings show that PBOs suffer from the lack of knowledge transfer (Lin & Lo, 2015; Grant, 2016; Balle et al*.,* 2019). This requires greater reliance on social network activities (interpersonal skills) to support project-based learning (Williams, 2008). Bartsch, Ebers and Maurer (2013) argued that project teams' social capital could remove the barriers to PBO learning. Social capital requires intra-organizational social networking between the project team with colleagues outside the project. Carayannis and Campbell (2018) interlink academic mechanisms for achieving knowledge with those of interaction mechanisms of inter and intra workings in and between society and organizations. The authors were of the opinion that to convert to a full knowledge society and achieve KE, "almost everyone acts also as a knowledge worker" (p.11) which emphasizes the point that people really do matter.

3. Methodology

Mays, Roberts and Popay (2001) defined scoping reviews as a means of synthesizing "key concepts underpinning a research area, especially where an area is complex" (p.194). Each of the areas that we looked at have been the foci of years of extensive research, yet there has not been an approach beforehand that analyzed an aggregate of relevant multiple themes for PBOs knowledge transfer. We considered 202 sources of literature spanning over fifty years. The findings have been reimagined under the lens of the Syllk Model (Duffield & Whitty, 2015), which in itself gave us the six elements to consider as a starting point. Peters et al. (2022) noted that scoping reviews have rapidly become an acceptable approach to synthesize evidence.

Bragge et al. (2011) created three recommendations for scoping reviews based upon the earlier writings of Katz et al. (2003), Mays, Roberts and Popay (2004), Arksey and O'Malley (2005) and Bates, Clapton and Coren (2007). They proposed that scoping reviews should have three main functions:

1. To delineate what is being explored, which in our case is the half century of extant literature on project-based knowledge transfer.
2. To conduct a search for appropriate literature, which we have done by using a plethora of rich sources, and

3. To report on those characteristics.

Munn et al. (2018) refined the context for scoping reviews and advocated that the primary purpose of a scoping review is to provide an overview of literature and illuminate significant gaps. Figure 2 provides an overview of how the themes were identified and the dissemination was conducted. The authors also highlighted that tabular information were the likely outcomes of a scoping review, as can be evidenced in our five tables. They further emphasized that scoping reviews provide a map of literature but do not assess the quality of each respective study. As a result, methodological limitations are not required within scoping reviews. Scoping reviews are an approach consistently employed to evidence synthesis for researchers. They are removed from the necessity to compare, contrast and create analytical comparisons based on combining data results, and instead endeavour to describe and present relevant findings (Peters et al., 2022).

3.1 Approach to the Literature Review

Rather than take a reductive approach, which is the one that systematic reviews adopt, we preferred to start with a sufficiency of literature on each theme, and we were not afraid to add to those outputs if we felt that our exploration warranted such extension. In total, we reviewed 202 sources of information spanning over five decades. A scoping review is distinct from a systematic review in that the breadth of literature covered in a scoping review exceeds the more limited foci of a systematic review by design. We have explored and mapped existing literature on relevant topics related to the Syllk Model and have identified key concepts by determining the wide extent of available evidence. This was designed to tackle both the general and emergent research questions.

Our working question included what has been done before and what progress has been made in previous research. We used the framework adopted by Levac, Colquhoun & O'brien, (2010) to refine the research question for our scoping review. We wanted to review extant literature on PBOs' knowledge transfer to establish what it already tells us. From there our more targetted research questions were:

Research Question 1: *How does the Syllk model help interpret and categorize knowledge transfer dynamics in PBO contexts?*

Research Question 2: *What adaptations are required, if any, to the Syllk Model (Duffield & Whitty, 2015) to better facilitate knowledge transfer within PBOs?*

Research Question 3: *What are the key barriers to knowledge transfer in PBOs?*

It also made sense for us to consider the antecedents that go into knowledge transfer by reviewing literature on knowledge management, organizational learning, a learning organization, organizational culture and investigate how the knowledge management and learning infrastructure impacts PBOs. This allowed us to assess facilitators and barriers to organizational learning and thus identify the gaps in literature, as per a major output of any scoping review.

Consistent with the ethos of scoping reviews, this study identified a broad array of literature. Scoping reviews aim to map a wide body of knowledge. This led to the identification and use of a significant number of relevant literature sources. The development of a protocol that clearly describes the scoping review process is nascent, but not without growing acceptance and guidance (Peters et al., 2022). Figure 2 illustrates the wealth of topics reviewed to meet our target.

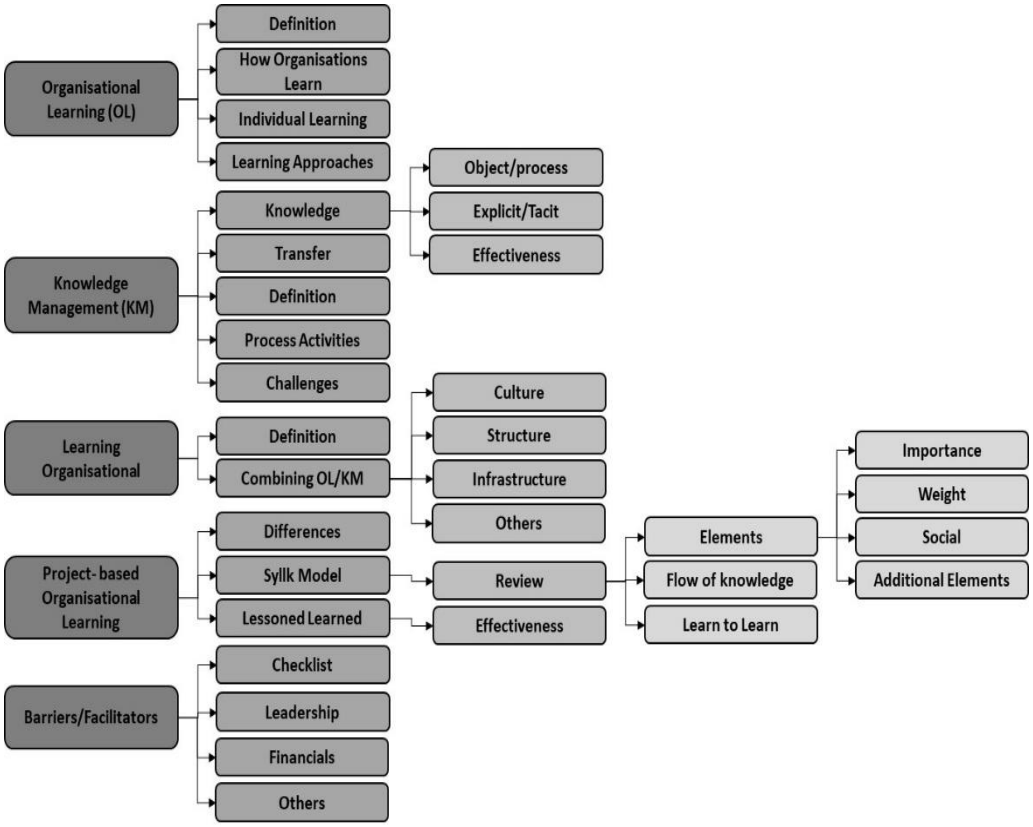


Figure 2: Themes and Dissemination Used Within the Scoping Review

3.2 Interpretive Structural Modelling (ISM)

Sage (1977) inspired several research outputs which, in turn, adopted ISM variants (see Singh, Garg & Deshmukh, 2007; Singh et al., 2021; Crupi et al., 2021). Instead of creating a new structural model, we employed the Syllk Model (Duffield & Whitty, 2015) as our antecedent ISM. This was supported by Singh and Kant's (2008) advice that ISMs are ideal tools to identify both facilitators and barriers to knowledge transfer. Thereafter we assessed if it was a good fit for the literature reviewed in its original format.

4. Findings

The folllowing findings provide a broad look at over 50 years of research to ascertain how PBOs transfer knowledge. We covered all the elements from the original Syllk Model created by Duffield and Whitty (2015).

4.1 Knowledge Management

Our research has problemetized the fact that knowledge management is still vaguely defined and often incorrectly construed as an offshoot of some other disciplines. These varying perspectives can lead to confusion in practice. Organizations may struggle to align their knowledge management strategies, choose appropriate tools, and communicate the value of knowledge management consistently. This lack of consensus could hinder the development of standardized knowledge management practices and metrics across industries.

To reduce this confusion, a more unified definition of knowledge management would be beneficial. We propose that this should balance process and capability perspectives, acknowledge both human and technological aspects, and clearly link knowledge management and knowledge transfer to organizational objectives while remaining adaptable to accommodate different contexts.

Our study reviewed previous scholars' work (Table 1) and we harmonized their outputs to provide the following definition:

Knowledge management is an integrated organizational capability and systematic process that leverages both human expertise and technological infrastructure to create, capture, organize, share, and apply knowledge assets. K*nowledge management should enhance organizational performance, foster innovation, and create*

sustainable competitive advantage by aligning knowledge-related activities with strategic objectives, while adapting to diverse operational contexts and evolving business environments.

Table 1: Definitions of Knowledge Management

Definitions	Author(s)	Field of Research
'A process of capturing, developing, sharing, and effectively using organizational knowledge'.	Nonaka (1994, p. 25)	Organization Science
'The systematic, explicit, and deliberate building, renewal, and application of knowledge to maximize an enterprise's knowledge-related effectiveness and returns from its knowledge assets'.	Wiig (1997, p. 9)	Knowledge Management
'Knowledge management is the process of capturing, distributing, and effectively using knowledge'.	Davenport & Prusak (1998, p. 2)	Organizational Management
'A systemic and organizationally specified process for acquiring, organizing, and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work'.	Alavi & Leidner (2001, p. 107)	Knowledge Management
'A process of knowledge creation, validation, presentation, distribution, and application'.	Bhatt (2001, p. 68)	Knowledge Management
'An organizational capability that allows people in organizations, working as individuals, or in teams, projects, or other such communities of interest, to create, capture, share, and leverage their collective knowledge to improve performance'.	Lakshman (2007, p. 58)	Organizational Learning
'The planning, organizing, motivating, and controlling of people, processes and systems in the organization to ensure that its knowledge-related assets are improved and effectively employed'.	King (2009, p.3)	Organizational Learning
'The deliberate and systematic coordination of an organization's people, technology, processes, and organizational structure in order to add value through reuse and innovation'.	Dalkir (2013, p. 4)	Knowledge Management
'The process of creating, sharing, using and managing the knowledge and information of an organization'.	Girard & Girard (2015, p. 20)	Knowledge Management
'An organization's ability to create new knowledge, disseminate it throughout the organization, and embody it in products, services, and systems'.	Massingham & Al Holaibi (2017, p. 62)	Knowledge Management
'A dynamic process of creating, storing, transferring, and applying knowledge to enhance organizational performance and create value'.	Asiaei & Bontis (2019, p. 371)	Knowledge Management
'The strategic and systematic management of knowledge assets, processes, and organizational environments to create value and enhance competitive advantage through innovation and organizational learning'.	Intezari, Taskin & Pauleen (2017, p. 494)	Knowledge Management

Source: Authors' own

4.2 Organizational Learning

Organizational learning refers to the process by which organizations acquire, share, and apply knowledge to improve performance and adapt to changing environments (Argote & Miron-Spektor, 2011; Crossan, Maurer & White, 2011; Argote, Lee & Park, 2021). It enables firms to develop new capabilities, innovate, and maintain a competitive edge (Easterby-Smith & Lyles, 2011; Hislop, Bosua & Helms, 2018). Research has emphasized the multilevel and dynamic nature of organizational learning, considering the interplay between individual, group, and organizational learning processes (Bapuji & Crossan, 2004; Marabelli & Newell, 2014).

Despite an evolution of over half a century, no single agreed definition prevails for organizational learning (Wang & Ahmed, 2003; Antunes & Pinheiro, 2020). A standalone theory purporting to encapsulate organizational learning does not exist (Crossan, Maurer & White, 2011). Notwithstanding 50 odd years of theorizing, the terminology remains open to interpretation. Some of the working definitions academics have adopted over the years are included in Table 2.

Table 2: Definitions of Organizational Learning

Definitions	Author(s)	Field of Research
'The process of improving actions through better knowledge and understanding'.	Fiol & Lyles (1985, p.803)	Organizational change and strategic management
'The means by which knowledge is preserved so that it can be used by individuals other than its progenitor'.	Sinkula (1994, p.3)	Market information processing
'The development of new knowledge or insights that have the potential to influence behaviour'.	Slater & Naver (1995, p.63)	Market Orientation
'Roughly defined as an information management strategy that consists of systematic efforts to transfer knowledge throughout an entire organization'.	Spector & Davidsen (2006, p.64)	Education
'A continuous transformation process of transferring individual knowledge to organizational systems'.	Yang (2007, p.85)	Knowledge Sharing
'Concepts which capture and describe the process of gaining information and transforming it into knowledge at a firm's operational level'.	Franco & Hasse (2009, p.628)	Entrepreneurship
'Includes processes of creating, retaining and transferring knowledge and has implications for performance and competitiveness of organizations'.	Argote & Hora (2017, p.579)	Management of technology

Source: Authors' own

To synthesize the best of the definitions above, we advocate that organizational learning is:

The composite of individual knowledge shared with the wider organization, which is captured and used within organizational systems. Knowledge preservation itself is a continuous process which fascilitates performance enhancement using optimized understanding of information and insights.

4.3 A Learning Organization

Cyert and March (1963) are credited with making the first reference to 'organizational learning'. Its development within the fields of management, leadership and business studies literature did not emerge until the late 1970s/ early 1980s (Argyris & Schon, 1978; Hedberg, 1981; Fiol & Lyles, 1985).

Edmondson's (1999) framework highlights the role of psychological safety in facilitating learning behaviours such as speaking up, seeking feedback, and experimenting . She described learning as an "ongoing process of reflection and action characterized by asking questions, seeking feedback, experimenting, reflecting on results, and discussing errors or unexpected outcomes of action" (Edmondson 1999, p.353), thus placing the individual at the centre of the learning.

The 4I framework (Intuiting, Interpreting, Integrating, Institutionalizing) was created by Crossan et al. (1995) and links individual, group, and organizational learning processes. It was further developed by Bapuji and Crossan (2004). Intuiting refers to the subconscious recognition of patterns and possibilities by individuals; interpreting is the explaining of an insight to oneself and others; integrating involves the development of shared understanding and coordinated action at the group level; and institutionalizing is embedding learning into organizational systems, structures, and routines. Crossan et al. (1995, p.525) elucidated that "institutionalizing is the process of ensuring that routinized actions occur". This last step seems missing for most PBOs. Institutionalization was also described as "the process of embedding learning that has occurred by individuals and groups into the institutions of the organization including systems, structures, procedures, and strategy" (Crossan & Bedrow, 2003, p.1090). This suggests that the embeded knowledge has to be captured, commissioned and communicated deliberately so that it can be applied to future learning scenarios.

Argote and Miron-Spektor (2011) emphasize the importance of knowledge transfer and creation through social interaction and experience accumulation. The authors claim that organizational learning occurs through the interplay of knowledge acquisition, distribution, and implementation, which are shaped by factors such as organizational context, network ties, and the characteristics of the knowledge itself. The need for social networks in project management has been acknowledged by many authors (e.g. Lin & Lo, 2015; Grant, 2016; Balle et al., 2019) but appear not to have been incorporated into the Syllk Model expressly, since Duffield and Whitty's (2015) definition of *social* did not mention networks specifically.

As with organizational learning, there are multiple definitions for a learning organization. Some of the working definitions academics have adopted are included in Table 3, but they are in no way exhaustive.

Table 3: Definitions of a Learning Organization

Definitions	Authors
'Organizations where people continually expand their capacity to create the results they desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together'.	Senge (1990, p.3)
'An organization skilled at creating, acquiring and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights'.	Garvin (1993, p.80)
'An organization that facilitates the learning of all its members, and consciously transforms itself and its context'.	Pedler, Burgoyne & Boydell (1997, p.3).
'A company that learns effectively and collectively and continually transforms itself for better management and use of knowledge; empowers people within and outside the organization to learn as they work; utilizes technology to maximize learning and production'.	Marquardt (2011, p.247)
'The aim of a learning organization is a continuous organizational development. With this, the company extends constantly his ability to form own future creatively and to adapt itself to changed market conditions'.	Luhn (2016, p.11)

Source: Authors' own

It is not our intention to provide a definition for a learning organization. Instead, we will offer an amended model and recommendations when we conclude this review to help guide PBOs towards incorporating learning logs.

4.4 Organizational Culture

Organizational culture comprises of core beliefs, values and hidden assumptions shared by its members (Schein, 1985; Hofstede, 1997). These affect the behaviour of individuals, groups, and organizations, as well as serve to facilitate learning activities (Cook & Yanow, 2011). Organizational culture has many facets according to authors. For example, it can enshrine openness supported by transformational leadership (Hult et al., 2000; Park & Eun-Jee, 2018), or a participative decision-making culture; where tolerance of errors and a readiness to spot errors and learn from them prevails (Schmitz et al., 2014). Culture can inculcate motivation to share information (von Zedtwitz, 2002), learning orientation (Hurley & Hult, 1998) and positive supervisory behaviour and organizational support (Ramus & Steger, 2000). All of these are aspects of organizational culture that can positively influence learning (Bapuji & Crossan, 2004; Papmehl, 2004). Conversely, the lack of learning culture can hinder or prevent learning and knowledge management innovation (McDermott & O'dell, 2001). The authors listed beforehand did not disaggregate culture's attributes, (present or in omission). There are also national organizational cultural considerations such as clan and adhocracy (Oh & Han, 2020) alongside multi-national organizational culture influences driven by leadership styles (Kortsch, Bashenkhaeva & Kauffeld, 2023) that are generally unconsidered.

Academic literature hinted that the fundamental driver behind a learning culture was a collective desire to improve through learning (Spector & Davidsen, 2006). There are limited empirical studies testing the link between learning culture and knowledge management practices (Schmitz et al., 2014).

Organizational culture is widely recognized as a critical factor in shaping learning behaviours and outcomes (Senge, 1990; Schein, 2017). A culture characterized by trust, openness to change, and a focus on continuous improvement supports organizational learning (Jyothibabu, Farooq & Bhusan Pradhan, 2010; Edmondson & Lei, 2014). In such an environment, employees feel psychologically safe to experiment, share knowledge, and challenge existing assumptions (Edmondson, 1999). In contrast, a culture of fear, blame, and rigid hierarchy can inhibit knowledge sharing and the application of new insights (Carmeli & Gittell, 2009; Bunderson & Boumgarden, 2010). When individuals perceive the risk of speaking up or admitting mistakes as too high, they are less likely to engage in the learning behaviours necessary for organizational adaptation and innovation.

Leaders play a crucial role in cultivating a learning-oriented culture by modelling desired behaviours, encouraging knowledge sharing, and allocating resources to support learning initiatives (Vera & Crossan, 2004; Annabi, 2022). Aligning organizational systems, such as performance management and reward structures, with

learning priorities is also important for reinforcing the desired cultural norms (Jyothibabu, Farooq & Bhusan Pradhan, 2010; Schein, 2017).

4.5 How Does Knowledge Management and Learning Infrastructure Impact upon Project-Based Organizations (PBOs)?

In PBOs, learning faces unique challenges due to the temporary and fragmented nature of project teams (Lindner & Wald, 2011). Knowledge tends to reside within project teams and can be lost when projects end, unless deliberate mechanisms are in place to capture and disseminate lessons learned (Sense, 2011). The transient nature of project-based work limits the opportunities for sustained knowledge sharing and collective sense-making across the organization (Bartsch, Ebers & Maurer, 2013). Project teams may operate in silos, with limited interaction and integration with the broader organizational context, hindering the transfer of insights and the development of organizational capabilities.

Adapting organizational learning processes to the project-based context is crucial for leveraging knowledge across the organization. This may involve implementing robust project debriefing procedures, designing knowledge repositories that transcend individual projects, and fostering a culture that prioritizes cross-project collaboration and learning (Sense, 2011). Failing to do so could result in the loss of valuable lessons learned and missed opportunities for organizational improvement and innovation.

4.6 Barriers to Organizational Learning

There are a significant number of barriers to lessons learned regarding organizational learning. Whilst each organization may not be subject to the same combination of barriers, they are more than likely to be subject to multiple barriers (Williams, 2007). To successfully transfer the lessons learned to organizational knowledge, barriers need to be overcome through the creation of facilitators (Duffield & Whitty, 2015). Therefore, having the fullest understanding of barriers is of primary importance. The barriers identified by previous research in Table 4 have been widely considered and are provided as a guideline and not suggestive of their existence or omission in all organizations. As part of our ISM approach, the barriers noted in Table 4 were interpreted and aligned to each of the six elements depicted in the Syllk Model.

Table 4: List of Barriers to Organizational Learning and Knowledge Management

Barriers	Publications	Syllk model Element
Lack of understanding of the value of lessons learned	Carrillo, Ruikar & Fuller (2013)	Learning
Organizational learning as a cost, not an investment	Matzdorf, Price & Green (2000); Zollo & Winter (2002)	Learning (Financial)
Not enough time	Keegan and Turner (2001); von Zedtwitz (2002); Carrillo et al. (2004); Williams (2007); Shokri-Ghasabeh & Chileshe (2014)	Learning (Financial)
Lack of resources	Shokri-Ghasabeh & Chileshe (2014)	Learning (Financial)
Lack of or delayed feedback	Rahmandad, Repenning & Sterman, (2009)	Learning
Focus on problem-solving and single-loop learning	Argyris & Schon (1978).	Learning
Lessons are not transferable	Williams (2007)	Learning
Wrong people are involved	Williams (2007)	Learning
Lack of incentive	Bandow, Gerweck & Self (2015)	Culture (Financial)
Lack of management and leadership support	Steiner (1998); Bontis, Crossan & Hulland (2002); Lin (2007); Miklosik & Zak (2015); Anlesinya (2018)	Culture
Lack of organizational learning culture	Stonehouse & Pemberton (1999); Carrillo et al. (2004)	Culture
Organizational blame culture	Papmehl (2004)	Culture
Fear of employees being poached	Panagiotakopoulos (2011)	Culture
Organizational readiness to change	Jafari & Kalanaki (2012)	Culture
Arrogant Organizational Disorder	Godkin & Allcorn (2009)	Culture

Barriers	Publications	Syllk model Element
Employee resistance	Carrillo et al (2004)	Social
Employee egos due to defensive routines and denial	Argyris (1992); Argyris & Schon (1978); Henfridsson & Soderholm (2000); Desouza (2003); Yang, Secchi & Homberg (2018).	Social
Lack of attention, personal interest and ability	von Zedtwitz (2002)	Social
Already put in enough effort	Williams (2007)	Social
Fragmentation of project teams once projects are completed	Keegan &Turner (2001); Disterer (2002); Wiewiora et al. (2009); McClory, Read, & Labib (2017)	Process (Financial)
Lack of understanding between process review, lessons learned and process improvement	Pitagorsky (2000)	Process
Lack of clear guidelines	Carrillo et al. (2004); Newell et al (2006); Williams (2007); Shokri-Ghasabeh & Chileshe (2014)	Process
Process does not capture useful lessons learned	Cooke-Davis (2002); Williams (2007).	Process
Knowledge too hard to capture, categorise and disseminate	Desouza (2003)	Process
Inadequate or ineffective infrastructure and communication	Argyris (1999); Pemberton & Stonehouse (2000); Desouza (2003); Carrillo, Ruikar & Fuller (2013).	Infrastructure (Financial)
Lack of organizational structure to support organizational learning	Steiner (1998); Schilling & Kluge (2009)	Infrastructure
Lack of human resources	Williams (2007)	Infrastructure
Data repository too hard to search	Williams (2007)	Technology

Source: Authors' own

For *Learning* it seems that research has determined that *time constraints* were a barrier, given the competing priorities of project timelines. Learning, or lack of it, and time constraints are both detailed as being driven by the organization.

Barriers for *Culture* include staff resisting new methods due to the time it would take to learn a new approach. Conversely, if the expression of the change requirement was staff generated, it may be considered a criticism by the management team. Management and leadership are areas that are either co-joined or distinctly separated by various authors and therefore, a stipulation of what each means would be needed for any ISM to be applied consistently. Furthermore, both the preceding points are interlinked in that change would still experience resistence even if change was welcomed by some organizational members. These barriers relate to the individual's attitudes. The most acknowledged facilitators included management/leadership support and a culture of supporting others' ideas and views, which are driven by the organization.

Working in silos and ineffective social networks were heralded as the top barriers under the *Social* element. Whereas, attitude, willingness to share/be open and informal communication channels were the main facilitators. To a large extent, these are driven by the individual.

From a *Technology* perspective: Associated barriers included a lack of IT training. This emphasizes that whereas the six elements are seen as discrete within the Syllk Model, this is not wholly representative given that training could arguably also fall within the *learning* element and *technology* can be seen as *infrastructure*. Technology can also be a facilitator. Hence, barriers and facilitators often form a contradiction.

Under the element of *Process*, previous researchers found that team members can provide dissimilar viewpoints probably due to lack of harmony in what a process actually means to the individual and therefore decide that it could incorporate one or more of the other plate items. Isolation could equally be considered a social element concern. Governance and policies of isolation could involve geographical location and resultantly, this element holds several potential meanings depending on the context of usage.

In the same way that isolation was considered under *Process*, geographical distance was the dominant barrier for *Infrastructure*. Further barriers included, a lack of infrastructure available for organizational use (Kezar &

Holcombe, 2020) which equally seemed pertinent to technology. Additionally, researchers have opined that organizations are unwilling to adopt new infrastructure to support outcomes if costs cannot be recharged to a specific project. Nomenclature and definitions tend to mean different things to different people, and sometimes even different things to the same people depending on the context.

4.7 Identifying The Gaps

There are two additional elements which should be included in the Syllk model: *Leadership* and *Financial*. We have indicated that studies such as that of Kortsch, Bashenkhaeva and Kauffeld (2023) acknowledge that leadership style influences organizational learning capacity (see also Turner & Müller, 2005). We are cognizant of the fact that leadership is often researched under the lens of transactional leadership (Aga, 2016) or ethical leadership (Bhatti et al*.,* 2021) or competencies (Mai, Do & Ho Nguyen, 2022) and we acknowledge the expertise within these studies and simply state that we are refering to leadership as a category without classifying the type/style or components of leadership therein.

Many of the barriers listed in Table 4 are influenced by organizational leadership. Popper and Lipshitz's (2000) research uncovered that leadership is a significant variable that impacts organizational learning. Vera and Crossan (2004) suggested that its influence is far-reaching and affects each element of the learning system. From a wider perspective, organizational leadership influences strategy, structure and establishes culture (Chang & Lee, 2007), approves processes and hiring employees, and supports transformational change (Garcia-Morales, Jiménez-Barrionuevo & Gutiérrez-Gutiérrez, 2012). Similarly to leadership, finance appears to impact all elements of the Syllk model.

One specific barrier identified in Table 4 was that organizational learning is seen as a cost, not an investment (Zollo & Winter, 2002). Lack of financial support appears to be the underlying causes of many other barriers (e.g. lack of resources, inadequate or ineffective infrastructure and communication, not enough time, lack of incentive).

It is apparent that all the barriers listed in Table 4 could be minimized through effective leadership. Another key pointer is that organizational learning requires financial commitment and that this linkage remains an under-researched area, despite the intrinsic value of learning being addressed by many scholars (Wiewiora, Chang & Smidt, 2020; Do et al., 2022; Ivaldi*,* Scaratti & Fregnan, 2022). Nonetheless, the cost of creating that value is not given any attention.

5. Discussion

The following discussion answers the three research questions that guided this study.

- Firstly, it examines **how does the Syllk model help interpret and categorize knowledge transfer dynamics in PBO contexts**. By applying the Syllk model as an analytical lens, the discussion provides insights into how the interplay of systems and components within the model elucidates the complexities of knowledge transfer processes in such organizational settings.
- Secondly, it considers **what adaptations are required, if any, to the Syllk Model (Duffield & Whitty, 2015) to better facilitate knowledge transfer within PBOs**. This allows us to present a revised Syllk Model, which we named the Aspirational Syllk (Asyllk) Model.
- Thirdly, it explores **what are the key barriers to knowledge transfer in PBOs**. This question aims to uncover the factors that hinder effectiveness of knowledge movement within the dynamic and often temporary structures typical of PBOs.

5.1 Application of the Syllk Model

Duffield and Whitty's (2015) Syllk Model holds relevance regarding some elements (i.e. learning, culture, social, technology, process and infrastructure). Nonetheless, it was evident that ambiguity is introduced when describing facilitators and barriers in relation to each discrete element. The uncertainty with regards some of the issues, outcomes, inputs or processes and where each should be located is worthy of further research. For example, would software fall within either the *technology* or the *learning* element? Should isolation be considered within the *process* or *social* or *infrastructure* elements? The ambiguous nature of what concepts belonged within which element showed that the elements, and the components of the elements, were interpreted differently by various authors. To that effect, Duffield and Whitty themselves later incorporated *leadership* into both *social* and *cultural* silos (Duffield & Whitty, 2016).

We used the Syllk Model to establish if it could be representative of existing literature on knowledge transfer. However, it raises questions on what interpretation ISMs scaffolds: the interpretation of the participant, or the researchers' interpretation of the participants' interpretations. Furthermore, there is no guidance regarding whether all elements are equally important to transferring lessons learned from projects to the mother organization. It has not been established if the *people* element is more important than the *systems* element. That would seem contrary to much of the literature covered in this scoping review, which found people to be crucial to both individual and organizational learning success. Equally, the linear flow of knowledge in the original Syllk Model seems optimistic and unrepresentative of other studies (Meyers, 1990; Vance, Zell & Groves, 2008). Often leadership is construed as fundamental to successful knowledge transfer within organizations, yet there is not a preferred way of representing leadership within the existing Syllk model.

Without a formal means of capturing the lessons learned, individual knowledge cannot be transformed into organizational knowledge. Nevertheless, project-to-project learning exists, facilitated by components within the *People* element. The dissemination and application of lessons learned is not inevitable.

These challenges are particularly significant in the context of PBOs, where teams are temporary, knowledge is distributed and formal systems often take a back seat to relational and experiential learning. The ambiguity in how elements are categorized in the Syllk Model reflects the broader challenge of codifying and transferring knowledge in environments with high staff turnover and limited structural continuity. As such, the model highlights the preeminent barriers mentioned earlier; those of unclear leadership roles and lack of systems emphasis. Additionally, the enablers where informal networks and cultural elements that shape how knowledge is retained or lost between projects. This aligns with the findings of this review, which suggest that while project-level learning occurs, mechanisms for institutionalizing that knowledge are weak and inconsistently applied.

We acknowledged that the Syllk Model served as an interpretive lens to categorize and analyze the barriers and enablers of knowledge transfer explored across the literature. Each element, i.e. *people*, *systems*, *technology*, *process*, *infrastructure*, and *learning* was used as coding to help sort findings into thematic clusters. This allowed us to observe where the literature concentrated, for instance, on *people* and *social* elements, and where significant gaps existed. This identified the underdeveloped areas or the insights gleaned on *infrastructure* or *financial* enablers. In this way, the Syllk Model helped structure the review by guiding attention to both *social* and *technical* subsystems, even if certain concepts resisted clear categorization. These interpretive challenges became the basis for proposing the new ISM Model.

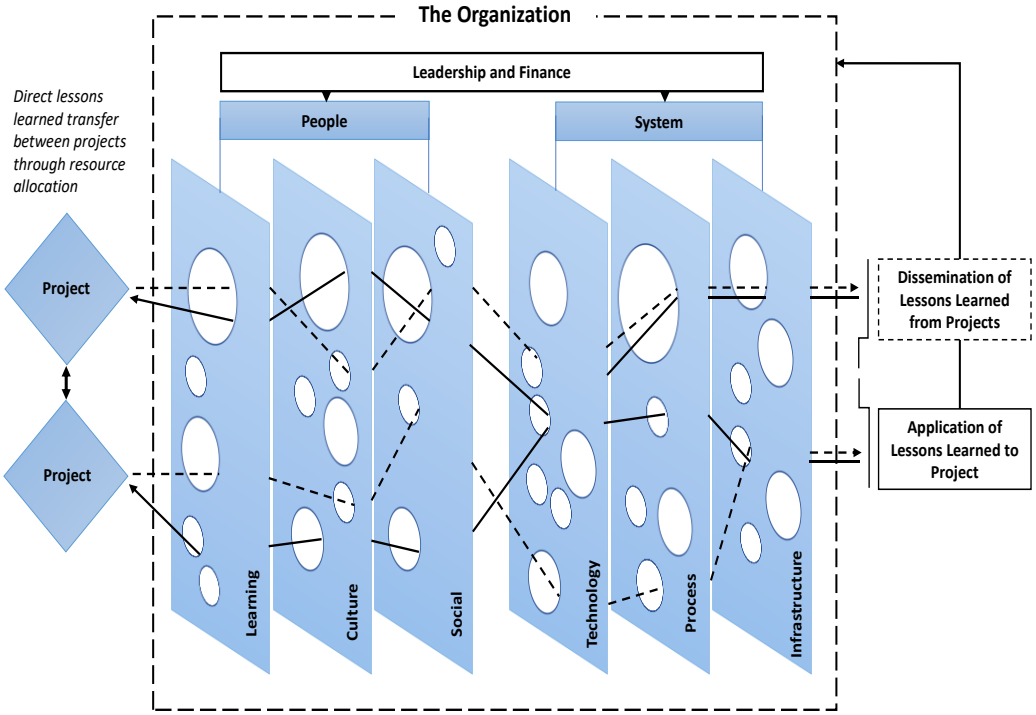
5.2 The Aspirational Syllk Model (Asyllk)

Applying an ISM was a valuable methodological tool to use for the scoping review because it allowed us to analyze the complexity of barriers to the six elements within the original Syllk Model and also explore the broader antecedents of knowledge transfer. Through an extensive examination of existing literature, covering over 200 sources, we were able to illustrate a detailed understanding of barriers to knowledge transfer within PBOs. This scoping review serves as a powerful resource for researchers and practitioners by offering insights into a plausible ammended model to employ in future research.

We offer the Aspirational Syllk (Asyllk) Model in Figure 3 and recommend that PBOs incorporate detailed learning logs within their project termination stage documentation capture. We found that the Duffield and Whitty's (2015) Syllk Model did not fully represent facilitators of, and barriers to, the knowledge transformation process noted within existing literature. This provides practical implications for other researchers because it illustrated that the six key elements within the original model omit fundamental factors such as *leadership* and *finance* and non-linear knowledge transfer. The expansive nature of our research explored the six elements (learning, culture, social, technology, process and infrastructure). Despite these topline headings The categorization of the elements is fuzzy which leads to misidentification and classification of facilitators and barriers. These barriers are often related to factors such as an internal fear culture, under-developed internal and external social networks and time pressures. Learning is not formalized and resources, including technology and infrastructure, was widely held to be a barrier within existing research.

The ASyllk Model is a useful tool for future researchers to investigate the dynamics related to other facilitators and barriers to organizational lessons learned (Figure 3). In the ASyllk Model the organizational environment is supported by *Leadership* and mandated by *Finance* hierarchies. The remaining six plates permit non-linear knowledge transfer and value the existence of both *People* and *Systems* within the learning ecosystem. Given the decentralized, short-cycle nature of PBOs, a more adaptive and systemically grounded model like ASyllk can help organizations codify learning more reliably across projects, where continuity and memory are often lacking.

The outcome facilitates and sustains dissemination and application of lessons learned. Sitting aside the *Systems* elements, this learning should systematically be enshrined in processes, procedure and policies.



Source: Authors' own

Figure 3: Aspirational Systemic Lessons Learned Knowledge (ASyllk) Model

The Asyllk has the capacity to consider the most appropriate elements to assess knowledge transfer. However, we recommend that the plates might need to be nuanced to incorporate the complexity of each project. For example, sustainability is often deemed a standalone concern. Over and above that, researchers may also want to embody the wider environment and issues relating to KE.

5.3 Key Barriers to Organizational Learning

Beyond the barriers that have been listed in Table 4, we found that additional organizational factors acting as barriers to knowledge transfer included the dearth of a knowledge-sharing culture, the paucity of time dedicated to knowledge transfer, experiential learning being unsupportive of mistakes, staff turnover, inadequate communication, cultural differences, and technological and infrastructure concerns, or lack thereof. Many of these reported issues were prevalent in organizations failing to optimize learning opportunities. These are shown in Table 5.

Table 5: Other Factors Acting as Barriers to Organizational Learning

People have to be allowed to make mistakes, it is an important part of the learning process, both individually and organizationally. If people are penalised for making mistakes when learning on-the-job they are less likely to take risks in the future, diminishing the potential for learning and development (see Bourne & Walker, 2004; Cannon & Edmondson, 2005; Frese & Keith, 2015).
Turnover of staff and the loss of knowledge that goes with them impacts the organization's ability to learn from an on-the-job, mentoring, project-learning perspective as well as from an organizational learning perspective unless their knowledge is captured and stored by the organization (see Massingham, 2018; Haughton, 2021).
Working with many different nationalities brings with it its own challenges of culture, attitudes, language barriers, approaches to learning, and ways of doing things (see Mesly *et al.,* 2013; Nnaji, 2024).
There are a lot of other learnings, not just technical, that happen on a project that are completely lost. These consist of behavioural and cultural elements, with each project having its own eco-system of characteristics, behaviours and dimensions. It is considered that these are not generally transferred to the organization (Lima *et al.,* 2019; Ram, 2023).

Source: Authors' own

Creating a list of facilitating tasks to overcome barriers is too simplistic. The answers are complex in that mostly they address ways to communicate and deal with the social aspects of staff management and the cost of creating conducive processes and procedures, including the infrastructure. These probably reside within the leadership and financial mantles that we mentioned in the preceding section. This reinforces the importance in having these areas directly accounted for within the Asyllk Model. Whilst the Asyllk Model assumes that staff management and technological support costs falls under leadership and finance respectively, a glossary of terms to explain the elements and umbrella themes is fundamental before any direct utilization is made of this or any other ISM.

6. Conclusion

PMI does not offer any specific guidance on what and how to tackle project termination in any of the iterations of their PMBoK guides (2008, 2013, 2017, 2021). The PMBoK mentions project termination but omits instructions beyond that. Project termination falls at the end of individual, collective and organizational learning opportunities. Schindler and Eppler (2003, p.220) poignantly stated that "If their specific knowledge of that project is not directly needed, organizational amnesia begins". Typically project fees include items necessary for project fulfilment from a client perspective and PBO learning falls outside that scope. When a project terminates, external partners/consultants, generally move on to their next undertaking and this may mean leaving the organization at project completion, thus losing expert knowledge. Clients are resistant to paying extra fees for documentation and knowledge if it is not for their benefit. Post-project reviews are more likely to happen where knowledge is a major project outcome (von Zedtwitz, 2002). Yet the issue of losing this knowledge should be viewed as a risk for PBOs. There seems little cognizance that future project teams could reduce costs by eliminating past failures. PBOs should formalize learning capture and knowledge transfer opportunities within appropriate systems as part of their own competitive ethos (Barney, 1991; Antunes & Pinheiro, 2020).

We conclude that the significant gap in literature on facilitating knowledge transfer has not helped in solving the bona fide scarcity of effective knowledge transfer mechanisms in PBOs. This might be rectified if project management included a distinct *how-to* manual providing tools, guidance and practical steps which will direct knowledge management and knowledge transfer at project closure. It seems apparent to us that a formalized and structured 'lessons learned' should be an output of every project in order to capture both knowledge and deficits, experienced by the project team. The omission of such a practical pathway is one that needs urgent attention. Our scoping review indicated that despite so many scholars highlighting the barriers to knowledge transfer over the last fifty years, we discovered that the more things change, the more they stayed the same.

6.1 Future Research

We recommend conducting empirical research in organizations, directly testing the Asyllk Model to ascertain whether it requires further modifications. Furthermore, improving knowledge management processes and approaches requires wider assessment of social and economic impacts for knowledge transfer in PBOs (Bucci and El-Diraby, 2018), which rightly contributes to a buoyant KE. Whilst some headway has been made, there is an imperative to foster increased professional and academic engagement in research that considers the KE capacity, particularly because contemporary research outputs show a marked difference between sectorial, regional and national studies (Marginson, 2010). It is still more typical to disaggregate knowledge and the economy as separate inputs rather than consider the synergy that can be gained through harnessing their duality for optimum effect.

6.2 Limitations

Despite our best auspices, there will undoubtedly be scholars whose work we missed irrespective of our wholehearted endeavours to represent the wealth of credible relevant research. We thank all these scholars whose diligence made this work possible.

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References

Aga, D. A. (2016). Transactional leadership and project success: the moderating role of goal clarity. *Procedia Computer Science*, 100, 517-525.

Ajmal, M. & Koskinen, K.U. (2008). Knowledge transfer in project-based organizations: An organizational culture perspective. *Project Management Journal*, 39(1), 7–15.

Alavi, M., & Leidner, D. E. (2001). Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, 25(1), 107-136.

Akhavan, P., Philsoophian, M., Rajabion, L., & Namvar, M. (2018). Developing a block-chained knowledge management model (BCKMM): beyond traditional knowledge management. The 19th European Conference on Knowledge Management, September, Italy.

Almeida, M. V., & Soares, A. L. (2014). Knowledge sharing in project-based organizations: Overcoming the informational limbo. *International Journal of Information Management*, 34(6), 770-779.

Anlesinya, A. (2018). Organizational barriers to employee training and learning: evidence from the automotive sector. *Development and Learning in Organizations: An International Journal*, 32(3), 8-10.

Annabi, C. A. (2022). Chapter 2, Mindfulness as a Strategy to Weather Challenges. *Innovative Leadership in Times of Compelling Changes: Strategies, Reflections and Tools*, (pp. 19-32). Springer US.

Antunes, H. D. J. G., & Pinheiro, P. G. (2020). Linking knowledge management, organizational learning and memory. *Journal of Innovation & Knowledge*, *5*(2), 140-149.

Arbabi, H., Salehi-Taleshi, M.J. & Ghods, K. (2020). The role of project management office in developing knowledge management infrastructure. *Engineering, Construction and Architectural Management*, 27(10), 3261-3287.

Argote, L. (2011). Organizational learning research: Past, present and future. *Management Learning*, 42(4), 439-446.

Argote, L., & Hora, M. (2017). Organizational learning and management of technology. *Production and Operations Management*, 26(4), 579-590.

Argote, L., & Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. *Organizational Behavior and Human Decision Processes*, 82(1), 150-169.

Argote, L., Lee, S., & Park, J. (2021). Organizational learning processes and outcomes: Major findings and future research directions. *Management Science*, 67(9), 5399-5429.

Argote, L., & Miron-Spektor, E. (2011). Organizational learning: From experience to knowledge. *Organization Science*, 22(5), 1123-1137.

Argyris, C. (1992). Overcoming organizational defenses. *The Journal for Quality and Participation*, 15(2), 26.

Argyris, C. (1999) On Organizational Learning, (2nd ed). Malden, MA: Blackwell Publishers.

Argyris, C., & Schon, D. A. (1978). *Organizational learning: A theory of action perspective*. Reading, MA: Addison-Wesley.

Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*, 8(1), 19-32.

Asiaei, K., & Bontis, N. (2019). Using a balanced scorecard to manage corporate social responsibility. *Knowledge and Process Management*, 26(4), 371-379.

Association for Project Management APM, April 2024 "The Project Professional is Growing Fast but Needs to Fill the Talent Shortage", available at: https://www.apm.org.uk/blog/the-project-profession-is-growing-fast-but-needs-to-fill-the-talent-shortage-apm-research/ (accessed on 8 May 2025).

Balle, A. R., Steffen, M. O., Curado, C., & Oliveira, M. (2019). Interorganizational knowledge sharing in a science and technology park: the use of knowledge sharing mechanisms. *Journal of Knowledge Management*, 23(10), 2016-2038.

Baloh, P., Uthicke, K., & Moon, G. (2008). A business process-oriented method of KM solution design: A case study of Samsung Electronics. *International Journal of Information Management*, 28(5), 433-437.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99-120.

Barney, J. B. (1995), *Human Resource Management: A Contemporary Approach*, (5th Ed.), Prentice Hall/Financial Times, New York.

Bandow, D., Gerweck, J., & Self, T. B. (2015). Supporting & empowering knowledge workers & communities of practice. *Quarterly Review of Business Disciplines*, 2(1), 1-17.

Bapuji, H., & Crossan, M. (2004). From questions to answers: reviewing organizational learning research. *Management Learning*, 35(4), 397-417.

Bartsch, V., Ebers, M., & Maurer, I. (2013). Learning in project-based organizations: The role of project teams' social capital for overcoming barriers to learning. *International Journal of Project Management*, 31(2), 239-251.

Bates, S., Clapton, J., & Coren, E. (2007). Systematic maps to support the evidence base in social care. *Evidence & Policy*, 3(4), 539-551.

Belhoste, N., & Dimitrova, A. (2024). Developing critical geopolitical awareness in management education. *Management Learning*, 55(4), 617-640.
Bhatt, G. D. (2001). Knowledge management in organizations: examining the interaction between technologies, techniques, and people. *Journal of Knowledge Management*, 5(1), 68-75.
Bhatti, S. H., Kiyani, S. K., Dust, S. B., & Zakariya, R. (2021). The impact of ethical leadership on project success: the mediating role of trust and knowledge sharing. *International Journal of Managing Projects in Business*, 14(4), 982-998.
Bontis, N., Crossan, M. M., & Hulland, J. (2002). Managing an organizational learning system by aligning stocks and flows. *Journal of Management Studies*, 39(4), 437-469.
Bourne, L., & Walker, D. H. (2004). Advancing project management in learning organizations. *The Learning Organization*, *11*(3), 226-243.
Bragge, P., Clavisi, O., Turner, T., Tavender, E., Collie, A., & Gruen, R. L. (2011). The global evidence mapping initiative: scoping research in broad topic areas. *BMC Medical Research Methodology*, 11, 1-12.
Bresnen, M., Edelman, L., Newell, S., Scarbrough, H. & Swan, J. (2003). Social practices and the management of knowledge in project environments. *International Journal of Project Management*, 21(3), 157–166.
Bucci, M. & El-Diraby, T. E. (2018). The functions of knowledge management processes in urban impact assessment: the case of Ontario. *Impact Assessment and Project Appraisal*, 36(3), pp. 265–280. doi: 10.1080/14615517.2018.1445179.
Bunderson, J. S., & Boumgarden, P. (2010). Structure and learning in self-managed teams: Why "bureaucratic" teams can be better learners. *Organization Science*, 21(3), 609-624
Cannon, M. D., & Edmondson, A. C. (2005). Failing to learn and learning to fail (intelligently): How great organizations put failure to work to innovate and improve. *Long Range Planning*, *38*(3), 299-319.
Carmeli, A., & Gittell, J. H. (2009). High-quality relationships, psychological safety, and learning from failures in work organizations. *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, 30(6), 709-729.
Carrillo, P., Robinson, H., Al-Ghassani, A., & Anumba, C. (2004). Knowledge management in UK construction: Strategies, resources and barriers. *Project Management Journal*, 35(1), 46-56.
Carrillo, P., Ruikar, K., & Fuller, P. (2013). When will we learn? Improving lessons learned practice in construction. *International Journal of Project Management*, 31(4), 567-578.
Carayannis, E.G. & Campbell, D.F. (2018). Definition of key terms: Knowledge, knowledge production, innovation, democracy, and governance. In *Smart Quintuple Helix Innovation Systems: How Social Ecology and Environmental Protection are Driving Innovation, Sustainable Development and Economic Growth* (pp. 5-15). Cham: Springer International Publishing
Casprini, E., De Massis, A., Di Minin, A., Frattini, F., & Piccaluga, A. (2017). How family firms execute open innovation strategies: the Loccioni case. *Journal of Knowledge Management*, 21(6), 1459-1485.
Chang, S. C., & Lee, M. S. (2007). A study on relationship among leadership, organizational culture, the operation of learning organization and employees' job satisfaction. *The Learning Organization*, 14(2), 155-185.
Chen, J. Q., Lee, T. E., Zhang, R., & Zhang, Y. J. (2003). Systems requirements for organizational learning. *Communications of the ACM*, 46(12), 73-78.
Cook, S. N., & Yanow, D. (2011). Culture and organizational learning. *Journal of Management Inquiry*, 20(4), 362-379.
Cooke-Davies, T. (2002). The "real" success factors on projects. *International Journal of Project Management*, 20(3), 185-190.
Crossan, M.M. & Berdrow, I. (2003). Organizational learning and strategic renewal. *Strategic Management Journal*, *24*(11), 1087-1105.
Crossan, M.M., Lane, H.W., White, R.E. & Djurfeldt, L. (1995). Organizational learning: Dimensions for a theory. *The International Journal of Organizational Analysis*, *3*(4), 337-360.
Crossan, M. M., Maurer, C. C., & White, R. E. (2011). Reflections on the 2009 AMR decade award: do we have a theory of organizational learning? *Academy of Management Review*, 36(3), 446-460.
Crupi, A., Del Sarto, N., Di Minin, A., Phaal, R., & Piccaluga, A. (2021). Open innovation environments as knowledge sharing enablers: the case of strategic technology and innovative management consortium. *Journal of Knowledge Management*, 25(5), 1263-1286.
Cyert, R. M. & March, J. G. (1963). *A Behavioral Theory of the Firm*. Englewood Cliffs, NJ: Prentice Hall.
Dalkir, K. (2013). Knowledge Management in Theory and Practice. Routledge.
Davenport, T. H., & Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Harvard Business Press.
Desouza, K. C. (2003). Strategic contributions of game rooms to knowledge management: some prelimenary insights. *Information & Management*, 41(1), 63-74.
Dimitriades, Z. S. (2005). Creating strategic capabilities: organizational learning and knowledge management in the new economy. *European Business Review*, 17(4), 314-324.
Disterer, G. (2002). Management of project knowledge and experiences. *Journal of Knowledge Management*, 6(5), 512-520.

Do, H., Budhwar, P., Shipton, H., Nguyen, H. D., & Nguyen, B. (2022). Building organizational resilience, innovation through resource-based management initiatives, organizational learning and environmental dynamism. *Journal of Business Research*, 141, 808-821.

Donate, M. J., & de Pablo, J. D. S. (2015). The role of knowledge-oriented leadership in knowledge management practices and innovation. *Journal of Business Research*, 68(2), 360-370.

Duffield, S. M. (2017). An advanced systemic lesson learned knowledge model for project organisations (Doctoral dissertation, University of Southern Queensland).

Duffield, S., & Whitty, J. (2012), A systemic lessons learned and captured knowledge (SLLCK) model for project organizations". In Proceedings of the 9th Annual Project Management Australia Conference (PMOz 2012) (pp. 4-18). EventCorp.

Duffield, S., & Whitty, S. J. (2015). Developing a systemic lesson learned knowledge model for organisational learning through projects. *International Journal of Project Management*, 33(2), 311-324.

Duffield, S., & Whitty, S. J. (2016). How to apply the Systemic Lessons Learned Knowledge model to wire an organisation for the capability of storytelling. *International Journal of Project Management*, 34(3), 429-443.

Du Plessis, M. (2007). The role of knowledge management in innovation. *Journal of Knowledge Management*, 11(4), 20-29.

Easterby-Smith, M. (1997). Disciplines of organizational learning: contributions and critiques. *Human Relations*, 50(9), 1085-1113.

Easterby-Smith, M., & Lyles, M. A. (2011). In praise of organizational forgetting. *Journal of Management Inquiry*, 20(3), 311-316.

Edmondson, A. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly*, 44(2), 350-383.

Edmondson, A. C., & Lei, Z. (2014). Psychological safety: The history, renaissance, and future of an interpersonal construct. *Annual Review of Organizational Psychology and Organizational Behavior*, 1(1), 23-43.

Fai Pun, K., & Nathai-Balkissoon, M. (2011). Integrating knowledge management into organisational learning: A review of concepts and models. *The Learning Organization*, 18(3), 203-223.

Fiol, C. M., & Lyles, M. A. (1985). Organizational learning. Academy of Management Review, 10(4), 803-813.

Fjellström, D., Bai, W., Oliveira, L., & Fang, T. (2023). Springboard internationalisation in times of geopolitical tensions. *International Business Review*, 32(6), 102144.

Franco, M., & Haase, H. (2009). Entrepreneurship: an organisational learning approach. *Journal of Small Business and Enterprise Development*, 16(4), 628-641.

Frese, M., & Keith, N. (2015). Action errors, error management, and learning in organizations. *Annual Review of Psychology*, *66*(1), 661-687.

García-Morales, V. J., Jiménez-Barrionuevo, M. M., & Gutiérrez-Gutiérrez, L. (2012). Transformational leadership influence on organizational performance through organizational learning and innovation. *Journal of Business Research*, 65(7), 1040-1050.

Garvin, D. A. (1993). Building a learning organization. Harvard Business Review, July-August, 78-84.

Girard, J., & Girard, J. (2015). Defining knowledge management: Toward an applied compendium. *Online Journal of Applied Knowledge Management*, 3(1).

Godkin, L., & Allcorn, S. (2009). Dependent narcissism, organizational learning, and human resource development. Human Resource Development Review, 8(4), 484-505.

Grant, S. B. (2016). Classifying emerging knowledge sharing practices and some insights into antecedents to social networking: a case in insurance. *Journal of Knowledge Management*, 20(5), 898-917.

Gupta, B., Iyer, L. S., & Aronson, J. E. (2000). Knowledge management: practices and challenges. Industrial Management & Data Systems, 100(1), 17-21.

Hadad, S., (2017). Knowledge economy: Characteristics and dimensions. *Management Dynamics in the Knowledge Economy*, 5(2), 203-225.

Hassan, F., & Annabi, C. A. (2019). Come fly with ME: The Impact of 3PLs within the aircraft Manufacturing, Repair and Overhaul Industry in the United Arab Emirates, *International Journal of Industrial Distribution & Business, 10*(4), 13-24.

Haughton, R. (2021). *Exploring knowledge retention strategies to prevent knowledge loss in project-based organizations (PBOs)* (Doctoral dissertation, Walden University).

Hedberg, B. (1981). How Organizations Learn and Unlearn, in Nystrom, P.C. and Starbuck, W. H. (Ed.), *Handbook of Organizational Design*, Vol. 1. Oxford University Press, New York, 3-27.

Henfridsson, O., & Söderholm, A. (2000). Barriers to learning: on organizational defenses and vicious circles in technological adaptation. *Accounting, Management and Information Technologies*, 10(1), 33-51.

Hislop, D., Bosua, R., & Helms, R. (2018). *Knowledge management in organizations: A critical introduction.* Oxford University Press.

Ho, C. T., Chen, Y. M., Chen, Y. J., & Wang, C. B. (2004). Developing a distributed knowledge model for knowledge management in collaborative development and implementation of an enterprise system. *Robotics and Computer-Integrated Manufacturing*, 20(5), 439-456.

Hobday, M. (2000). The project-based organisation: an ideal form for managing complex products and systems? *Research Policy*, 29(7–8), 871–893.

Hofstede, G. (1997). *Culture and Organizations: Software of the Mind: Intercultural Cooperation and its importance for Survival*. McGraw-Hill.
Hoopes, D. G., Madsen, T. L., & Walker, G. (2003). Guest editors' introduction to the special issue: why is there a resource-based view? Toward a theory of competitive heterogeneity. *Strategic Management Journal*, 24(10), 889-902.
Hult, G. T. M., Ferrell, O. C., Hurley, R. F., & Giunipero, L. C. (2000). Leadership and relationship commitment: a focus on the supplier–buyer–user linkage. *Industrial Marketing Management*, 29(2), 111-119.
Hurley, R. F., & Hult, G. T. M. (1998). Innovation, Market Orientation, and Organizational Learning: An Integration and Empirical Examination. *Journal of Marketing, 62*(3), 42–54.
International Organization for Standardization ISO, June 2022 "The New Project-Based Economy", available at: https://www.iso.org/contents/news/2022/06/newsproject-based-management.html (accessed 8 November 2024).
Intezari, A., Taskin, N., & Pauleen, D. J. (2017). Looking beyond knowledge sharing: an integrative approach to knowledge management culture. *Journal of Knowledge Management*, 21(2), 492-515.
Ivaldi, S., Scaratti, G., & Fregnan, E. (2022). Dwelling within the fourth industrial revolution: organizational learning for new competences, processes and work cultures. *Journal of Workplace Learning*, 34(1), 1-26.
Jafari, P., & Kalanaki, M. (2012). Relationship between the dimensions of learning organization and readiness-to-change. *Procedia-Social and Behavioral Sciences*, 46, 5811-5815.
Jyothibabu, C. D., Farooq, A., & Bhusan Pradhan, B. (2010). An integrated scale for measuring an organizational learning system. *The Learning Organization*, 17(4), 303-327.
Katz, D. L., Williams, A. L., Girard, C., Goodman, J., Comerford, B., Behrman, A., & Bracken, M. B. (2003). The evidence base for complementary and alternative medicine: methods of evidence mapping with application to CAM. *Alternative Therapies in Health and Medicine*, 9(4), 22-37.
Keegan, A., & Turner, J. R. (2001). Quantity versus quality in project-based learning practices. *Management Learning*, 32(1), 77-98.
Kezar, A. J., & Holcombe, E. M. (2020). Barriers to organizational learning in a multi-institutional initiative. *Higher Education*, *79*(6), 1119-1138.
Kim, D. H. (1993). The link between individual and organizational learning. *Sloan Management Review*, 35(1), 37-50.
Kortsch, T., Bashenkhaeva, V. & Kauffeld, S. (2023). Learning from leaders: the mediating role of leadership between national culture and organizational learning culture. *Human Resource Development International*, 26(2), 151-174.
King, W. R. (2009). Knowledge management and organizational learning (pp. 3-13). Springer US.
Kirchner, K., Ipsen, C., & Hansen, J. P. (2021). COVID-19 leadership challenges in knowledge work. *Knowledge Management Research & Practice*, 19(4), 493-500.
Lakshman, C. (2007). Organizational knowledge leadership: A grounded theory approach. Leadership & Organization Development Journal, 28(1), 51-75.
Lartey, P.Y., Shi, J., Santosh, R.J., Afriyie, S.O., Gumah, I.A., Husein, M. & Bah, F.B.M. (2022). Importance of organizational tacit knowledge: Barriers to knowledge sharing. In *Recent advances in Knowledge Management*. IntechOpen.
Lee, E. L., & Lee, W. O. (2022). Enabling continuous innovation and knowledge creation in organizations: Optimizing informal learning and tacit knowledge. In *Third International Handbook of Lifelong Learning* (pp. 1-20). Springer International Publishing.
Lee, Y., Tao, W., Li, J. Y. Q., & Sun, R. (2021). Enhancing employees' knowledge sharing through diversity-oriented leadership and strategic internal communication during the COVID-19 outbreak. *Journal of Knowledge Management*, 25(6), 1526-1549.
Levac, D., Colquhoun, H., & O'brien, K. K. (2010). Scoping studies: advancing methodology. *Implementation Science*, 5, 1-9.
Lima, G. D., Costa, J. A., Dorça, F. A., & Araújo, R. D. (2024). An analysis of technological resources to encourage self-regulated learning behaviour in virtual learning environments in the last decade. *International Journal of Learning Technology*, *19*(1), 85-108.
Lin, H. F. (2007). Knowledge sharing and firm innovation capability: an empirical study. *International Journal of Manpower*, 28(3/4), 315-332.
Lin, S. W., & Lo, L. Y. S. (2015). Mechanisms to motivate knowledge sharing: integrating the reward systems and social network perspectives. *Journal of Knowledge Management*, 19(2), 212-235.
Lindner, F., & Wald, A. (2011). Success factors of knowledge management in temporary organizations. *International Journal of Project Management*, 29(7), 877-888.
Lindkvist, L. (2005). Knowledge communities and knowledge collectivities: A typology of knowledge work in groups. *Journal of Management Studies*, 42(6), 1189–1210.
Lipshitz, R., Popper, M., & Friedman, V. J. (2002). A multifacet model of organizational learning. *The Journal of Applied Behavioral Science*, 38(1), 78-98.
Lotti Oliva, F. (2014). Knowledge management barriers, practices and maturity model. *Journal of Knowledge Management*, 18(6), 1053-1074. https://doi.org/10.1108/JKM-03-2014-0080
Luhn, A. (2016). The learning organization. *Creative and Knowledge Society*, 6(1), 1-13.
Mai, N. K., Do, T. T., & Ho Nguyen, D. T. (2022). The impact of leadership competences, organizational learning and organizational innovation on business performance. *Business Process Management Journal*, 28(5/6), 1391-1411.
Malik, H., & Annabi, C. A. (2022). The impact of mindfulness practice on physician burnout: A scoping review. *Frontiers in Psychology*, 13, 956651.

Marabelli, M., & Newell, S. (2014). Knowing, power and materiality: A critical review and reconceptualization of absorptive capacity. *International journal of Management Reviews*, 16(4), 479-499.
Marginson, S., (2010). Higher education in the global knowledge economy. *Procedia-Social and Behavioral Sciences*, *2*(5), 6962-6980.
Marquardt, M. J. (2011). The coach as catalyst for action learning. *Training & Management Development Methods*, 25(1), 101.
Massingham, P. R. (2018). Measuring the impact of knowledge loss: a longitudinal study. *Journal of Knowledge Management*, *22*(4), 721-758.
Massingham, P., & Al Holaibi, M. (2017). Embedding knowledge management into business processes. Knowledge and Process Management, 24(1), 53-71.
Matzdorf, F., Price, I., & Green, M. (2000). Barriers to organizational learning in the chartered surveying profession. *Property Management*, 18(2), 92-113.
Mays N, Roberts E., & Popay J. (2001). Synthesizing research evidence. In *Studying the Organisation and Delivery of Health Services: Research methods*, N Fulop, P Allen, A Clarke, N Black (eds.), Routledge: London; 188–219
Mays, N., Roberts, E., & Popay, J. (2004). Synthesising research evidence. In *Studying the Organisation and Delivery of Health Services* (pp. 200-232). Routledge.
McClory, S., Read, M., & Labib, A. (2017). Conceptualising the lessons-learned process in project management: Towards a triple-loop learning framework. *International Journal of Project Management*, 35(7), 1322-1335.
McDermott, R., & O'dell, C. (2001). Overcoming cultural barriers to sharing knowledge. *Journal of Knowledge Management*, 5(1), 76-85.
Mesly, O., Lévy-Mangin, J. P., Bourgault, N., & Nabelsi, V. (2013). Effective multicultural project management: the role of human interdependence. *International Journal of Managing Projects in Business*, *7*(1), 78-102.
Meyers, P.W. (1990). Non-linear learning in large technological firms: Period four implies chaos. *Research Policy*, 19(2), 97-115.
Miklosik, A., & Zak, S. (2015). Framework for effective removal of knowledge management implementation barriers. *Procedia Economics and Finance*, 30, 513-521.
Mitchell, V. W., Harvey, W. S., & Wood, G. (2022). Where does all the 'know how' go? The role of tacit knowledge in research impact. Higher Education Research & Development, 41(5), 1664-1678.
Miterev, M., Mancini, M., & Turner, R. (2017). Towards a design for the project-based organization. *International Journal of Project Management*, 35(3), 479-491.
Mothapo, K., & Joseph, N. (2023). Transferring IT project management experiential knowledge into organisational learning. *Journal of Contemporary Management*, 20(1), 1-37.
Mubarak, N., Khan, J., Riaz, A. & Jaafar, M. (2024). Role of a knowledge leader to strengthen economy through project success. *Journal of the Knowledge Economy*, 15(3), 10129-10150.
Mumford, A. (1992). Individual and organizational learning: The pursuit of change. *Management Decisions.* 30(6), 143-148.
Mumford, J. (2016). *Understanding work-based learning*. CRC Press.
Munn, Z., Peters, M. D., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC medical Research Methodology*, 18, 1-7.
Naot, Y.B.H., Lipshitz, R. & Popper, M. (2004). Discerning the quality of organizational learning. *Management Learning*, 35(4), 451-472.
Newell, S., Bresnen, M., Edelman, L., Scarbrough, H., & Swan, J. (2006). Sharing knowledge across projects: limits to ICT-led project review practices. *Management Learning*, 37(2), 167-185.
Nnaji, E. S. (2024). Influence of Transformational Leadership on the Sustainability of Universities: Focus on Universities in Cross River State, Nigeria. *Kashere Journal of Education*, *6*(3), 47-59.
Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science*, 5(1), 14-37.
Odor, H. O. (2018). A literature review on organizational learning and learning organizations. *International Journal of Economics & Management Sciences*, 7(1), 1-6.
O'Dell, C., & Hubert, C. (2011). *New Edge in Knowledge: How Knowledge Management Is Changing the Way We Do Business.* Wiley, Hoboken, NJ.
Oh, S. Y., & Han, H. S. (2020). Facilitating organisational learning activities: Types of organisational culture and their influence on organisational learning and performance. *Knowledge Management Research & Practice*, 18(1), 1-15.
Panagiotakopoulos, A. (2011). Barriers to employee training and learning in small and medium-sized enterprises (SMEs). *Development and learning in organizations: An International Journal*, 25(3), 15-18.
Papmehl, A. (2004). Culture change and organic growth. *CMA Management*, 78, 16-18.
Park, S., & Kim, E. J. (2018). Fostering organizational learning through leadership and knowledge sharing. *Journal of Knowledge Management*, 22(6), 1408-1423.
Paver, M., & Duffield, S. (2019). Project management lessons learned "the elephant in the room". *The Journal of Modern Project Management*, 6(3).
Pedler, M., Burgoyne, J. D., & Boydell, T. (1997). *The Learning Company: A strategy for sustainable development.* London: McGraw-Hill.
Pemberton, J. D., & Stonehouse, G. H. (2000). Organisational learning and knowledge assets–an essential partnership. *The Learning Organization*, 7(4), 184-194.

Pemsel, S., & Müller, R. (2012). The governance of knowledge in project-based organizations. *International Journal of Project Management*, *30*(8), 865-876.
Pemsel, S. & Wiewiora, A. (2013). Project management office - a knowledge broker in project-based organisations. *International Journal of Project Management*, 31(1), 31-42.
Peters, M.D., Godfrey, C., McInerney, P., Khalil, H., Larsen, P., Marnie, C., Pollock, D., Tricco, A.C. & Munn, Z., (2022). Best practice guidance and reporting items for the development of scoping review protocols. *JBI evidence synthesis*, 20(4), 953-968.
Pitagorsky, G. (2000). Lessons learned through process thinking and review. PM Network. 14(3), 35-40.
Popper, M., & Lipshitz, R. (2000). Organizational learning: Mechanisms, culture, and feasibility. *Management Learning*, 31(2), 181-196.
Powell, T. H., & Ambrosini, V. (2012). A pluralistic approach to knowledge management practices: Evidence from consultancy companies. Long Range Planning, 45(2-3), 209-226.
Project Management Institute (PMI). (2008), A Guide to the Project Management Body of Knowledge (PMBOK® Guide), (4th Ed.). PMI. Newtown Square, Pennsylvania.
Project Management Institute (PMI). (2013), A Guide to the Project Management Body of Knowledge (PMBOK® Guide), (5th Ed.). PMI. Newtown Square, Pennsylvania.
Project Management Institute (PMI). (2017). A guide to the project management body of knowledge:(PMBOK® guide), (6th Ed.). PMI. Newtown Square, Pennsylvania.
Project Management Institute (2021). A Guide to the Project Management Book of Knowledge, (PMBOK guide), (7th Ed.). PMI. Upper Darby, Pennsylvania.
Project Management Institute (PMI). (2023). "AI Disruption to Transform Project Success Rate", available at: https://www.projectmanagement.com/blog-post/75207/ai-disruption-to-transform-project-success-rates#_= (accessed on 8 November 2024).
Putra, A. S., Novitasari, D., Asbari, M., Purwanto, A., Iskandar, J., Hutagalung, D., & Cahyono, Y. (2020). Examine relationship of soft skills, hard skills, innovation and performance: The mediation effect of organizational learning. *International Journal of Science and Management Studies*, 3(3), 27-43.
Raidén, A. B., & Dainty, A. R. (2006). Human resource development in construction organisations: an example of a "chaordic" learning organisation? *The Learning Organization*, 13(1), 63-79.
Raidén, A.B., Dainty, A.R. & Neale, R.H. (2008). Understanding employee resourcing in construction organizations. Construction management and economics, 26(11), 1133-1143.
Ram, J. (2023). Investigating staff capabilities to make projects resilient: A systematic literature review and future directions. *International Journal of Production Economics*, *255*, 108687.
Ramus, C. A., & Steger, U. (2000). The roles of supervisory support behaviors and environmental policy in employee "Ecoinitiatives" at leading-edge European companies. *Academy of Management Journal*, 43(4), 605-626.
Rahmandad, H., Repenning, N., & Sterman, J. (2009). Effects of feedback delay on learning. System Dynamics Review, 25(4), 309-338.
Rastogi, P. N. (2002). Knowledge management and intellectual capital as a paradigm of value creation. Human Systems Management, 21(4), 229-240.
Reason, J. (1997). Managing the risks of organizational accidents. Ashgate, Aldershot, Hants, England.
Roberts, J., (2009). The global knowledge economy in question. *Critical Perspectives on International Business*, 5(4), 285-303.
Sage, A.P. (1977). *Interpretive Structural Modelling: Methodology for Large Scale Systems* (pp. 91–164), McGraw-Hill, New York, NY.
Santhose, S. S., & Lawrence, L. N. (2023). Understanding the implementations and limitations in knowledge management and knowledge sharing using a systematic literature review. *Current Psychology*, *42*(36), 32427-32442.
Schein, E.H. (1985). *Organizational Culture and Leadership*. Jossey Bass, San Francisco.
Schein, E. H. (1996). Three cultures of management: To key to organizational learning. *Sloan Management Review*, 38(1), 9-20.
Schein, E. H. (2017). Organizational culture and leadership. John Wiley & Sons.
Schindler, M., & Eppler, M. J. (2003). Harvesting project knowledge: a review of project learning methods and success factors. *International Journal of Project Management*, 21(3), 219-228.
Schilling, J., & Kluge, A. (2009). Barriers to organizational learning: An integration of theory and research. *International Journal of Management Reviews*, 11(3), 337-360.
Schmitz, S., Rebelo, T., Gracia, F. J., & Tomás, I. (2014). Learning culture and knowledge management processes: To what extent are they effectively related? *Journal of Work and Organizational Psychology*, 30(3), 113-121.
Senge, P. M. (1990). The Fifth Discipline: The Art and Practice of the Learning Organization. Crown Business, NY.
Senge, P. M. (1997). The fifth discipline. *Measuring Business Excellence*, 1(3), 46-51.
Sense, A. J. (2011). The project workplace for organizational learning development. International Journal of Project Management, 29, 986-993.
Serinkan, C., Kiziloglu, M., Akcit, V., & Enli, P. (2014). *Organizational learning capacity in cargo industry. Procedia-Social and Behavioral Sciences*, 116, 4005-4009.
Shokri-Ghasabeh, M., & Chileshe, N. (2014). Knowledge management: Barriers to capturing lessons learned from Australian construction contractors' perspective. *Construction Innovation*, 14(1), 108-134.

Shrivastava, P. (1983). A typology of organizational learning systems. *Journal of Management Studies*, 20(1), 7-28.
Singh, M.D., & Kant, R. (2008). Knowledge management barriers: an interpretive structural modeling approach. *International Journal of Management Science and Engineering Management*, 3(2), 141-150.
Singh, R. K., Garg, S. K., & Deshmukh, S. G. (2007), Interpretive structural modelling of factors for improving competitiveness of SMEs, *International Journal of Productivity and Quality Management*, 2(4), 423-440.
Singh, S. K., Gupta, S., Busso, D., & Kamboj, S. (2021). Top management knowledge value, knowledge sharing practices, open innovation and organizational performance. *Journal of Business Research*, 128, 788-798.
Sinkula, J. M. (1994). Market information processing and organizational learning. *Journal of Marketing*, 58(1), 35-45.
Slater, S. F., & Naver, J. C. (1995). Market orientation and the learning organization. *Journal of Marketing*, 59(3) 63-74.
Spector, J. M., & Davidsen, P. I. (2006). How can organizational learning be modelled and measured? *Evaluation and Program Planning*, 29. 63-69.
Steiner, L. (1998). Organizational dilemmas as barriers to learning. The Learning Organization, 5(4), 193-201.
Stonehouse, G. H., & Pemberton, J. D. (1999). Learning and knowledge management in the intelligent organisation. *Participation and Empowerment: An international Journal*, 7(5), 131-144.
Sydow, J., Lindkvist, L. & DeFillippi, R. (2004). Project-based organizations, embeddedness and repositories of knowledge: Editorial. *Organization Studies*, 25(9), 1475–1489.
Swan, J., Scarbrough, H., & Newell, S. (2010). Why don't (or do) organizations learn from projects? *Management Learning*, 41(3), 325-344.
Tarziján, J. & Brahm, F. (2014). Subcontracting in project-based firms: Do you follow the same pattern across your different projects? *International Journal of Project Management*, 32(6), 995-1006.
Terzieva, M. (2014). Project knowledge management: how organizations learn from experience. *Procedia Technology*, 16, 1086-1095.
Thiry, M. (2008). From PMO to PBO: The PMO as a vehicle for organizational change. *Project Management Institute*. Available at https://www.pmi.org/learning/library/evolving-pmo-into-pbo 7311#:~:text=Project%2DBased%20Organizations%20(PBOs),as%20other%20less%20known%20forms (accessed 8 May 2025)
Tshuma, B., Steyn, H., & van Waveren, C. C. (2022). The mediation role of the PMO in the transfer of knowledge between projects–a case study of five PMOs. *International Journal of Managing Projects in Business*, *15*(1), 150-174.
Todorović, M. L., Petrović, D. Č., Mihić, M. M., Obradović, V. L., & Bushuyev, S. D. (2015). Project success analysis framework: A knowledge-based approach in project management. *International Journal of Project Management*, 33(4), 772-783.
Turner, J. R., & Müller, R. (2005). The project manager's leadership style as a success factor on projects: A literature review. *Project Management Journal*, 36(2), 49-61.
Turner, J.R. & Keegan, A.E. (2001). Mechanisms of governance in project-based organizations: Roles of the broker and steward. *European Management Journal*, 19(3), 254–267.
van Waveren, C. C., Oerlemans, L. A., & Pretorius, M. W. (2014, December). Knowledge transfer in project-based organizations. A conceptual model for investigating knowledge type, transfer mechanisms and transfer success. In *2014 IEEE International Conference on Industrial Engineering and Engineering Management* (pp. 1176-1181). IEEE.
Vance, C., Zell, D., & Groves, K. (2008). Considering individual linear/nonlinear thinking style and innovative corporate culture. *International Journal of Organizational Analysis*, 16(4), 232-248.
Vera, D., & Crossan, M. (2004). Strategic leadership and organizational learning. *Academy of Management Review*, 29(2), 222-240.
von Zedtwitz, M. (2002). Organizational learning through post–project reviews in R&D. R*&D Management*, 32(3), 255-268.
Wang, C. L., & Ahmed, P. K. (2003). Organisational learning: a critical review. *The Learning Organization*, 10(1), 8-17.
Wiegmann, D. A., Wood, L. J., Cohen, T. N., & Shappell, S. A. (2022). Understanding the "Swiss cheese model" and its application to patient safety. *Journal of Patient Safety*, 18(2), 119-123.
Wiewiora, A., Trigunarsyah, B., Murphy, G. D., & Liang, C. (2009), "Barriers to effective knowledge transfer in project-based organizations" (pp. 220-230). In Proceedings of the 2009 International Conference on global innovation in construction. Loughborough University, UK.
Wiewiora, A., Chang, A., & Smidt, M. (2020). Individual, project and organizational learning flows within a global project-based organization: exploring what, how and who. *International Journal of Project Management*, 38(4), 201-214.
Williams, T. (2007). Post-Project Review to Gain Effective Lessons Learned, *Project Management Institute*, Newtown Square, PA.
Williams, T. (2008). How do organizations learn lessons from projects – and do they?" IEEE Transactions on Engineering Management, 55(2), 248-266.
Wiig, K. M. (1997). Knowledge management: Where did it come from and where will it go*?" Expert Systems with Applications*, 13(1) 1-14.
Yang, J.T. (2007). The impact of knowledge sharing on organizational learning and effectiveness. *Journal of Knowledge Management*, 11(2), 83-90.
Yang, Y., Secchi, D., & Homberg, F. (2018). Are organizational defensive routines harmful to the relationship between personality and organizational learning? *Journal of Business Research*, 85, 55-164.
Yao, J., Crupi, A., Di Minin, A., & Zhang, X. (2020). Knowledge sharing and technological innovation capabilities of Chinese software SMEs. *Journal of Knowledge Management*, 24(3), 607-634.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, 13(3), 339-351.

Zhou, Q., Deng, X., Hwang, B. G., & Yu, M. (2022). System dynamics approach of knowledge transfer from projects to project-based organization. *International Journal of Managing Projects in Business*, 15(2), 324-349.

Enhancing the Colombian Public Sector Performance: A Systemic Knowledge Management Strategy Based on ISO 30401 and the IPMM

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Abstract: Knowledge management (KM) is recognized as being vital for organizational competitiveness and sustainability for both private and public organizations. A great myriad of theories, frameworks, and tools have been developed, many of which have been developed with private organizations in mind, given their dependence on maintaining competitiveness in the market for their survival. However, the stakes for public organizations could be considered greater, as their decisions and actions affect a wide range of stakeholders, and their management, in general, faces important challenges, such as the high turnover of their employees. For this reason, numerous efforts have been made to improve the way knowledge is managed in public institutions, yet its effective implementation in public entities remains a challenge. In Latin America, one of the countries where explicit efforts have been made to foster KM in public institutions is Colombia. The country has developed an Integrated Planning and Management Model (IPMM), which includes a specific mandate for KM implementation in all the public institutions of the country. Although the IPMM includes this KM mandate, Colombian public entities have been facing several difficulties in achieving the KM implementation. In fact, KM adoption has been slow and its impact limited, signalling the need for systemic solutions. This research employs a systemic approach, grounded in the ISO 30401 standard and a comprehensive literature analysis, to develop a KM implementation strategy tailored to the IPMM. The proposed strategy, emphasizing strategic, human, and operational factors, positions KM as the central organizing principle of the IPMM and, at the same time, is aligned with ISO 30401 guidelines. This integration aims to ease the implementation of KM within a KM system that leads to enhancing the performance of public entities in Colombia. Although being developed for Colombian public entities, the proposed strategy offers valuable insights for public administrations globally seeking to leverage KM for strategic advantage to better fulfil their mandates for the benefit of society as a whole.

Keywords: Knowledge management, Public sector, System approach, Knowledge standards, ISO 30401, Colombia

1. Introduction

Organizational knowledge (OK) is widely recognized as a driver of enhanced performance and process quality, contributing to cultural, economic, and technological advancements (Wiig, 2002; Iman and Fatheia, 2019). Knowledge management (KM) thus serves as a critical differentiator for organizations, both public and private, fostering competitiveness and sustainability. In the case of public organizations, the role of public administration (PA) is underscored by Bueno et al. (2004), who emphasize its part in safeguarding and enhancing the well-being and quality of life of citizens. Consequently, the management of OK becomes crucial in preserving and enhancing collective intellectual capital and maintaining the economic foundations necessary for societal progress and well-being.

However, KM in public administration faces several challenges. For Fergusson et al. (2013), the managerialist perspective of KM that predominates in the Public Sector - PS, over modern practice-based perspectives, affects the innovation and effectiveness of public services. Other studies, such as the one of Mittelstädt (2025), which focuses on European Members of Parliament, finds that organizational and cultural impediments significantly

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hinder the efficacy of knowledge-based activities within parliamentary settings. Specifically, the extant technical and human capital proves inadequate for facilitating comprehensive and transparent knowledge dissemination. Moreover, ideological dispositions, professional ambitions, and electoral considerations introduce further complexities. Mittelstädt (2025) concludes that the absence of a structured KM framework has resulted in resource scarcity and a deficiency of specialized expertise, thereby hindering the effective processing and utilization of the substantial volume of information generated daily. In the same vein, McEvoy, Ragab and Arisha (2017) posit that the PS faces the challenge of developing "a comprehensive strategy and approach" (p. 45) in relation to KM, as well as "to overcome the cultural barriers that permeate its hierarchies by promoting teamwork, reducing bureaucracy decision making, and increasing value management" (p. 45). Similarly, Freitas (2017) argues that "the greatest challenge for public administration is to develop systematic practices to meet new social demands for public goods and services" (p.431), driven by the need for greater competence, performance standards, monitoring, flexibility, and a focus on results and accountability.

As it is shown, the PS, as one of the largest producers and consumers of OK (Wiig, 2002), encounters unique challenges. In developing countries, these challenges are exacerbated given the resource constraints and the political, economic, and social factors that often hinder progress (Ndiege and Backhouse, 2023). In fact, while Schutte and Barkhuizen (2015) state the importance of knowledge sharing for local government institutions, according to Ali et al. (2016), the bureaucratic structure typical of the sector, where OK is perceived as a source of power, may inhibit the sharing of information and knowledge, and conduct to a "knowledge hiding" behaviour (Connelly et al. 2012, p. 65), which highlights the need for effective KM systems in the PS. Furthermore, McEvoy, Ragab and Arisha (2018) propose a taxonomy of KM in the PS, where several key aspects are included: Accountability, Government Intervention, Insularity, New Public Management, Culture, and Security & Provisioning, all of which pose different challenges for the management of knowledge in the PS.

In Latin America, research on KM is limited (Ndiege and Backhouse, 2023), particularly, in the PS, compared to its private sector counterpart (Mc Evoy et al, 2018). Colombia has sought to address this gap by establishing the Integrated Planning and Management Model (IPMM) in 2017. The IPMM provides guidelines for institutional planning and management at the national and territorial levels, aiming to improve the quality and coverage of public services. Comprising seven dimensions and 19 policies (Administrative Department of the Civil Service - DAFP, 2023), one key dimension is Knowledge and Innovation Management which seeks to "generate and document strategic information in an organized and systematic manner to manage knowledge, learn to improve practices, and adapt to changes more effectively" (DAFP, 2020a, p.15).

Despite these efforts, Galindo (2019) identifies persistent challenges related to KM in the Colombian PS. These include difficulties in knowledge transfer, insufficient competence among officials, and knowledge loss due to staff turnover. These issues hinder continuous improvement, adaptation to environmental changes, and the achievement of strategic objectives. In response, the DAFP has developed several tools to guide the implementation of KM, such as the IPMM Operational Manual (DAFP, 2021), KM Guidelines (DAFP, 2020a), and the Guide for Implementing KM within the IPMM framework (DAFP, 2020b). In addition, in 2018, the International Organization for Standardization (ISO) introduced the ISO 30401 standard, "Knowledge Management Systems – Requirements," aimed at helping organizations establish management systems that promote value creation through OK (ISO, 2018). This standard outline minimum management principles and requirements to serve as a guide for organizations wishing to optimize the value of their knowledge. However, data from recent KM assessments, collected via the Single Management Report and Progress Form – FURAG (For its initials in Spanish) (DAFP, 2023a) from 3363 Colombian territorial entities, reflect limited compliance: 40.0% in 2022 and 35.7% in 2023. These results indicate that the practical implementation of KM remains insufficient, potentially affecting decision-making, institutional improvement, and performance outcomes.

The documents published by the DAFP to support the implementation of KM in Colombian public entities are perceived as theoretical, fragmented and incoherent, despite sharing a common structure. The analysis of these documents reveals the absence of the systemic and integrative approach advocated by the ISO 30401 standard and do not adequately address the strategic, human and operational factors of an integrated management system (Bautista-Rodríguez, Peña and Pérez, 2023), essential for build and integrate effective management systems into practice.

Hence, there is a recognized need for an integrated approach to the implementation of KM in public administration. A mixed-methods approach is employed, building on the findings of previous research that examined the convergence between the IPMM and ISO 30401 (Gutiérrez Vargas, 2023). Finally, a strategy is proposed to facilitate the understanding and practical implementation of KM in Colombian PS entities.

2. Theoretical Framework

In this section we describe the theoretical bases of this work, especially the KM general concept, with a focus on its application to public entities, including the ISO 30401:2018 Standard and the Integrated Planning and Management Model (IPMM), proposed for the Colombian PS. The different concepts included in this section are presented in figure 1.

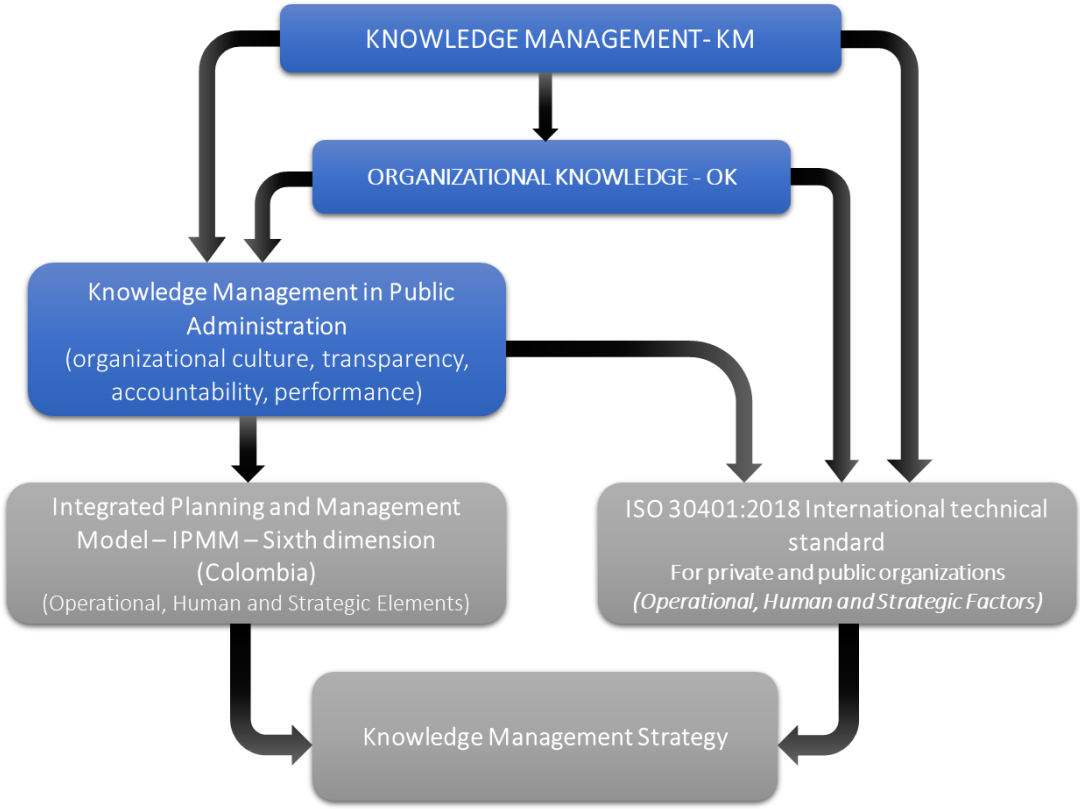

Figure 1: Concepts included in the theoretical framework

2.1 Knowledge Management

The literature on KM is vast, and an exhaustive analysis is beyond the scope of this study. For this work, a review of the basic relevant literature was performed to illustrate the fundamental concepts in this field, starting by the concept of knowledge, including the knowledge management – KM notion and reviewing some standards on KM. KM is generally recognized as "a systematic and organized approach to improve the organization's ability to mobilize knowledge to enhance decision making, take actions and deliver results in support of the underlying business strategy" (Sheng-hsun and Huang-pin, 2005, p. 354), KM emphasizes Organizational Knowledge, OK, not just as individual knowledge, but as collective knowledge, to ensure that OK benefits business strategy.

2.1.1 Organizational knowledge (OK)

According to the international standard ISO 30401 (2018), knowledge is defined as "an asset of a human being or an organization that enables them to make decisions and execute effective actions in a given context" (p.12). This definition underscores the dynamic nature of knowledge and its direct relevance to decision-making and action, aligning with the process-oriented approach advocated in this study. As we are interested in public institutions, the concept of organizational knowledge (OK) must be reviewed.

Davenport and Prusak (1998) define organizational knowledge (OK) as "a fluid mix of experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information" (p. 5). This highlights the complexity of OK and the necessity of managing its development within organizations. Sveiby (2001, p.1) similarly describes OK as "the art of creating value by strengthening intangible assets." He emphasizes the importance of viewing the organization as a network of knowledge and knowledge flows, which generate economic value. Nonaka et al. (1998) further characterize OK

as "a human and dynamic process of justifying personal beliefs in the pursuit of truth" (p.7). It's important to note that the justification of beliefs is critical to the transformation of tacit knowledge into explicit knowledge, a fundamental aspect of KM. This last concept, KM, has been defined by Cong and Pandya (2003) as "An ability of an organisation to use its collective knowledge through a process of knowledge generation, sharing and exploitation enabled by technology to achieve its objectives" (p. 27).

2.1.2 Knowledge management in public administration

KM in public administration has gain interest among researchers, focusing on specific settings, or the way KM can improve efficacy, and even identify barriers for managing knowledge. KM in the context of the PS, is essential for "improving renewal processes" (For Edge, 2005, p. 45) and "increasing efficiency in all areas" (McAdam and Reid, 2000, p.328). It also supports public participation in decision-making, builds social intellectual capital, and fosters a workforce capable of knowledge production (Wiig, 2002).

Despite the recognised importance of KM for the PS, research on KM in the PS remains fragmented, focusing primarily on KM as a process, its practices, its relationship with strategy and information technology, innovation in OK, and personal and organizational learning or focus their attention on specific organizations within the PS. An example of the latter is Boyer (2016), who centres his attention on KM for Public-Private Partnerships and proposes and a KM Approach for Public-Private Partnerships centred mainly on learning, including training and experiential learning, networks, and the use of external knowledge, including the absorptive capacity of public organizations.

Regarding KM processes, several studies emphasize the importance of organizational culture, transparency, accountability, and the enhancement of organizational performance and competitiveness in KM processes (Vyas, Bhala and Najneen, 2020; Ngoc-Tan and Gregor, 2019; Kudryavtsev and Sadykova, 2019; Laihonen, Kork, and Sinervo, 2024); while others show some aspects that may hinder KM in PS (Borgia, et al., 2024). For example, Borgia, et al. (2024), studying the Italian PS, found that knowledge-hiding behaviour increases as work-related experience and health conditions increase, decreases as similar industry experience and skills increase; and is related to gender, as women show higher knowledge-hiding behaviour scores than men. Conversely, Hamblin et al. (2024) suggest that Organizational Ambidexterity (OA) has the potential to improve the performance of public administrations (PAs) by enabling them to effectively manage inherent tensions and competing pressures, thereby enhancing their capability to create public value and address various service delivery challenges. Additionally, the significance of Knowledge Management Systems (KMS) established by ISO (ISO 9001:2015 and ISO 30401:2018) for organizational management models is well recognized (Kudryavtsev and Sadykova, 2019).

Regarding, KM practices, Laihonen and Kokko (2020) contend that governance mechanisms significantly affect these practices, and that institutional complexity must be accounted for to address the competing and contradictory logics present in the PS (p.10). KM, therefore, must be integrated into broader organizational management and proposed as a strategy centred on the organization's processes (Kudryavtsev and Sadykova, 2019; Massaro, Dumay and Garlatti, 2015). This requires strong political support and leadership that fosters a culture valuing knowledge sharing and management (Sharif et al., 2021; Laihonen and Kokko, 2020).

However, Latin America is "almost ignored" in KM research on PS organizations (Massaro, Dumay and Garlatti, 2015, p.13). In the Colombian PS, KM is defined by the DAFP (2021) as a process through which actions, mechanisms, or instruments are implemented to identify, generate, capture, transfer, appropriate, analyse, evaluate, disseminate, and preserve knowledge. The objective is to strengthen public management, foster innovation, and improve the provision of goods and services to stakeholders (p.102). Nevertheless, several challenges to KM application in the PS persist, including cultural resistance to change, knowledge hoarding (Sveiby and Simons, 2002), incompatible information systems, hierarchical and bureaucratic structures, and a disconnect between KM and management strategy (Behn, 2003; Liebowitz and Chen, 2003).

2.1.3 Integrated planning and management model (IPMM)

The evolution of the concept of Public Administration (PA) into Public Management (PM) reflects a shift toward an approach based on effectiveness and efficiency, where citizen participation plays a crucial role in legitimizing modernization efforts (De la Garza, Yilán and Barredo, 2018). In Colombia, this shift led to the establishment of a governance framework through Decree 1082 of 2012, which aimed to integrate various initiatives in response to the new Political Constitution of 1991. These initiatives, designed to improve administrative management and the quality of services provided to citizens, were consolidated within the Integrated Planning and Management Model (IPMM). Decree 1499 of 2017 further updated the IPMM to enhance the integration of the Management System with the Internal Control System, with the goal of "directing, planning, executing,

monitoring, evaluating, and controlling the management of public entities" (DAFP, 2023, p.18). This update also extended the model's scope to include national and territorial entities.

The IPMM encompasses seven operational dimensions that align with institutional objectives: Human Talent, Strategic Direction, Management with Values for Results, Evaluation of Results, Information and Communication, KM, and Internal Control. These dimensions are deployed through 19 policies (DAFP, 2023). As the governing body of the IPMM, the Administrative Department of Public Function (DAFP) has developed a range of mechanisms and tools to guide public servants in applying the model. These resources include the Operational Manual and its annexes (DAFP, 2021), technical documents, and the Unified Management Progress Report (DAFP, 2023a).

The sixth dimension of the IPMM, Knowledge and Innovation Management, highlights the importance of preserving and sharing the knowledge of state entities in order to streamline public policy, facilitate learning and adaptation to new technologies, interconnect internal knowledge, and promote good management practices. It also transversally strengthens the other dimensions of the IPMM by seeking to enable entities to improve their management and learn about themselves and their environment through the generation, capture, evaluation, and distribution of the knowledge they produce. (DAFP, 2020b, p. 7).

2.1.4 ISO 30401:2018 standard

The International Organization for Standardization (ISO) introduced the ISO 30401:2018 technical standard, which outlines minimum requirements for KMS. This standard emphasizes that OK is an intangible, complex asset created by people, and it underscores the importance of organizational culture in effective KM (ISO, 2018, p.12).

This standard has been studied by several authors. Pawlowsky, Pflugfelder and Wagner (2021) note that ISO 30401 takes a dynamic approach to KM, prioritizing human agency over technological solutions and emphasizing culture and leadership as key enablers of a successful KMS. However, they also point out that the standard focuses more on intra-organizational KM than on inter-organizational knowledge sharing. Similarly, Zeferino et al. (2020) suggest that ISO 30401 supports the establishment of a KMS tailored to each organization's specific needs and contributes to the overall development of KM. Carlucci et al. (2022) further argue that the standard provides "a standardized set of requirements and declarations for effective knowledge management" (p.976), generating renewed interest in KMS implementation and emphasizing the role of OK in strategic management. Schmitt (2022) highlights the process-oriented approach promoted by ISO 30401, which balances technological and human elements, fostering trust and collaboration while promoting systemic thinking to help organizations adapt to changing environments (p.971). The standard follows a structure harmonized with other ISO management systems and adopts the Plan-Do-Check-Act (PDCA) cycle, promoting continuous improvement (Alba and Jiménez, 2021).

Despite the growing interest in implementing KM according to this standard, Carlucci et al. (2022) note concerns regarding resource limitations, particularly in terms of personnel and time, which may hinder its application, especially for small and medium-sized enterprises. Interpreting and complying with the standard's requirements can also be challenging. For contributing to counteract these challenges, Bautista-Rodríguez, Peña and Pérez (2023) categorize the requirements of ISO management standards into three key factors: Strategic, Human, and Operational. The strategic factor concerns the overall governance, resource allocation, risk management, and performance evaluation of the organization. The human factor relates to organizational culture, leadership, roles, responsibilities, and communication, as well as the development of competencies. The operational factor addresses process management in relation to the value chain, documented information management, performance monitoring, and the implementation of continuous improvement actions. These factors form the foundation of the proposed approach for KM implementation.

2.1.5 Knowledge management strategy

KM literature identifies a life cycle for OK, which forms the basis for its management within organizations. Nair and Prakash (2009), as cited by Mendonça, Dos Santos and Varvakis (2022, p.4), outline five key stages in the KM process: identifying, creating, storing, sharing, and applying knowledge while Nonaka (1994) describes KM as a dynamic and continuous process of interaction between tacit and explicit knowledge. This process involves a permanent cycle of knowledge transformation through the phases of socialization, combination, externalization, and internalization (p.20).

A KM strategy, as described by Zack (1999), refers to "the balance between resources and knowledge-based capabilities required to deliver products or services superior to competitors" (p.131). Laihonen and Mäntylä (2018) offer a complementary perspective, defining a KM strategy as encompassing "valuable knowledge and the processes necessary for its acquisition, exchange, and utilization" (p.3). These authors further suggest that a robust KM strategy should address the identification of performance gaps, outline how OK can bridge those gaps, and include the selection of KM tools and initiatives. This approach is particularly critical in the PS, where transparency, networking, and citizen participation are paramount.

Schutte and Barkhuizen (2015) propose “an integrated framework for social identity theory and KM as well as local government service outcomes” (p. 138), comprising 5 interdependent premises that should be taken into account “in order to implement KM principles and achieve subsequent organisational effectiveness” (p. 138). The 5 interdependent premises are: Customer-focused KM, knowledge distribution networks, knowledge as a sharing culture, knowledge as symbolic capital and social epistemology. Furthermore, Laihonen and Mäntylä (2018) emphasize that a KM strategy must align with the organization's competitive strategy and business vision.

Consequently, numerous studies have explored the implementation of KM strategies, with particular focus on identifying Critical Success Factors (CSFs) for successful KM execution (Onofre and Teixeira, 2021; Laihonen and Mäntylä, 2018; Cahyaningsih and Sensuse, 2014). Laihonen and Mäntylä (2018) identify four critical factors for the success of strategic KM in local governments: strategic focus, integration of KM into management systems, data refinement, and data quality (p.11). Strategic Knowledge Management (SKM) can also encompass planning, organizational culture, data management, specific KM activities, and performance monitoring.

The specific elements that comprise SKM may vary across studies; however, for the purposes of this analysis, we adopt the SKM framework outlined by Laihonen and Mäntylä (2018) and the Integrated Planning and Management Model (IPMM). This framework includes a strategic approach that aligns KMS with organizational strategy, integration with existing management processes and systems, and consideration of the human aspects embedded in organizational culture, to bring the KMS to the reality of the entity's processes.

The following table presents a thematic analysis of the main aspects included in this theoretical framework (See table 1):

Table 1: Thematic analysis of the theoretical framework

CONCEPT	SPECIFIC CHARACTERISTICS	OPERATIONAL FACTOR	HUMAN FACTOR	STRATEGIC FACTOR
Knowledge Management - KM	KM emphasizes Organizational Knowledge not just as individual knowledge, but as collective knowledge, to ensure that OK benefits business strategy.	KM is a systematic and organized approach to improve the organization’s ability to mobilize knowledge.	Knowledge is created by people and that it is intangible and complex	KM enhance decision making in support of the business strategy
Source:	The authors	Sheng-hsun and Huang-pin, 2005, p. 354	Barnes, 2022, p. 52	Sheng-hsun and Huang-pin, 2005, p. 354
Organizational Knowledge - OK	Organizational knowledge is dynamic in nature and directly related to decision-making and action, aligning with the process-oriented approach advocated in this study.	A fluid mix of experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information	A human and dynamic process of justifying personal beliefs in the pursuit of truth	The art of creating value by strengthening intangible assets
Source:	The authors	Davenport and Prusak, 1998, p. 5	Nonaka et al., 1998, p.7	Sveiby ,2001, p.1

CONCEPT	SPECIFIC CHARACTERISTICS	OPERATIONAL FACTOR	HUMAN FACTOR	STRATEGIC FACTOR
Knowledge Management in Public Administration	Knowledge management in public sector - PS focuses on how to improve the effectiveness of citizen services, transparency, accountability, and even identify barriers to knowledge management itself.	Governance mechanisms significantly affect KM, institutional complexity must be taken into account to address the competitive and contradictory logics present in the PS.	Challenges persist in the application of KM in PS, including cultural resistance to change, knowledge hoarding, and hierarchical and bureaucratic structures.	KM allows for the effective management of inherent tensions in the PS, thereby enhancing its capacity to create public value and address various challenges in service delivery.
Source:	The authors	Laihonen and Kokko, 2020, p. 10.	Sveiby and Simons, 2002.	Hamblin et al., 2024.
Integrated Planning and Management Model – IPMM Sixth dimensión, Colombia	A process through which actions, mechanisms, or instruments are implemented to identify, generate, capture, transfer, appropriate, analyse, evaluate, disseminate, and preserve knowledge.	Knowledge management is conceived under the "Plan, Do, Check, Act" (PDCA) cycle, whose purpose is the proper management of resources through continuous evaluation and improvement.	The culture of sharing and dissemination, to consolidate institutional memory through the preservation of organizational learning.	Knowledge management must be aligned with the entity's strategic planning to contribute to the achievement of institutional objectives.
Source:	DAFP, 2021, p. 102	DAFP, 2020b, p. 34	DAFP, 2020b, p. 44	DAFP, 2020b, p. 41
ISO 30401:2018 International technical standard	In 2018, the International Organization for Standardization (ISO) introduced the international technical standard ISO 30401, which describes the minimum requirements for KM in organizations of any nature.	The process-oriented approach promoted by ISO 30401 is highlighted, balancing technological and human elements, fostering trust and collaboration while promoting systems thinking.	ISO 30401 prioritizes human agency over technological solutions and emphasizes culture and leadership as key enablers for creating a successful knowledge management system.	The standard provides a set of generic requirements for effective knowledge management and emphasizes the role of OK in strategic management.
Source:	The authors	Schmitt, 2022, p. 971.	Pawlowsky, Pflugfelder and Wagner, 2021.	Carlucci et al., 2022
Knowledge Management Strategy	A KM strategy should address the identification of performance gaps, outline how OK can bridge those gaps, and include the selection of KM tools and initiatives, to produce knowledge and innovation for the value groups and stakeholders of the entities, through the management of the processes.	Strategic knowledge management (SKM) includes planning, organizational culture, data management, specific KM activities, and performance monitoring.	Knowledge management as a dynamic and continuous process of interaction between tacit knowledge (in people) and explicit knowledge (collective, organizational)	Critical factors for the success of strategic knowledge management in local governments are alignment with organizational strategy and the integration of knowledge management into management systems.

CONCEPT	SPECIFIC CHARACTERISTICS	OPERATIONAL FACTOR	HUMAN FACTOR	STRATEGIC FACTOR
Source:	Laihonen and Mäntylä, 2018.	Laihonen and Mäntylä, 2018.	Nonaka et al., 1994.	Laihonen and Mäntylä, 2018.

3. Materials and Methods

This research aims to design a strategy for implementing KM in PS entities, grounded in the integration of the ISO 30401:2018 standard and the IPMM. The goal is to establish a KM implementation strategy where the ISO 30401 standard serves as the central framework for aligning the IPMM. This exploratory study builds on current KM practices within the sixth dimension of the IPMM, with a descriptive approach that emphasizes the alignment between the two models. The research is structured into the following phases:

Phase 1: Bibliographic Review: A comprehensive literature review was conducted focusing on KM in the PS, the IPMM, and relevant methodologies and frameworks. This review identified the key components necessary for formulating the KM implementation strategy. The research used search terms such as "knowledge management," "public institutions," "Integrated Planning and Management Model," and "IPMM" in databases like Scopus, Web of Science, SciELO, and Redalyc, filtering for studies conducted in Colombia and Latin America between 2013 and 2023. Out of 348 documents, 83 relevant studies were selected, along with grey literature from civil service resources related to the IPMM. After reviewing their thematic relevance in titles and abstracts, a final sample of 52 documents was defined. The study began with an analysis of foundational KM concepts, followed by a specific examination of KM in the Colombian PS, contributing to the theoretical framework outlined earlier. Figure 2 presents the process followed in this phase.

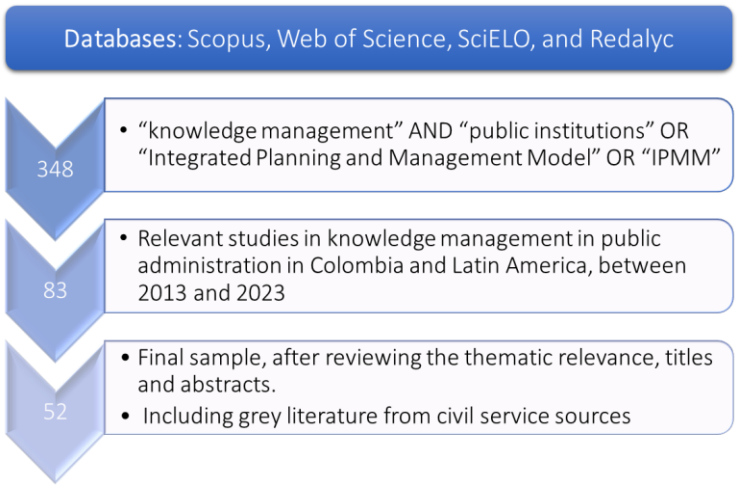

Figure 2: Bibliographic review process

Phase 2: Analysis of ISO 30401:2018 and IPMM Alignment: This phase involved identifying and analysing the articulation between the ISO 30401:2018 standard and the IPMM. The research examined 748 relationships between the two models, identifying a convergence rate of over 70% (Gutierrez, 2023). Complementary aspects, such as the use of specific tools, document management, and knowledge network promotion, were recognized. However, divergences were also identified, including the scope of Quality Management Systems (QMS), the evaluation of competencies for KM roles, and continuous improvement mechanisms.

Phase 3: Strategy Development: The final phase focused on defining a strategy that positions the systemic approach of ISO 30401:2018 as the integrating framework for the IPMM. This strategy is structured around the strategic, operational, and human dimensions, aligning with the DAFP guidelines for Knowledge and Innovation Management (KIM) and organizational process. The PDCA (Plan-Do-Check-Act) cycle is central to this approach. The strategic factors highlighted by Laihonen and Mäntylä (2018), alignment with organizational strategy, integration with other existing management systems, human dimensions embedded in the organizational culture, and a focus on practicality, underpin the proposal.

4. Results

According to Schmitt (2022), ISO 30401 promotes a KM process-oriented approach, that balances technological elements with human capabilities. The standard outlines the need to "implement, maintain, and continually improve a knowledge management system, including the necessary processes and their interactions" (ISO, 2018, p.6). It further defines a management system as "a set of interrelated or interacting elements within an organization, designed to establish policies, objectives, and processes to achieve these objectives" (ISO, 2018, p.2). This approach aligns with the guidelines set forth by the DAFP, which instructs entities to identify objectives, document existing processes, assign responsibilities, map process interrelationships, and ultimately create a comprehensive process map (DAFP, 2020, p.44-48). Additionally, the DAFP emphasizes that processes should be directly tied to the value chain, forming the foundation for an entity's process management (DAFP, 2020, p.56). Consequently, a holistic approach to KM, one that generates value for public entities, must integrate these processes into a coherent system. As entities function as open social systems, these processes must interact to achieve shared objectives within a specific context.

Barnes (2022) notes that ISO 30401 views OK as a life cycle, encompassing the acquisition, consolidation, retention, sharing, and application of OK for decision-making, aligned with organizational objectives. Once knowledge becomes obsolete, it must be removed from the system to prevent errors or inefficiencies (ISO, 2018). In contrast, IPMM proposes a cyclical approach for the construction, maturation and dynamization of CO in the PS. This cycle, called "double cycle of knowledge and innovation management" (DAFP, 2020a, p.40), includes processes related to the creation of OK, its instrumentalization, sharing, application, evaluation, improvement and dissemination, as well as organizational learning.

Both models—ISO 30401 and IPMM—conceptualize KM as a continuous cycle, contributing to progressive improvement. However, ISO 30401 emphasizes structuring a KMS that incorporates dynamic processes to continuously renew OK (Pawlowsky, Pflugfelder and Wagner, 2021). Therefore, KM strategies must be structured around the establishment of a Knowledge and Innovation Management System (KIMS), as proposed by ISO 30401. These strategies must promote continuous cycles of KM (DAFP, 2020; Barnes, 2022) and efficient process management (Schmitt, 2022; DAFP, 2020). In addition, they must overcome the predominance of the managerialist and theoretical perspective for KM in PS, with a pragmatic approach that facilitates its effective implementation (Ferguson, Burford, and Kennedy, 2013). For these strategies to succeed, they must be aligned with the entity's overall strategy and vision and must strike a balance between resources and capabilities (Laihonen and Mäntylä, 2018; Zack, 1999). The proposed general strategy, which positions the systemic approach of ISO 30401 as the central framework for IPMM, involves developing the strategic, operational, and human factors of SKM, following the recommendations of Bautista-Rodríguez, Peña and Pérez (2023). This strategy is in accordance with the guidelines established by the DAFP for both KIM and process management, as depicted in Figure 3.

This figure illustrates the interaction between the strategic, operational, and human factors outlined in the ISO 30401 standard. These elements align with the KM and innovation guidelines proposed by the DAFP, facilitating the implementation of the KIMS within PS entities.

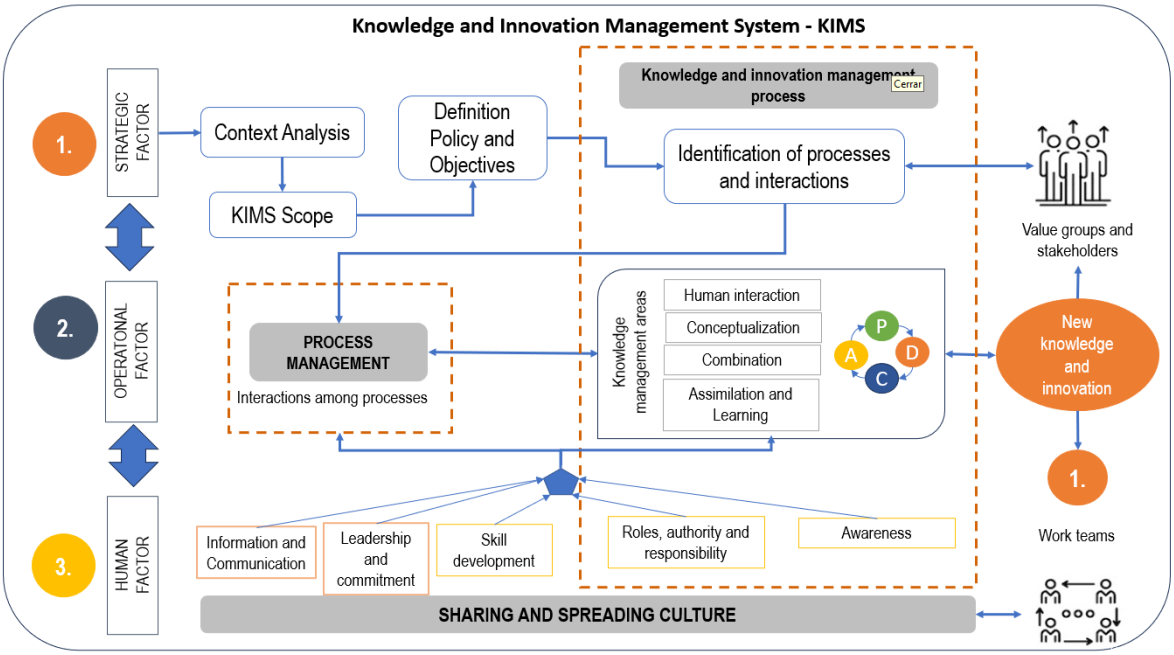

Figure 3: Knowledge and Innovation Management System in the Colombian PS

The figure shows how the requirements of ISO 30401 and DAFP guidelines converge to support practical and effective KM and innovation management, considering three key factors, which are now described.

4.1 Strategic Factor

The development of the KIMS from a strategic perspective is grounded in the following key elements:

- Contextual analysis: This involves identifying the internal and external factors that most influence knowledge management (KM) within the entity, considering the needs and expectations of both value and interest groups (DAFP, 2020b; ISO, 2018).
- Definition of scope: The scope of the KIMS is established in terms of the business processes that provide significant value to the organization and its stakeholders. This entails delineating the domains of organizational knowledge (OK) that the KIMS should prioritize (ISO, 2018).
- Strategic alignment: A strategy is formulated to guide the KIMS in alignment with the contextual analysis and institutional objectives (DAFP, 2020b). This strategy is expressed through the KM policy and objectives, which are integrated with the overall organizational strategy (Gupta et al., 2022).
- Process identification: The processes constituting the KIMS, including KM-specific processes, are identified (ISO, 2018; DAFP, 2020b). These processes, tied to the entity's value chain and daily routines, provide the operational foundation for KM activities.
- Interaction mapping: Key interactions between processes and stakeholders are recognized and linked to ensure the effective achievement of KMSInn objectives and policies (DAFP, 2020; ISO, 2018).

4.2 Operational Factor

After defining the strategic components of the KIMS—context, scope, policy, objectives, processes, and interactions—the system is extended operationally into each value chain processes, to establish KM practices.

According to ISO 30401, the KIMS must incorporate specific tasks and behaviors to achieve its objectives (ISO, 2018), which include:

- Human interaction: Knowledge is exchanged and generated through daily interactions within KIMS processes.
- Conceptualization: Tacit knowledge is codified into explicit knowledge through documentation during key process moments.
- Combination: Experts formalize and structure new knowledge, integrating it with pre-existing knowledge to ensure its availability.

- Assimilation and learning: New knowledge is absorbed into routine practices through formal training and coaching activities.

Each process should identify where these four tasks are carried out, making KM an integral part of the organization's operations. This involves defining the physical or virtual spaces for KM (such as the "Ba" concept by Nonaka and Konno, 1995) and managing these spaces through the PDCA (Plan-Do-Check-Act) cycle to consolidate new knowledge (ISO, 2018). An instrument, proposed in the form of a table, would help operationalize these activities, detailing processes, tasks, KM spaces, PDCA management, and evidence of outcomes (an example is available at: https://zenodo.org/record/8157078).

The systematic implementation of these tasks within processes results in the creation and consolidation of new organizational knowledge. These spaces facilitate the conversion of data into actionable knowledge, supporting both problem-solving and innovation projects aimed at generating strategic knowledge that contributes to public value (DAFP, 2020b).

To further enhance KM, it is proposed that a specific process dedicated to KM be established. This process, incorporated into the entity's process map or as a sub-process, would harmonize KM efforts across the organization following the PDCA cycle. The expected outcomes include a KM diagnosis, a general implementation plan for the KMSInn policy, analysis of existing knowledge, innovation project formalization, and performance reviews (DAFP, 2020a). The KM leader, as outlined in the Human Factor section, would oversee this process.

4.3 Human Factor

The implementation of the third component of the KIMS highlights the critical role of human talent, which is emphasized in the Integrated Planning and Management Model (IPMM): "human talent is the heart of the IPMM... and central to KM and innovation implementation" (DAFP, 2020b, p. 39). ISO 30401 similarly emphasizes that "knowledge is created by people" (ISO, 2018, p. vi), underscoring the importance of leadership, role clarity, competency development, communication, awareness, and organizational culture.

4.3.1 Authority, roles, and responsibilities

The KIMS requires clearly defined roles with appropriate levels of authority and responsibility. According to DAFP guidelines (2020b), a KM leader must be appointed, supported by teams from areas such as Human Resources, Planning, ICT, and Communications.

This leader's responsibilities include advancing KM policy, guiding self-diagnosis efforts, formulating improvement plans, and overseeing performance reviews (DAFP, 2020a). ISO 30401 adds that the leader must ensure compliance with KIMS requirements and communicate relevant roles to stakeholders.

4.3.2 Competency development

Competency, defined as the ability to apply knowledge and skills to achieve expected results (ISO, 2018), is essential for KIMS operation. It is necessary to determine the competencies required by those designing and continuously improving the KIMS Human talent, especially when integrated with KM processes, facilitates the development of competencies that enable public servants to support learning and innovation (DAFP, 2020a).

4.3.3 Communication

The fifth dimension of the IPMM, Information and Communication, supports the interaction of entities with their environment throughout the management cycle, ensuring the flow of internal information between KIMS processes and external communication with stakeholders (DAFP, 2021). Clear communication, as prescribed by ISO 30401, promotes visibility and accountability within the KIMS crucial for its effective implementation.

4.3.4 Awareness

Awareness of the KIMS is essential for its effective operation. This awareness ensures that individuals understand their roles and responsibilities in achieving KM objectives (Pawlowsky, Pflugfelder and Wagner, 2021; ISO, 2018). The KM leader plays a key role in fostering this awareness through training, communication, and performance evaluations.

4.3.5 Organizational culture

A critical component of KM in public entities is the establishment of a "Sharing and Dissemination Culture", which aims to consolidate institutional memory and promote the effective use of intellectual capital within the organization (DAFP, 2021, p. 108). The ISO 30401 standard underscores that cultivating a KM culture is essential for the sustainable implementation of the KIMS and identifies key elements that shape this culture, including leadership behaviour, trust, institutional policies and procedures, incentives, training, digital environments, and technology (ISO, 2018). This also follows authors such as Schutte and Barkhuizen (2015) regarding the importance of establishing a sharing culture.

The development and reinforcement of this culture are achieved through the formalization of spaces that facilitate knowledge sharing (DAFP, 2020a). These spaces, along with organizational guidelines and leadership behaviours, serve as the foundation for fostering a culture where organizational knowledge (CO) is consciously valued and utilized. The successful integration of this culture depends on several factors, including information and communication, leadership and commitment, competency development, clear roles and responsibilities, and awareness-building initiatives. These elements are systematically integrated into the work teams responsible for managing knowledge and innovation within the entity.

DAFP (2020b) highlights the strong connection between knowledge management and innovation, noting that innovation relies on effective KM to gain a comprehensive understanding of the challenges that require innovative solutions. Furthermore, it is posited that innovation must generate new strategic knowledge for the entity (DAFP, 2020b, p. 32).

While KM typically occurs within ongoing processes and contributes to continuous or incremental improvements (García-Fernández, 2016), innovation is achieved through time-bound projects, which, supported by KM (Caccamo, Pittino and Tell, 2023), have the potential to lead to transformative changes. The "Generation and Production" axis of KM promotes the creation of new ideas through teams capable of ideating, experimenting, researching, and innovating (DAFP, 2020a). Consequently, innovation challenges identified within public entities should be approached as distinct projects, with KM processes providing the necessary data and information to support methodologies such as design thinking, which facilitates the generation of innovation.

5. Conclusions

The purpose of this research is to propose a strategy to facilitate the understanding and practical implementation of KM in Colombian PS entities. For this purpose, we developed a literature review that reveals that there are few studies on KM in PS, especially in Latin America. Ndiege and Backhouse (2023) point out that developing countries face challenges that hinder management in general, such as an unfavorable political environment, cultural aspects, poor organizational structures, and lack of leadership support, but in addition, there are specific difficulties for KM, such as the lack of KM strategies and policies and weak KM processes, along with deficiencies in information technologies.

To face these difficulties, some models, such as the ISO 30401 and the IPMM, have been proposed. Although they present some similarities, they also present differences that make their joint implementation difficult at the same organization. One of the most explicit contrasts between ISO 30401 and the IPMM, is their fundamental orientation. ISO 30401 focuses on the systematization of OK, through the implementation of a structured and standardized KMS aligned with organizational processes under the PHVA cycle (Plan-Do-Check-Act). The IPMM approach emphasizes public value and the improvement of public management, highlighting knowledge as an instrument to strengthen innovation, institutional efficiency, and service delivery. Likewise, ISO 30401 proposes a more integrated and pragmatic approach, where strategic, human, and operational factors are considered central axes of a cohesive management system. In contrast, the IPMM's technical documents, although valuable, have been described as theoretical, fragmented, and lacking a clear systemic articulation, which has hindered their practical adoption by public entities. In summary, ISO 30401 provides a robust structure for operationalizing KM from an internal perspective, while the IPMM focuses on generating impact in the public sphere. The convergence between the two models, as proposed in this research, allows strengthening the actual implementation of KM.

For defining how these two models converge, the literature review also allowed the identification of the main conceptual and theoretical bases. These bases are organized deductively, as shown in Figure 1. The thematic analysis of these bases allows recognizing similar aspects among the different levels of conceptualization (see Table 1). These aspects are consistent at different conceptual levels, showing their importance for effective KM.

Elements such as planning, data management, processes, technology, evaluation, and improvement, among others, are reiteratively present. They are linked to the operational aspects of KM. Therefore, in this research, they are denominated operational factors. The human nature of organizational knowledge is also recognized at different conceptual levels. In addition, important elements such as learning, communication, culture, and interaction, among others, are identified. These elements are included in the human factor. Additionally, it is proposed that there must be a close relationship between organizational strategy and KM to create value, achieve organizational objectives, and face the organizational challenges. This is called the strategic factor. These three factors—operational, human, and strategic—are the articulating axes of the proposed strategy.

Under this context, a systemic strategy, characteristic of the ISO 30401 model, is proposed to integrate the efforts of Colombian public entities in the real and effective implementation of KM. Figure 3 describes how to link the sixth dimension of IPMM with ISO 30401. The strategic, human, and operational factors are essential components of the KIMS, whose purpose is to produce knowledge and innovation for the value groups and stakeholders of the entities through the management of the processes of the value chain. Each process must develop four specific spaces, physical or virtual, for KM: human interaction, conceptualization, combination and assimilation, and learning. These spaces are managed according to the PDCA cycle to generate the institutional knowledge necessary for continuous improvement and to support innovation projects. According to the proposal, knowledge generation and innovation are based on a sharing and spreading culture, which emphasizes the importance of the human factor in the production of knowledge and innovation.

Further research is needed to specify methods for operating and effectively monitoring KM spaces, as well as for the creation of indicators to measure the development of knowledge and innovation in PS entities, under the proposed framework. Nevertheless, we think that this approach may offer Colombian public entities, as well as those located in other countries, the opportunity to put KM into practice, based on the proposed strategy. To verify this, further studies should be carried out, which would help overcome the limitations of the present study in terms of the lack of application cases in PS, not only in Colombian public institutions, but in other locations as well.

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Ethical Statement: Ethical approval was not required since this is a scoping review on extant research and grey material already within the public domain.

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Data availability statement: As mentioned in the "Results" section, an instrument, proposed in the form of a table, would help operationalize the activities of Human interaction, Conceptualization, Combination, and Assimilation and learning, detailing processes, tasks, KM spaces, PDCA management, and evidence of outcomes is available at: https://zenodo.org/record/8157078.

References

Adeinat, I. M. and Abdulfatah, F. (2019) 'Organizational culture and knowledge management processes: case study in a public university', *VINE Journal of Information and Knowledge Management Systems*, 49(1), pp. 35-53. doi: 10.1108/VJIKMS-05-2018-0041.

Alba Herrera, J. A. and Jiménez, O. M. (2021) 'Estrategias y métodos para la gestión del conocimiento de acuerdo con los requisitos NTC-ISO 30401:2019', *Signos*, Investigación en Sistemas de Gestión, 13(2), pp. 259-294. doi: 10.15332/24631140.6672.

Ali, A., Haizan, R., Abdullah, R. and Azmi, M. (2016) 'Developing conceptual governance model for collaborative knowledge management system in public sector organizations', *Journal of Information and Communication Technology* (JICT), 15(2), pp. 171–191. doi: 10.32890/JICT2016.15.2.9.

Barnes, S. (2022) 'How radical KM is knowledge management: Referencing ISO knowledge management systems—requirements standard 30401', *Business Information Review*, 39(2), pp. 51–55. doi: 10.1177/02663821221097875.

Bautista-Rodríguez, S., Peña, G. and Pérez, A. J. (2023) 'Methodological Approach to the implementation of Integrated Management Systems for Small and Medium-sized enterprises', *International Journal for Quality Research*, 17(3), pp. 757-781. Available at: https://www.ijqr.net/journal/v17-n3/10.24874.IJQR17-03.012.pdf (Accessed: 21 March 2025).

Behn, R. D. (2003) 'Why Measure Performance? Different Purposes Require Different Measures', *Public Administration Review*, 63(5), pp. 586-606. doi: 10.1111/1540-6210.00322.

Borgia, M., Das, S., Di virgilio, F. and La Torre, M. (2024) 'Human Capital Dimensions Influencing Knowledge Hiding in the Public Sector: Evidence from Italy', *Electronic Journal of Knowledge Management*, 22(1), pp. 14-25. doi: 10.34190/ejkm.22.1.3176.

Boyer, E. J. (2016) 'Identifying a knowledge management approach for public-private partnerships', *Public Performance & Management Review*, 40(1), pp. 158–180. doi: 10.1080/15309576.2016.1204928.

Bueno, E., Casani, F., Morcillo, P., Plaz, R., Rodriguez, J., Rodriguez, O., Merino, C., Salmador, M. and Murcia Rivera, C. (2004) *La Administración Pública como agente de conocimiento en la Sociedad de la Información: Sistema de gestión y desarrollo del capital intelectual*. Universidad Autónoma de Madrid, Instituto Universitario de Administración de Empresas (IADE). Available at: https://dialnet.unirioja.es/servlet/libro?codigo=490817 (Accessed: 21 March 2025).

Caccamo, M., Pittino, D. and Tell, F. (2023) 'Boundary objects, knowledge integration, and innovation management: A systematic review of the literature', *Technovation*, 122. doi: 10.1016/j.technovation.2022.102645.

Cahyaningsih, E. and Sensuse, D. (2014) 'Critical Success Factor for Implementing KM in Government Human Capital Management: Case Study Badan Kepegawaian Negara', *Jurnal Sistem Informasi*, 10(8). doi: 10.21609/jsi.v10i1.372.

Carlucci, D., Kudryavtsev, D., Santarsiero, F., Lagrutta, R. and Garavelli, A. (2022) 'The ISO 30401 Knowledge Management Systems: a new frame for managing knowledge. Conceptualisation and practice', *Knowledge Management Research & Practice*, 20(6), pp. 975-986. doi: 10.1080/14778238.2022.2118637.

Connelly, C. E., Zweig, D., Webster, J. and Trougakos, J. P. (2012) 'Knowledge hiding in organizations', *Journal of Organizational Behavior*, 33(1), pp. 64–88. doi: 10.1002/JOB.737.

Cong, X. and Pandya, K. V. (2003) 'Issues of Knowledge Management in the Public Sector', *Electronic Journal of Knowledge Management*, 1(2), pp. 181-188. Available at: https://academic-publishing.org/index.php/ejkm/article/view/701 (Accessed: 21 March 2025).

Davenport, T. and Prusak, L. (1998) *Working Knowledge: How Organizations Manage What They Know*. Harvard Business School Press.

De la Garza, D., Yilán, E. and Barredo, D. (2018) 'Tendencias en la administración pública moderna: la nueva gestión pública en México', *Revista Venezolana de Gerencia*, 23(81), pp. 31-43. Available at: https://www.redalyc.org/articulo.oa?id=29055767003 (Accessed: 21 March 2025).

Departamento Administrativo de la Función Pública- DAFP. (2020) *Guía para la gestión por procesos en el marco del modelo integrado de planeación y gestión (MIPG)*. Available at: https://www.funcionpublica.gov.co/sites/default/files/documentos/Guia_gestion_por_procesos_MIPG_v2.pdf (Accessed: 21 March 2025).

Departamento Administrativo de la Función Pública- DAFP. (2020a) *Lineamiento técnico de gestión del conocimiento y la innovación*. Available at: https://www.funcionpublica.gov.co/sites/default/files/documentos/Lineamiento_Tecnico_Gestion_Conocimiento_Innovacion_MIPG.pdf (Accessed: 21 March 2025).

Departamento Administrativo de la Función Pública- DAFP. (2020b) *Guía para la implementación de la gestión del conocimiento y la innovación en el marco del modelo integrado de planeación y gestión (MIPG)*. Available at: https://www.funcionpublica.gov.co/sites/default/files/documentos/Guia_Implementacion_Gestion_Conocimiento_Innovacion_MIPG.pdf (Accessed: 21 March 2025).

Departamento Administrativo de la Función Pública- DAFP. (2021) *Manual Operativo del Modelo Integrado de Planeación y Gestión: Consejo para la Gestión y Desempeño Institucional*. Available at: https://www.funcionpublica.gov.co/sites/default/files/documentos/Manual_Operativo_MIPG_Consejo_Gestion_Desempeno_Institucional.pdf (Accessed: 21 March 2025).

Departamento Administrativo de la Función Pública- DAFP. (2023) *Marco general del Modelo Integrado de Planeación y Gestión: Consejo para la Gestión y Desempeño Institucional*. Available at: https://www.funcionpublica.gov.co/sites/default/files/documentos/Marco_General_MIPG_Consejo_Gestion_Desempeno_Institucional.pdf (Accessed: 21 March 2025).

Departamento Administrativo de la Función Pública. (2023a) *Resultados Medición del Desempeño Institucional 2023*. Available at: https://www.funcionpublica.gov.co/sites/default/files/documentos/Resultados_Medicion_Desempeno_Institucional_2023.pdf (Accessed: 21 March 2025).

Edge, K. (2005) 'Powerful PS knowledge management: A school district example', *Journal of Knowledge Management*, 9(6), pp. 42–52. doi: 10.1108/13673270510629954.

Ferguson, S., Burford, S. and Kennedy, M. (2013) 'Divergent Approaches to Knowledge and Innovation in the Public Sector', *International Journal of Public Administration*, 36(3), pp. 168–178. doi: 10.1080/01900692.2012.749278.

Freitas, E. da S. (2017) 'Gestão do Conhecimento na Administração Pública: tendências de aprimoramento dos Tribunais de Contas', *Revista Controle: Doutrinas e artigos*, 15(1), pp. 424-457. Available at: https://dialnet.unirioja.es/servlet/articulo?codigo=6167805 (Accessed: 21 March 2025).

Galindo, L. V. (2019) 'Aproximación a los lineamientos para la implementación de la gestión del conocimiento en las entidades del sector público en Colombia', *Signos Investigación en Sistemas de Gestión*, 12(1), pp. 181-197. doi: 10.15332/24631140.5428.

García – Fernández, M. (2016) 'Influencia de la gestión de la calidad en los resultados de innovación a través de la gestión del conocimiento. Un estudio de casos', *Innovar*, 26(61), pp. 45-64. doi: 10.15446/innovar.v26n61.57119.

Gupta, A., Sing, R., Kamble, S. & Mishra, R. (2022) 'Knowledge management in industry 4.0 environment for sustainable competitive advantage: a strategic framework', *Knowledge Management Research & Practice*, 20(6), pp. 878–892. doi: 10.1080/14778238.2022.2144512.

Gutiérrez Vargas, L. (2023) *Criterios de articulación de la norma ISO 30401 con la gestión del conocimiento e innovación del modelo integrado de planeación y gestión MIPG*. Master's Thesis, Universidad Santo Tomás. Available at: https://repository.usta.edu.co/handle/11634/50126 (Accessed: 21 March 2025).

Hamblin, R., Plimmer, G., Badar, K. and Lasthuizen, K. (2024) 'Organizational ambidexterity: A bibliometric review and framework for future public administration research', *Public Performance & Management Review*, 47(5), pp. 1073–1109. doi: 10.1080/15309576.2024.2373178.

International Organization for Standardization – ISO. (2015) *ISO 9001:2015. Quality Management Systems - Requirements*. Geneva, Switzerland: ISO. Available at: https://www.iso.org/obp/ui/#iso:std:iso-iec-ieee:90003:ed-1:v1:en:sec:intro (Accessed: 21 March 2025).

International Organization for Standardization – ISO. (2018) *ISO 30401:2018. Knowledge Management Systems - Requirements*. Geneva, Switzerland: ISO. Available at: https://www.iso.org/obp/ui/#iso:std:iso:30401:ed-1:v1:en (Accessed: 21 March 2025).

Kudryavtsev, D. and Sadykova, D. (2019) *'Towards Architecting a Knowledge Management System: Requirements for an ISO Compliant Framework'*. In: The Practice of Enterprise Modeling, PoEM 2019, Luxembourg, Luxembourg, November 27–29, 2019, Proceedings 12, pp. 36-50. Springer International Publishing. doi: 10.1007/978-3-030-35151-9_3.

Laihonen, H. and Kokko, P. (2020) 'Knowledge management and hybridity of institutional logics in PS', *Knowledge Management Research & Practice*, 21(1), pp. 14–28. doi: 10.1080/14778238.2020.1788429.

Laihonen, H. and Mäntylä, S. (2018) 'Strategic knowledge management and evolving local government', *Journal of Knowledge Management*, 22(1), pp. 219-234. doi: 10.1108/JKM-06-2017-0232.

Laihonen, H., Kork, A. A. and Sinervo, L. M. (2024) 'Advancing Public Sector knowledge management: towards an understanding of knowledge formation in public administration', *Knowledge Management Research & Practice*, 22(3), pp. 223-233. doi: 10.1080/14778238.2023.2187719.

Liebowitz, J. and Chen, Y. (2004) *'Knowledge Sharing Proficiencies: The Key to Knowledge Management'*. In: Bernus, P. and Blazewicz, J. (eds) Handbook on Knowledge Management 1. International Handbook on Information Systems, pp. 409-424. Springer, Berlin.

Massaro, M., Dumay, J. and Garlatti, A. (2015) 'Public sector knowledge management: a structured literature review', *Journal of Knowledge Management*, 19(3), pp. 530-558. doi: 10.1108/JKM-11-2014-0466.

McAdam, R. and Reid, R. (2000) 'A comparison of public and private sector perceptions and use of knowledge management', *Journal of European Industrial Training*, 24(6), pp. 317-329. doi: 10.1108/03090590010346424.

McEvoy, P., Ragab, M. and Arisha, A. (2017) 'Review on the KM Applications in Public Organisations', *The Electronic Journal of Knowledge Management*, 15(1), pp. 37-48. Available at: https://academic-publishing.org/index.php/ejkm/article/view/1095 (Accessed: 21 March 2025).

McEvoy, P. J., Ragab, M. and Arisha, A. (2018) 'The effectiveness of knowledge management in the Public Sector', Knowledge Management Research & Practice, 17(1), pp. 39–51. doi: 10.1080/14778238.2018.1538670.

Mendonça, T. C., Dos Santos, N. and Varvakis, G. (2022) 'Knowledge management practices in the institutions of the Brazilian justice system', *Revista Digital de Biblioteconomia e Ciencia da Informacao*, 20. doi: 10.20396/rdbci.v20i00.8668083.

Mittelstädt, R.M. (2025) 'Knowledge is Power: An Explorative Study of Knowledge Work Among European Members of Parliament', *Electronic Journal of Knowledge Management*, 23(1), pp. 34-46. doi: 10.34190/ejkm.23.1.3735.

Ndiege, J. R. A. and Backhouse, J. (2023) 'Knowledge management in local governments in developing countries: a systematic literature review', *VINE Journal of Information and Knowledge Management Systems*, 53(3), pp. 450-466. doi: 10.1108/VJIKMS-12-2020-0215.

Ngoc-Tan, N. and Gregor, A. (2019) 'Knowledge Management and Its Impacts on Organizational Performance: An Empirical Research in Public Higher Education Institutions of Vietnam', *Journal of Information and Knowledge Management*, 18(2). doi: 10.1142/S0219649219500151.

Nonaka, I. and Konno, N. (1998) 'The concept of Ba. Building a foundation for knowledge creation', *California Management Review*, 40(3), pp. 40-54. doi: 10.2307/41165942.

Onofre, I. and Teixeira, L. (2021) *'Implementation of a Knowledge Management Strategy: Reflections and Critical Success Factors'*. In: Proceedings of the 11th Annual International Conference on Industrial Engineering and Operations Management, Singapore, March 7-11, 2021. IEOM Society International. Available at: http://www.ieomsociety.org/singapore2021/papers/828.pdf (Accessed: 21 March 2025).

Pawlowsky, P., Pflugfelder, N. and Wagner, M. (2021) 'The ISO 30401 knowledge management systems standard – a new framework for value creation and research?', *Journal of Intellectual Capital*, 22(3), pp. 506-527. doi: 10.1108/JIC-07-2020-0256.

Schmitt, U. (2022) 'Validating and documenting a new knowledge management system philosophy: a case based on the ISO 30401:2018-KMS standard', *Knowledge Management Research & Practice*, 20(6), pp. 960-974. doi: 10.1080/14778238.2022.2064349.

Schutte, N. and Barkhuizen, N. (2015) 'Knowledge Management and Sharing in Local Government: A Social Identity Theory Perspective', *Electronic Journal of Knowledge Management*, 13(2), pp. 130-141. Available at: https://academic-publishing.org/index.php/ejkm/article/view/1050 (Accessed: 21 March 2025).

Sharif, Sh., Lodhi, R. N., Munir, A. M. and Farhana, Y. (2021) 'Authentic leadership and knowledge management in public libraries: role of organizational commitment using mixed method research', *Library Philosophy and Practice*, pp. 1-26. Available at: https://goo.su/Mljyc1 (Accessed: 21 March 2025).

Sheng-hsun Hsu and Huang-pin Shen (2005) 'Knowledge management and its relationship with TQM', *Total Quality Management & Business Excellence*, 16(3), pp. 351-361. DOI:10.1080/14783360500054111

Sveiby, K.-E. (2001) 'A knowledge-based theory of the firm to guide in strategy formulation', *Journal of Intellectual Capital*, 2(4), pp. 344-358. Available at: https://goo.su/KP9l6a (Accessed: 21 March 2025).

Sveiby, K.-E. and Simons, R. (2002) 'Collaborative climate and effectiveness of knowledge work: An empirical study', *Journal of Knowledge Management*, 6(5), pp. 420–433. doi: 10.1108/13673270210450388.

Vyas, A., Bhala, P. and Najneen, A. (2020) 'Competitive analysis of interaction between organizational culture and knowledge management in indian higher education institutions: Public and private sector', *International Journal of Advanced Science and Technology*, 29(5), pp. 5313-5322. Available at: https://onx.la/7e2c5 (Accessed: 21 March 2025).

Wiig, K. M. (2002) 'Knowledge management in public administration', *Journal of Knowledge Management*, 6(3), pp. 224–239. doi: 10.1108/13673270210434331.

Zack, M. H. (1999) 'Developing a Knowledge Strategy', *California Management Review*, 41(3), pp. 125–145. doi: 10.2307/41166000.

Zeferino, E., Pereira, R., Malvestiti, R. and de Souza, J. (2020) 'ISO 30401. The standardization of knowledge', *International Journal of Development Research*, 10(06), pp. 37155-37159. Available at: https://www.journalijdr.com/iso-30401-standardization-knowledge (Accessed: 21 March 2025).

A Knowledge-Sharing Practices Perspective for Poverty Eradication Among Rural Women

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Abstract: Knowledge-sharing practices is crucial for communities striving to combat poverty. The paper explores knowledge-sharing practices for poverty eradication among rural women in Ghana and makes recommendations to improve knowledge sharing. It adopted the interpretive paradigm and a qualitative research approach. The primary data were obtained from 111 rural women in the Northern region, Ghana. Face-to-face interviews, focus-group discussions and observations were used to collect data. The study was guided by the following question: "What are the knowledge-sharing practices for poverty eradication among rural women in the northern region of Ghana?" Thematic analysis was conducted based on Braun and Clarke's (2006) framework. The findings revealed that rural women engage in a variety of knowledge-sharing practices such as social interactions with extension officers, interactions between family and friends, interactions with social cliques and self-proclaimed experts, village meetings, religious leaders and institutions meetings, Communities of Practice and knowledge sharing programmes. The study recommends the need for rural women to seek professional knowledge from established knowledge centers. A dedicated mobile phone helpline project is also recommended, as well as the training and motivation of extension officers to improve the quality of extension services provided to rural women. Additionally, elements such as literacy programs, appropriate leadership, stakeholder participation, trust and respect for culture, ICT technology, gender-equity campaigns, behavioral change, social amenities and resource availability and ongoing knowledge-sharing programmes were also considered crucial for enhancing knowledge sharing practices. The study contributes to knowledge management by demonstrating how tacit knowledge flows are sustained through informal networks, trust, and reciprocity in rural contexts. By foregrounding these socially embedded and community-driven practices, it broadens knowledge management theory beyond corporate settings and highlights their relevance for poverty eradication and women's empowerment. The study is timely as it seeks to leverage knowledge management practices to eradicate poverty, empower women, and address gender inequality in line with Goals 1 and 5 of the Sustainable Development Goals.

Keywords: Knowledge management, Knowledge-Sharing practices, Rural women, Poverty eradication, Ghana

1. Introduction

Poverty is currently one of the most pressing global challenges, and knowledge sharing (KS) practices are central to achieving equality and poverty eradication (Qureshi, Sutter & Bhatt, 2017:1). Goal 1 of the 2030 Sustainable Development Goals (SDGs) outlined by the United Nations (UN) aim to eradicate poverty, while Goal 5 strives to empower women and combat gender inequality (UN, 2017:3-5). Rural women account for a great proportion of the world's agricultural labour force. According to the Committee for Economic Development (CED) (2003), 70% of the world's agricultural labour force comprises women. KS practices may alleviate poverty among women in rural areas (Bishop, 2019:22; FAO, 2011:2; Fox et al., 2018:52; Taylor & Ramos, 2016). Access to knowledge by rural women on various crucial aspects such as health, agriculture, nutrition, water management and education will enable these women to gain greater control over their lives and make informed decisions that positively impact their families and communities, thereby enhancing their socio-economic standing and addressing the underlying causes of poverty (FAO, 2011:24; Mchombu & Mchombu, 2014:5; Upali, 2013:190; Taylor & Ramos, 2016).

From a theoretical standpoint, this study is anchored in Knowledge Management (KM) frameworks that conceptualise knowledge as a process involving creation, storage, transfer, and application **(**Igbinovia & Ikenwe, 2017:30; Chatti, 2012:831)**.** Within these frameworks, KS is understood as the most critical process that enables the movement of tacit and explicit knowledge across individuals and communities (Kucharska & Bedford, 2024:21; Manamela 2018:20). Additionally, drawing on intellectual capital perspectives (Bardy, Rubens & Eberle, 2017; Christensen, 2018; Agndal & Nilsson, 2006), the study positions rural women's informal knowledge systems as vital intangible assets that generate social and economic value when shared effectively. These frameworks collectively provide the lens through which the study examines how community-based KS practices can contribute to poverty alleviation.

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In the 2021 Population and Housing Census (PHC), women accounted for 50.7% of the rural population in Ghana and 31.2% of households across the country were headed by females (Ghana Statistical Service, 2021). International communities and non-profit organisations acknowledge the pivotal role of rural women, leading to the ratification of various conventions, treaties, and interventions aimed at championing women's rights and empowering them in rural settings (Ofosu-Baadu, 2012:3). For example, in 2016, ministers from the Economic Community of West African States (ECOWAS) responsible for gender and women's affairs made a commitment in New York, during the official launch of the ECOWAS-FAO (Food and Agriculture Organization of the United Nations) technical cooperation program, to pursue the zero-hunger vision for ECOWAS member states. Similarly, the African Union (AU) Heads of States consecutively designated 2015 as the year of women's empowerment and 2016 as the year focused on development and women's human rights (FAO & ECOWAS, 2018:11). Likewise, the Ghanaian government has enacted various legislations and implemented programs to promote women's rights and empower rural women for poverty eradication (Ofosu-Baadu, 2012:3). These initiatives include the Convention on Eliminating any act of Discrimination against Women (CEDAW), the Livelihood Empowerment Against Poverty Programme (LEAP), the Structural Adjustment Programme (SAP), the Women in Development Fund (WDF), the Microfinance and Small Loans Centre (MASLOC), and the Millennium Development Authority (MiDA) (Rabiu, 2018:23). Additionally, Article 17 of the 1992 Constitution of Ghana prohibits discrimination against women.

Despite these initiatives, a critical research gap remains. While prior studies in Ghana and other developing contexts have explored women's empowerment, civil rights to land, credit access, markets, and agricultural production, they have not sufficiently examined how informal, community-based knowledge systems contribute to poverty alleviation (FAO, 2011:2; Taylor & Ramos, 2016). In particular, little is known about how rural women access, share, and apply knowledge within socio-cultural and infrastructural constraints such as low literacy, limited mobile networks, and traditional gender roles (GSS, 2014:61; Mchombu & Mchombu, 2014:5). Addressing this gap is central to understanding how knowledge as intellectual and social capital can be mobilised for poverty reduction.

Against this backdrop, the study aims to explore the knowledge-sharing practices for poverty eradication among rural women and make recommendations to improve KS practices for poverty eradication among rural women. Specifically, the following research question guided the study;

RQ1: What are the knowledge-sharing practices for poverty eradication among rural women in the northern region of Ghana?

The study contributes theoretically by extending KM frameworks to under-researched, low-literacy contexts, offering insights into how informal knowledge systems can be leveraged for community-driven poverty reduction and women's empowerment.

2. Literature Review

2.1 Knowledge Sharing and Knowledge-Sharing Practices

Knowledge sharing is a vital process within the broader framework of KM (Valdés et al., 2024:68; Varamezov, 2024:73). KS is the act of exchanging knowledge or engaging in behaviors that assist others in acquiring knowledge (Hendricks, 2021). It is the transfer of both implicit and explicit knowledge from those who possess it to those who seek it (Varamezov, 2024:76). Knowledge sharing is generally conceptualised through two main types of knowledge: tacit knowledge embedded in individual experience and challenging to articulate (Xue, 2017:33; Gamble, 2020) and explicit (documented and easily transferable knowledge) (Panahi, Watson & Partridge, 2012: 648). Practices to manage these different knowledge types require specific strategies: explicit knowledge often relies on technological systems like databases and documentation (Bloodgood & Salisbury, 2001; Hajric, 2018:12) while tacit knowledge sharing benefits more from relational methods, such as mentorships and informal networks (Argote & Ingram, 2000). Researchers noted that knowledge sharing should be a voluntary endeavor (Osei, Ato-Mensah & Affum, 2015:158; Varamezov, 2024:76). It aids members within a community in performing their activities more efficiently (Mtega, Dulle & Benard, 2013:206). However, achieving this requires motivation, a supportive environment, a sense of security, a robust reward system, and a platform for sharing (Frimpong, Williams, Akinbobola, Kyeremeh & Kwarteng, 2018:39; Varamezov, 2024:76).

Knowledge sharing is delineated in this paper as a deliberate and reciprocal process among community stakeholders, where they share past experiences, expertise and insights on a particular subject to collectively generate fresh knowledge for sustainable development. Within this context, information, learning, community involvement, curiosity and discernment of right and wrong decisions are regarded as the wellsprings of this

knowledge (Aji, Binowo, Sensuse & Lusa, 2024:467; Xue, 2017:32). Knowledge sharing practice embodies the critical success factors that determine the success or failure of KM initiatives in a firm (Aji, et al., 2024:480). Scholars have conceptualised the term KM practice differently (Aji, et al., 2024:480; Onofre & Teixeira 2022:94). Ali & Avdic (2015:113) propose a KM framework for sustainable rural development that emphasises contextualised processes and stakeholder participation, which is directly relevant to rural women's KS practices.

Effective knowledge sharing practices play a crucial role in enabling the reuse and revitalisation of knowledge at the individual level (Asiedu, Abah & Dei, 2022:3). Knowledge-sharing practices occur within social interactions and involve personal experiences casual conversations, interpersonal relationships and day-to-day activities (Asiedu, Abah & Dei, 2022:6; Panahi et al., 2012:1098). Communities of Practice and knowledge-sharing systems are designed by organisations that foster learning and subsequently contribute to the creation of new knowledge (Asiedu, Abah & Dei, 2022:3; Davenport & Prusak, 1998).

2.2 Formal vs. Informal Knowledge Sharing

Knowledge is typically shared either formally via training, workshops and the use of digital platforms or informally through storytelling, apprenticeships, and social bonding. Both forms of knowledge are essential for effective KM, but their effectiveness can vary based on context and the nature of knowledge being shared (Asiedu, Abah & Dei, 2022:6; Wendo, Duncan & Bosire, 2025:8). Rural development literature stresses the power of informal knowledge channels in marginalised communities where formal systems are weak or distrusted (Bonuedie & Fombad, 2024:63; Hlongwane, Slotow & Munyai, 2021:1). Recent studies further emphasise that digital platforms have expanded the reach of formal knowledge sharing, but digital literacy and trust issues often limit their effectiveness in rural settings (Zamiri & Esmaeili, 2024:7). Conversely, informal mechanisms such as peer-to-peer exchanges and community gatherings remain resilient and adaptive, especially among women in low-resource environments (Frias-Navarro & Montoya-Restrepo, 2020:235). Kommey (2020) illustrates how community KM systems can be designed to support informal knowledge in rural settings. For example, studies on smallholder and artisanal communities document practical strategies for farmer knowledge sharing and show how mixed-methods and community-based KM frameworks can be applied in Ghana. In Ghana, rural women's informal networks often serve as primary channels for sharing agricultural practices, health advice and economic strategies, yet such mechanisms are underrepresented in academic frameworks (Osei & Zhuang, 2020: 1; Dadzie, Ndebugri, Inkoom & Akuamoah-Boateng, 2022:10). This study aims to highlight and systematise these often-overlooked informal practices.

2.3 Knowledge Sharing and Poverty Eradication

The meaning of poverty varies across contexts; this study adopts United Nations Development Programme's (UNDP) framing of poverty as deprivation of essential resources (UNDP, 2006:5). The UN's people-centred approach highlights education, training, social protection and decent work as key to poverty eradication (UN, 1995; UN, 2017:3). Knowledge sharing contributes to these aims by improving access to information, skills, and collective problem-solving mechanisms (Qureshi, Sutter & Bhatt, 2017:1). Several studies point to KS as an enabler of livelihoods and resilience in rural contexts (e.g., Mchombu & Mchombu, 2014:5; Ingutia & Sumelius, 2022:149). Literature suggests that building community intellectual capital through the combination of local wisdom and external knowledge can sustainably enhance development outcomes, reinforcing the argument that KS is a form of social and intellectual capital that underpins poverty reduction strategies (Bardy, Rubens & Eberle, 2017; Christensen, 2018; Agndal & Nilsson, 2006)

2.4 Knowledge Sharing in Gendered-Context

The elimination of poverty among rural women involves empowering them across political, social and economic spheres, enabling them to make choices that enhance their well-being (Akhter & Cheng, 2020:1; Désilets & Fernet, 2019:3). Studies affirm that a key obstacle to disseminating expertise within local communities lies in deficient knowledge-sharing methods (Cronkleton et al., 2021:1; Lwoga, Stilwell & Ngulube, 2010:3). Improved knowledge sharing practices are intrinsically linked to advancements in health, human rights, gender equality, leadership skills, negotiation abilities and decision-making among rural women (Ingutia & Sumelius, 2022:149; Sari, Kumalasari & Zunaidah, 2021:753). Knowledge sharing practices for poverty eradication among rural women include, social interactions among family and friends, extension services officers and social cliques (Antwi-Agyei & Stringer, 2021:2; FAO, 2019a:9), Communities of Practice and village meetings (Harris-Fry, Saville, Paudel, Manandhar, Cortina-Borja & Skordis, 2022: 2; FAO, 2019a:10).

2.5 Social Capital, Intellectual Capital and KM

Theoretical background on KS draws from organisational and KM perspectives (Argote, Ingram, Levine & Moreland, 2000; Hislop, Bosua & Helms 2018). Social capital theory explains how networks, trust and reciprocity facilitate KS (Putnam, Xavier, Rohe, Vidal, Hutchinson, Gress & Woolcock, 2004), while intellectual capital (IC) frames knowledge as an asset that can be developed and mobilised for social and economic returns (Bardy, Rubens & Eberle, 2017). In this paper, tacit and explicit knowledge distinctions are used to map how KS practices in rural communities travel across social ties and informal institutions (Xue, 2017:33; Panahi et al., 2012:648). Social capital theory is therefore useful for understanding how tacit knowledge—often transmitted orally and through practice can be leveraged through community KM strategies to yield development outcomes (Sitar, Bogilović & Pahor, 2018:111). Practical KM frameworks for rural settings (Ali & Avdic, 2015; Economic Commission for Latin America and the Caribbean, 2010:13; Fombad, 2018; Parveen & Leonhäuser, 2004:9) emphasise participatory systems, locally appropriate technologies, and community knowledge stewards—elements that can guide interventions aimed at improving KS among rural women.

2.6 Barriers and Enablers to KS

The theoretical framing of KS also includes barriers at various levels—individual, organisational, and technological (Cyr & Choo, 2010:825; Wijesinghe & Kathriarachchi, 2022:60). Individual barriers include reluctance due to lack of perceived reciprocity (Khesal et al., 2013:497), low self-esteem, inadequate peer interaction, lack of confidence (Tahleho & Ngulube, 2022:4; Wijesinghe & Kathriarachchi, 2022:60; Xu & Li, 2022:36), and the tendency for knowledge shared through social interactions to remain undocumented, leading to its loss if not preserved, practised, or transmitted to future generations. Organisational barriers may arise from structural or cultural impediments, such as hierarchical rigidity, while technological barriers relate to inadequate systems or tools for knowledge transfer, particularly in contexts requiring specialised or networked resources. Social Capital Theory provides insights into overcoming these barriers by emphasising the importance of building and maintaining networks that foster trust and cooperation (Cummings, Seferiadis, Maas, Bunders & Zweekhorst, 2019). In sum, KS practices are shaped by factors such as cultural alignment, incentives for participation, and the strategic integration of technology to support both tacit and explicit knowledge exchange (Frimpong et al., 2018:39). Social Capital Theory further enriches this understanding by highlighting the critical role of social relationships and community norms in facilitating effective knowledge sharing (Mchombu, 2014:8; Liu, Qu, Huang, Chen, Yue, Zhao & Liang, 2014:190).

2.7 Synthesis and the Research Gap

Although prior research recognises the importance of KS and documents a range of formal and informal practices, there is limited studies that (a) combine KM and intellectual capital theoretical frameworks with empirical, qualitative evidence from rural women in northern Ghana (Kommey, 2020:44; Osei & Zhuang, 2020: 1; Dadzie, Ndebugri, Inkoom & Akuamoah-Boateng, 2022:10). Additionally, there is limited studies that examine how informal, community-based KS systems operate under socio-cultural and infrastructural constraints to contribute specifically to poverty eradication in Ghana (FAO, 2011:2; N-yanbini & Owusu-Ansah, 2024; Taylor & Ramos, 2016). This study fills that gap by applying KM and intellectual capital lenses to rich qualitative data from Tintang, Tongnoli and Nagbali, thereby linking KM theory to grassroots practice for poverty eradication. The study aims to provide a deeper understanding of the contextual factors that enable or hinder effective knowledge sharing for poverty eradication. The findings will inform practical recommendations for enhancing knowledge-sharing practices in rural Ghana.

3. Research Methodology

This study adopted a qualitative design within an interpretive paradigm to explore knowledge-sharing practices among rural women in the Mion district of Ghana's northern region. This approach was appropriate for the study's Knowledge Management (KM) focus, as it allowed the exploration of tacit knowledge exchanges in natural settings—insights that quantitative methods could not provide (Morgan 2016:2). A total of 111 participants took part: 32 in semi-structured interviews, 79 in focus groups, and 16 through direct observation. Data were collected over four weeks (June–July 2021), coinciding with the post-planting season when rural women had relatively fewer responsibilities. Snowball sampling was used to recruit participants, facilitated by a local assemblyman who served as the researchers' main contact. Interviews and focus groups were organised through peer-led recommendations, which proved effective given the communities' close-knit social networks and low literacy levels. The study was conducted in three farming communities—Tintang, Tongnoli, and Nagbali

characterised by agrarian livelihoods, extended family systems, patriarchal cultural structures, and communal labour practices.

Three complementary instruments were employed: semi-structured interviews, focus groups, and direct observation. Interviews enabled private and detailed exploration of personal experiences, while focus groups provided insights into shared norms, debates, and community validation. Observations complemented both methods by validating verbal accounts and capturing spontaneous acts of knowledge sharing in natural contexts. Together, these methods provided depth, breadth, and triangulation. This triangulation of data sources (interviews, focus groups, observations) was not only a methodological strength but also a key strategy to enhance credibility and dependability, ensuring that findings were supported by multiple lines of evidence. Although the researchers' gender as women could be perceived as a potential bias, this was mitigated through methodological triangulation and reflexivity. The researchers maintained a reflexive journal throughout the study to record assumptions, positionality, and decision-making, which enhanced confirmability. They had no prior personal ties to the communities, reducing the risk of bias, while reliance on local assistants for translation supported transparency.

Thirty-two participants (26 rural women and 6 stakeholders) took part in semi-structured, face-to-face individual interviews. These were held at locations chosen by participants for privacy and comfort, often under trees, in open compounds, or local community centers. The main aim of the interviews was to understand personal knowledge-sharing practices, and the potential of these practices in poverty reduction. Interview questions were guided by a semi-structured protocol (see Appendix A), with open-ended prompts such as: "In your opinion, how does knowledge sharing help eradicate poverty among women in your community?", "How often do women in your community meet to share knowledge for poverty reduction?" and "Whom do you depend on for knowledge on your health, agricultural activities, nutrition, water management, education and employment among others?" The interviews lasted between 30 to 45 minutes depending on the participant's availability and willingness to elaborate. Translations were done on-site from Dagbani to English by trained local research assistants. The interviews were audio-recorded with participants' consent. Thematic saturation was reached by the 32nd interview, when responses became repetitive and no new insights emerged.

Additionally, seventy-nine rural women participated in three separate focus group discussions, one per community. Each group included between 20 to 31 participants. The focus group aim was to understand group-level dynamics, shared perceptions of knowledge-sharing and to observe how cultural and social norms influenced interactions. Group discussions helped capture community narratives and validate individual responses from the interviews. Each focus group lasted approximately 90 minutes and followed a structured guide (see Appendix B), which included similar questions asked during the individual interviews. Moderation was done by the researchers with the assistance of a local female interpreter. Seating arrangements were informal (under a tree) to encourage open discussion. Discussions were audio-recorded with participants' consent. Focus group findings were compared with interview data to identify convergences and divergences, supporting triangulation and analytic rigor.

Sixteen key observational scenarios were recorded across all communities. These observations were conducted during both interviews and focus groups, as well as during informal village interactions and farm visits. The observations were unstructured but intentional, focused on events or behaviors relevant to the study objectives. For example, the researcher noted situations such as women gathering to process food, exchanging farming advice in the market, or performing tasks while men remained passive observers highlighting gender dynamics in knowledge sharing. Observations served as both a confirmatory and exploratory tool, helping to detect non-verbal cues, validate participant narratives and identify emerging patterns that were later probed in interviews or discussions. Where observations raised uncertainties, clarification was sought from local guides.

Data preparation involved verbatim transcription of interview recordings, translated from Dagbani to English. Coding was guided by the research questions (e.g., knowledge sources, benefits of knowledge sharing) and participant identifiers. To facilitate analysis, participants were assigned specific codes: Nagbali interviewees as N-P1 to N-P5, Tintang as TIN-P1 to TIN-P9, Tongnoli as TON-P1 to TON-P12, and stakeholders as ST-P1 to ST-P6. Focus group participants were coded by community and speaking order (e.g., TON-SP1 to TON-SP3, TIN-SP1 to TIN-SP3, N-SP1 to N-SP3). Data from interviews, focus groups and observations were all analysed thematically using Braun and Clarke's (2006) six-phase framework which consists of; familiarising with the data, generating initial codes, searching for themes, reviewing themes, defining the themes and writing up the outcome.

Analysis centred on responses to the research questions, such as the types of knowledge shared (health, agriculture, nutrition, education, water management, employment), who shared knowledge and with whom,

frequency of exchanges, and perceived benefits or limitations. This enabled identification of recurring issues and patterns, producing themes such as "social interactions as primary knowledge sources," "sporadic or irregular meetings," and "barriers including male dominance, limited mobility, or lack of trust." Observational data reinforced these themes, for instance highlighting gendered roles or spontaneous exchanges in markets and farms. The analysis further examined how such practices shaped women's access to livelihoods and essential services, clarifying their role in poverty reduction. Coding and categorisation were managed manually to ensure close engagement with the transcripts.

Trustworthiness was established through Lincoln and Guba's (1985) criteria: credibility (triangulation, member checks), transferability (thick contextual descriptions), dependability (audit trail of coding decisions), and confirmability (reflexive journal and peer debriefing). Researcher positionality was also considered. Although the researchers' gender could have introduced bias, reflexive journaling and lack of prior ties to the communities helped mitigate this. Overall, the qualitative design directly supports the KM lens by revealing how rural women's tacit knowledge flows are shaped by cultural norms, social capital, and community structures (Chatti, 2012; Onofre & Teixeira, 2022).

4. Findings and Discussions

The previous section examined the methodology of the study. In this section, the findings are presented, interpreted and discussed in relation to the research objectives. The findings are presented according to emergent thematic categories drawn from the coding of interview transcripts, using Braun and Clarke's thematic analysis framework. These themes are critically discussed in relation to Social Capital Theory and Knowledge Management (KM) literature to draw deeper insights into how knowledge-sharing (KS) practices influence poverty eradication among rural women. The article sought to explore knowledge-sharing practices for poverty eradication among rural women in the northern region of Ghana. It was guided by the following objectives:

- Explore the knowledge-sharing practices for poverty eradication among rural women
- Make recommendations to improve knowledge sharing practices for poverty eradication among rural women

The knowledge-sharing practices for poverty eradication among rural women that emerged from the study were social interactions with extension officers, interactions between family and friends, interactions with social cliques and self-proclaimed experts, village meetings, meetings called by religious leaders and institutions, Communities of Practice, knowledge-sharing programmes and promotion of knowledge-sharing benefits. Figure 1 presents a list of the findings that are explained in the following subsections.

Figure 1: Knowledge sharing practices among rural women

4.1 Social Interactions

Social interaction was a predominant knowledge sharing practice among rural women, encompassing interactions with extension officers, interactions between family and friends, and interactions with social cliques and self-proclaimed experts. Studies supports the notion that social interactions foster learning and the creation of knowledge (Boateng, 2018:46; Chua, 2002:11; Frias-Navarro & Montoya-Restrepo, 2020:235; Koloniari, Vraimaki & Fassoulis, 2019:21; Panahi et al., 2012:1098). Three different types of knowledge sources were identified, which are shared during these social interactions, as revealed in the study findings, are presented in Figure 2 and discussed in the subsequent sections. However, participants in the study highlighted several challenges associated with such interactions within their communities.

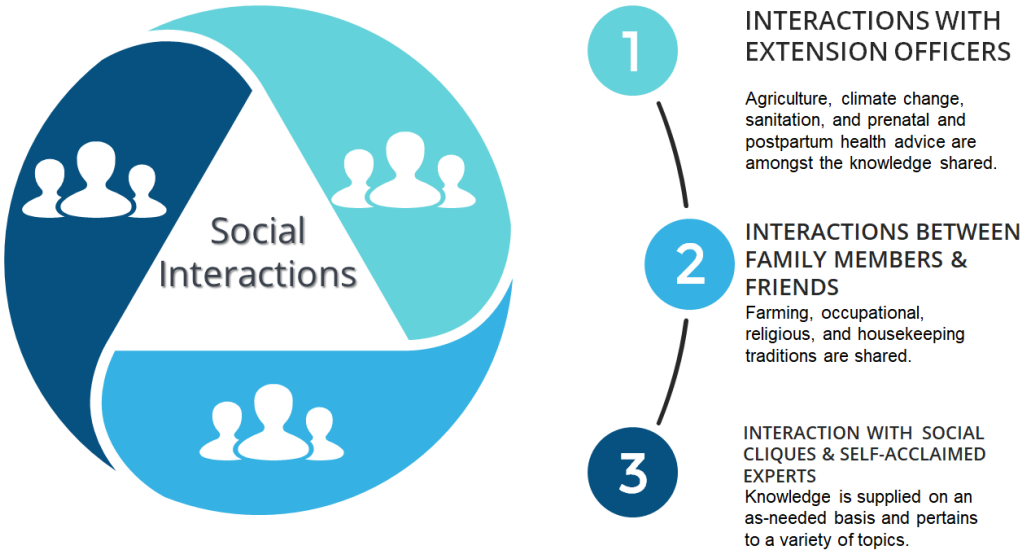

Figure 2: Three types of social interactions amongst rural women

4.1.1 Interactions with extension officers

Knowledge shared from interaction with extension officers included knowledge shared by agriculture extension officers, knowledge shared by assemblymen from the municipal assembly and knowledge shared by community health nurses tasked by the government to visit rural communities to attend to new-born babies as noted below

> *"The Agricultural officer visits occasionally. Although this season he hasn't been around. We don't have anyone to consult about our health concerns. The only time we interact with community nurses is when they come to weigh babies as required by the government. But they are here specifically for the babies so they have little patience to answer other questions. We lack a clinic. When someone falls ill, we send them to the traditional clinic at the chief's compound for assistance. If the issue surpasses them, we have to arrange for a motorbike to transport the sick person to Sang, the nearby village." - TIN-P1*

> *"At times, we struggle to find someone to discuss our health issues. However, for matters related to farming, the agricultural extension officer stops by from time to time to engage with us." - TIN-P4*

> *"When it comes to Agriculture, the agricultural extension officer makes occasional visits. However, they usually lack knowledge about many things. They sometimes delay addressing our questions, and we can visibly see that some of these extension officers disrespect us because we are economically disadvantaged. If our children were educated, we wouldn't have to rely on these individuals and endure their disrespect." - TON-P2*

> *"There is one agricultural extension officer who visits from time to time. As for health, due to my role as a birth attendant, I'm acquainted with the nurses. So, when I go to the clinic in Sang and meet them, they provide assistance." - TON-P3*

> *"Two unfamiliar individuals came, and then another person arrived from the district assembly to provide information on sanitation. For guidance on how to raise my children, I turn to my husband for insights on their upbringing." - N-P5*

These findings were corroborated with the focus-group findings, where it was clear that interactions with extension officers is a basic knowledge sharing practice among rural women but fraught with challenges. as noted below:

> "We all depend on our individual husbands for knowledge. The road is bad so the experts don't come here. Even the agricultural extension officers come only once in a *while." TON-SP1*

Many participants highlighted agricultural extension officers as important, though inconsistently available, knowledge providers. Trust in officers was mixed and often influenced by their frequency of visits and interpersonal approach. From a KM perspective, extension officers embody explicit knowledge carriers whose effectiveness depends on continuous interaction, contextualisation, and trust-building. Disruptions in their presence weaken the knowledge cycle and reduce the ability of rural women to convert new information into usable intellectual capital. According to Lwoga, Stilwell and Ngulube (2010:1), sustainable KS in rural areas requires strengthening linking social capital—connections to institutions and actors with access to external resources. The limited presence of officers reflects systemic weaknesses in institutional support and affects the capacity of rural women to access timely, actionable knowledge. Agricultural extension officers are expected to visit rural women's farms, organise group meetings and demonstrations, and provide contact information for rural women to readily reach them regarding various concerns (Antwi-Agyei & Stringer, 2021:2; FAO, 2019a:9; Kambey, Campbell, Cottier-Cook, Nor, Kassim, Sade & Lim, 2021:2). Assemblymen are also tasked with serving as a liaison between their communities and the district assembly secretariat and other development institutions. Their efforts are supported by unit committee members, who collaborate with assembly members to enforce bylaws within their communities (Ahadzie, Dinye, & King, 2021:159; Dery, 2018:3; Ghana's Decentralization Policy, 2010). The findings, revealed that community health nurses were scheduled to visit once a month. These nurses are responsible for disseminating information on maternity, neonatal and child healthcare, both preventive and curative (Abane, Mariwah, Owusu, Kasim, Robson & Hampshire, 2021:2; Bawah, Phillips, Assuming, Jackson, Walega, Kanmiki, Sheff & Oduro, 2019:6; Woods, Haruna, Konkor & Luginaah, 2019:803). As noted in the findings, some interviewed participants claimed that certain extension staff lacked patience and respect and were unable to respond appropriately to some of their inquiries. Extension officers, especially community health nurses, have been accused of displaying disrespect towards rural women (Adatara, Strumpher & Ricks, 2019:5; Nachinab, Adjei, Ziba, Asamoah & Attafuah, 2019:5). This resonates with Kommey's (2020) observation that the quality of interpersonal relations is crucial in rural KS systems, where trust is often the only currency enabling knowledge flow. Similarly, a study by Bellerose, Alva, Magalona, Awoonor-Williams, and Sacks (2021:726) found a lack of regular supervision for community health nurses. A disrespectful attitude to rural women during interactions can have a negative impact on their knowledge sharing, hindering them from seeking information on antenatal and postnatal health, as well as agricultural improvement, which are crucial for their well-being and, consequently, poverty eradication.

However, it is reasonable to assume that extension officers may face these challenges to knowledge sharing due to a lack of motivation and the remoteness of such rural communities. For instance, Bellerose et al. (2021:3) in a study of nurse motivation to accept rural postings noted that the rural location is a demotivating factor for community health nurses as it limits their career advancement. Financial, logistical and technological challenges such as a poor telecommunication network, a lack of wellington boots and bicycles, and a lack of recognition and refresher training programs are demotivating factors for community health personnel (Kweku, Manu, Amu, Aku, Adjuik, Tarkang, Komesuor, Asalu, Amuna, Boateng, & Alornyo, 2020:8). Extension officers and other relevant stakeholders who aim to share knowledge with rural women in order to eradicate poverty may be discouraged by the long distances they would have to travel, the poor road network, the lack of mobile phone networks, and other deficits in social amenities that this study found to be prevalent in rural communities where rural women reside.

4.1.2 Interactions between family members and friends

Social interactions between families were found to be the second knowledge-sharing practice among rural women. This informal network functioned as a key social capital resource, enabling trust-based knowledge flows. The rural women emphasised that they confide in their husbands, children, and other family members as the primary individuals they trust for knowledge sharing, as outlined below.

> *"We have no one else to turn to except our husbands. When our husbands attend seminars and gatherings and gain some knowledge about nutrition, they return and share that knowledge with us, advising on what type of food to provide for the children and how to manage the household." - TIN-P2*
>
> *"I rely on children in the village who have completed high school. When nurses come to the communities to weigh babies, I turn to them for knowledge. If it's something confidential, I keep it to myself and face it quietly." - N-P4*
>
> *"I've only been married for a few months, so I'm solely reliant on my husband." - TON-P8*
>
> *"I've only been married for a few months, so I haven't yet figured out who to rely on. I'm not aware that I need that knowledge." - TIN-P8*

The focus group discussions further revealed that rural women rely on their school-age children and husbands for knowledge. Also, the direct observations of individual rural women further affirmed that interactions within family and social circles play a significant role in knowledge-sharing practices among rural women.

Among the types of knowledge shared among family members and friends are farming techniques, occupational insights, housekeeping tips and religious perspectives. The findings reveal that rural women heavily rely on their families, especially their spouses and educated children, for information. The reliability of familial sources builds a trusted foundation for learning, but may also restrict the breadth of knowledge if it remains within insular circles. Most participants rated the government's extension services provided through the municipal assembly and the work of community health nurses as inadequate. However, the lower level of education among rural women's spouses and children raises concerns about the validity, authenticity and reliability of the knowledge they impart to rural women.

Rural women acquire knowledge from gatherings with family members and friends, such as communal labor, religious meetings, social events like weddings, naming ceremonies, funerals and casual conversations during everyday activities. These interactions foster the exchange of personal experiences and other sources of knowledge, offering support and guidance to one another (Amati, Meggiolaro, Rivellini & Zaccarin, 2018:3; Chua, 2002:1; Panahi et al., 2012:1098). Nevertheless, rural women trust them, which is crucial for maintaining these social interactions (Kacperska & Łukasiewicz, 2020:2; Koranteng, Wiafe, Katsriku & Apau, 2020:1; Kwon, 2019:19). For instance, in a study on cervical cancer prevention among rural women conducted by Banik, Sahu and Bhattacharjya (2022:765), some rural women were hesitant to discuss their sexual activities, with a majority of them declining to talk to outsiders. This highlights the importance of trust in such contexts. Trust emerged as a recurring motif. Rural women are more likely to share or act on knowledge when the source is trusted, particularly when it comes from spouses or children.

From a Social Capital Theory perspective, these familial and friendship networks embody bonding capital—tight-knit networks marked by trust and obligation (Putnam et al., 2004). Such networks function as knowledge nodes where tacit knowledge is stored, validated, and transmitted, effectively forming micro-reservoirs of intellectual capital (Bardy, Rubens & Eberle, 2017:167). From a KM perspective, these exchanges can also be seen as informal yet structured processes of knowledge acquisition, transfer, and application (Shongwe, 2016:144). Rural women capture knowledge through trusted family members (acquisition), adapt it to household needs (transfer), and embed it into daily livelihood practices (application). This interpretation aligns with Ahmed, Seleim and Khalil (2011:603), who argue that intellectual capital is created and sustained within social contexts that foster trust and reciprocity. Comparatively, Bardy et al. (2017) found that combining local wisdom with external knowledge flows enabled rural communities in Ghana to build community intellectual capital. This resonates with the present findings, where reliance on family strengthens trust but also risks narrowing knowledge diversity if external flows remain weak. Unlike Bardy's case, where institutional actors reinforced local knowledge, this study shows that family-based reliance without strong external linkages may reinforce silos.

For practice, these findings suggest that development agencies and KM practitioners should leverage the trust embedded in family networks while deliberately expanding bridging capital to ensure broader diffusion of knowledge. For example, knowledge-sharing interventions could embed family representatives as peer facilitators in community programmes, ensuring that trusted household knowledge nodes extend their reach beyond insular circles (Bardy et al., 2017; Shongwe, 2016).

4.1.3 Interactions with self-proclaimed experts

The last category of social interaction, occurred from social cliques with self-acclaimed knowledgeable persons. It is worth noting that while the information shared within these groups may not always be entirely accurate, the rural women often felt compelled to rely on it. Below are some of the perspectives they expressed.

> *"There's a man on a motorbike who travels through the villages selling various medicines. He's the one we turn to for health advice. He brings the medicines every market day." - TON-P2*

The interviewer then inquired if he possessed formal or technical expertise for diagnosing diseases. TON-P2 replied,

> *"He lacks formal or technical expertise in dispensing medicines or diagnosing diseases. Nevertheless, in the absence of an alternative, the village relies on him for health knowledge and common remedies. He complements the work of herbalists, providing supplies to the remote areas in the Mion district. For more severe conditions, the herbalist takes charge."*
>
> *"I have no one to turn to for advice on my health concerns. When I'm unwell, I refrain from going to the farm. Instead, I purchase medicine from the mobile vendor who visits our village. I stay home for a while before returning to work on the farm. Fortunately, I rarely fall ill." - TON-P4*

The focus-group results consistently reinforced this sentiment. TIN-SP3 reiterated throughout the discussion that she believes they lack a reliable source of knowledge due to various limitations and their remote geographical location, which makes it challenging for anyone to be aware of their circumstances. For instance:

> *"We all depend on our social clicks and whoever comes around from the cities for knowledge. The road is bad so the experts don't come here. Even the agricultural extension officers come only once in a while." TON-SP1*

During visits to the rural communities, the researcher had the opportunity to observe the unlicensed drug seller navigating the villages on his motorcycle. At each stop, women eagerly purchased their required medications. Some already had a clear idea of what they needed for common issues like headaches or stomachaches. For those unsure, the vendor offered recommendations tailored to their condition. His arrival was met with enthusiasm from the local women and residents, a testament to their trust in his expertise. Given the absence of pharmacies, licensed chemical stores, and clinics in the area, the rural women held great appreciation for his services.

Some participants identified individuals known for specific expertise as informal "self-proclaimed experts." These self-proclaimed experts assert a certain level of knowledge without formal qualifications to support their claims. This could involve a local individual assuming the role of a medical practitioner or pharmacist despite lacking formal medical training. Despite the absence of official credentials, such individuals may gain credibility due to their knowledge in traditional medicine, for instance. These actors represent nodes of tacit knowledge accumulated over years of lived experience. While such sources contribute to preserving indigenous knowledge, the lack of verification can lead to misinformation (Banik, Sahu, & Bhattacharjya, 2022:765). Banik, Sahu and Bhattacharjya (2022:765) identified a similar pattern in their study, where a small subset of women exhibited poor health-seeking behavior and lacking access to an authoritative and reliable source relied on various self-proclaimed sources for knowledge. False knowledge, in such cases, can be detrimental (Talwar, Dhir, Singh, Virk & Salo, 2020). It can be particularly dangerous when sharing faulty knowledge poses a health risk or hinders efforts to combat poverty. Over time, individuals claiming expertise may be found to lack the knowledge they purport to possess. To mitigate the risk of misinformation, rural women may benefit from seeking guidance from certified professionals when available.

From a KM perspective, these self-proclaimed experts highlight the challenge of validating tacit knowledge within informal networks. Their advice circulates based on trust and social positioning rather than formal accreditation, reflecting what Shongwe (2016:144) describes as the dominance of experience-based knowledge in community contexts. While this can strengthen local resilience, it also exposes women to risks of misinformation if knowledge is not cross-validated with credible sources.

Theoretically, these actors can be viewed through Social Capital Theory as "bonding agents" whose credibility is reinforced by social ties rather than institutional legitimacy (Putnam et al., 2004). Yet, as Bonuedie and Fombad (2025:119) argue, effective poverty alleviation requires bridging local knowledge with external expertise to build community intellectual capital. The reliance on self-proclaimed experts demonstrates the consequences of weak

bridging capital, where institutional gaps are filled by informal authorities whose knowledge may not always align with best practices.

Comparatively, Ahmed, Seleim and Khalil (2011:603) argue that intellectual capital must be embedded within both structural and relational networks to be reliable. The findings of this study expand on that view by showing how, in the absence of strong institutional structures, relational trust alone drives knowledge circulation, albeit with mixed outcomes. This extends existing KM theory by demonstrating the double-edged role of trust: enabling access but not guaranteeing accuracy.

These insights suggest that KM interventions in rural areas should not seek to eliminate self-proclaimed experts, but rather to integrate and train them within structured systems (e.g., community knowledge banks or peer educator programmes). This way, their social legitimacy can be leveraged while simultaneously enhancing the accuracy and reliability of the knowledge shared (Bardy et al., 2017; Shongwe, 2016). Development agencies could, for instance, provide tailored training or certification for such informal actors, bridging indigenous authority with professional validation.

4.2 Communities of Practice

Communities of Practice also emerged as a form of knowledge-sharing practices among rural women as indicated in their responses below.

> *"We gather every Friday under the big tree. Those among us who come across new insights related to our work; they impart it. Our lives are somewhat better than those in neighboring villages because we share regularly and exchange each other's thoughts. We collaborate through communal labor. One time we focus on gathering and processing shea, ensuring it's prepared well. We also assist those engaged in farming. We've reaped numerous benefits from our gatherings." N-P2*

> *"We have three distinct groups; some consist of 20 members, others 30. Typically, we assemble on market days and Fridays. During our sessions, we discuss the challenges we've faced during the week, and fellow women offer their insights. My group comprises 40 women. Another group totals 20 members, and the third group is a mix of men and women, where they receive instruction on crafting items like sandals. A person can choose to be part of two groups. Additionally, three individuals were selected and trained by an NGO called Technosef. These three, in turn, shared their newfound knowledge with the rest of us."*
>
> *N-P3*

> *"I'm part of a group focused on charcoal production. We gather on an occasional basis, as the need arises." TIN-P5 and TIN-P8*

TON-P3 also mentioned the existence of a women's group, albeit one that seldom convenes. She elaborated that when they do gather, it is mostly for casual discussions. While the rural women in various villages have established small groups under the guidance of visiting NGOs, numerous interviewees pointed out that many of these groups prove ineffective due to the lack of follow-up from these NGOs. Nevertheless, in some communities, these groups serve alternative functions, such as coordinating communal efforts and exchanging local expertise.For example, rural women in Nagbali, emphasised their frequent assemblies and were grateful for the benefits. Figure 3 provides a visual record of yam mounds cultivated through knowledge-sharing gatherings at a communal farming initiative (an endeavor accompanied by singing, dancing, and theatrical performances).

Figure 3: Yam mounts planted in line through cooperate farming

Communities of Practice act as platforms for collective sense-making, where both tacit and explicit knowledge are exchanged in trust-based networks (Durand, Richard, Beaudet, Fortin-Pellerin, Hudon & Tremblay, 2022:2; Webber & Dunbar, 2020:1; Wenger, McDermott & Snyder, 2002:4). Communities of Practice exist among rural women in the form of women's groups led by some external stakeholders. This has become a common practice in rural communities where such groups, initiated by non-profit organisations, can help increase the sharing of nutrition, climate change, poverty eradication, and other relevant knowledge required by rural women to improve their livelihood (Harris-Fry, Saville, Paudel, Manandhar, Cortina-Borja & Skordis, 2022: 2-3). Bardy, Rubens and Eberle (2017) emphasise that such peer-based practices represent a form of "community intellectual capital" that enables groups to integrate local wisdom with external knowledge for sustainable development. The study's findings resonate with this, showing how rural women not only exchange farming knowledge but also social and cultural insights, thereby broadening the stock of collective intellectual capital.

However, attendance was irregular, with observations showing low participation in Tintang and Tongnoli. This highlights the challenge of sustaining such groups without external facilitation or embedded governance structures. Ahmed, Seleim and Khalil (2011:603) argue that intellectual capital flourishes where networks are nurtured through consistent interaction, suggesting that the limited functionality of some women's groups reflects gaps in maintaining structural and relational capital.

Ingutia & Sumelius (2022:149) observed that farmer groups elsewhere create stronger bargaining power in markets. In contrast, the groups in this study often lacked continuity and institutional reinforcement. This contrast underscores the need for KM practitioners and NGOs to support local CoPs with capacity-building and follow-up mechanisms to ensure they move beyond ad hoc gatherings to sustainable, knowledge-rich institutions.

4.3 Village Meetings

Village meetings emerged as another platform for knowledge-sharing practices for poverty eradication discerned through a combination of interviews, focus groups, and observations, as detailed below.

> *"Village meetings are held often in the communities and all community members are required to be there so I also join together with my family." TON-P5*

This was corroborated from the following focus-group discussions:

> *"We have different types of group meetings; the first is village meetings called by the heads of the community, which is compulsory. When we meet at the mosque too, various knowledge on how to live peacefully with our neighbours is shared with us and we also have various knowledge-sharing groups who meet at different times to discuss different issues."*
>
> *N-SP1, N-SP2 with other focus group participants echoing their responses.*

Village meetings are a common platform for knowledge-sharing, often used to address various community issues (FAO, 2019a:10). These gatherings, convened by chiefs and elders, are instrumental in discussing community affairs, resolving conflicts, disseminating crucial information like disease outbreaks or emergency measures, and conveying updates on government-introduced crops or upcoming events (FAO, 2019a:14).

These meetings illustrate both bonding and bridging social capital (Putnam et al., 2004). Bonding social capital refers to strong, close-knit ties within a community, while bridging social capital connects individuals across diverse groups, enabling access to broader resources and perspectives (Putnam et al., 2004). Social Capital Theory highlights how these settings foster shared norms, trust and reciprocity, which are essential for the circulation of tacit knowledge and collective action (Sitar, Bogilović & Pahor, 2018:111). In knowledge management terms, these meetings serve as socialisation spaces (Panahi et al., 2012:1098), enabling tacit knowledge exchange through storytelling and observation. However, the autocratic tendencies reported by participants show how hierarchical gatekeeping may stifle inclusive knowledge flows, reducing the community's intellectual capital (Mullin and Kotval (2022:7). Comparatively, similar gatherings in Maqiao town, China, gave villagers a platform to engage with local government on land and relocation issues (Zhang & Perkins, 2022:13), while in this study, rural women voiced limited agency in decision-making.

This finding extends earlier research by highlighting how power asymmetries constrain knowledge circulation, even in communal spaces intended for inclusivity. For practitioners, this suggests that development agencies should frame village meetings not merely as information-dissemination platforms but as participatory KM processes, where women's voices are deliberately incorporated to strengthen equity and knowledge justice.

4.4 Meetings Called by Religious Leaders and Institutions

It was observed that knowledge-sharing gatherings led by religious leaders and institutions serve as significant and effective platforms for knowledge sharing practices. This can be attributed to the religious beliefs entrenched within the study communities. Specifically, the communities exhibit strong adherence to Islamic faith, with rural women regularly attending the mosque on Friday. Given their reverence for Muslim religious figures and institutions, they readily adhere to their guidance (Anshel & Smith, 2014:11). Marriage is viewed as an act of devotion to God in the northern region of Ghana (Sarfo, Yendork & Naidoo, 2021). Consequently, families are inclined to support early marriages for their daughters. Concurring to this, the Quran and Hadith doctrines emphasise the duty of rural women to respect and obey their husbands (Afolayan, 2021:79). The prescribed role of women within the household, as outlined in the Quran, likely influences rural women's propensity to adopt certain viewpoints, including expressing themselves and contesting particular decisions put forth by their spouses. Sukadi, Ratomi, and Ningsih (2021:69) posit that gender disparities within Islamic communities may stem from misconceptions surrounding Islamic teachings pertaining to the roles of women and children in the family. Rural women are nurtured not to question the religious rules and traditional rites set forth by these leaders and institutions, as elaborated above.

Ancestors and divinities are frequently invoked to explain events and occurrences within the communities, mirroring practices in rural districts across Ghana. Various studies have highlighted how these traditional beliefs and practices can pose obstacles to knowledge-sharing initiatives aimed at poverty eradication (Ahinkorah et al., 2021:3; Alatinga, Affah, & Abiiro, 2021:6; Bakari et al., 2021:497). The study also unearthed a fascinating tradition linked to the abundant yield of shea trees in a given year—the "funeral of the shea tree's mother" rite. This ceremony involves community members gathering beneath a shea tree to offer sacrifices and share a meal. The shared stories and food consumption under the shea tree, along with specific prayers, contribute to the perception that the shea trees yielded an exceptionally bountiful harvest that year. This highlights the importance of considering the religious beliefs of rural communities and their leaders when promoting knowledge-sharing practices among rural women.

4.5 The Benefits of Knowledge Sharing

The findings from the interviews, focus groups, and observations as noted in the following responses revealed that capitalising on the advantages of knowledge-sharing will foster greater engagement in knowledge-sharing practices.

> *"Knowledge sharing is very beneficial because when we get knowledge on various things, it will limit some of our challenges as women. Whenever our leaders go and learn something new and they sit idle without sharing with anyone, it doesn't benefit anyone but so far, all the knowledge that we share amongst ourselves, when we apply it, it benefits us." N-P3*

> *"When we meet and someone has knowledge on soap making, another has on new cropping, and others, we can all share and our lives will improve. Lack of knowledge sharing contributes more to our poverty. There are certain trades that we need training to be able to engage in, but there is no resource person to impart new knowledge to us, so we are always backwards." N-P4*

> *"If I had the money to make some shoes or soap with the information we had about creating them, it would have really helped. Farming alone is not enough to sustain our livelihood. Sharing knowledge helps us to have new ideas." N-P5*

Most participants acknowledged their limited exposure to external knowledge. For example, N-P1 articulated the belief that knowledgeable women not only prosper but also secure access to food. She further emphasised that withholding knowledge from others can have serious consequences. Some of the interviewees highlighted the value of financial management resulting from the knowledge provided by an NGO to the communities. whereby these women were provided with savings boxes during their Friday gatherings to encourage saving. According to N-P1, without this knowledge, they would not have been able to set aside funds to support one another in times of need. N-P2 also emphasised that shared knowledge serves as a catalyst for generating fresh ideas, inspiring individuals to embark on new endeavors.

Other benefits identified from knowledge sharing for poverty alleviation as noted in the various responses below; were fostering peace and unity through shared prosperity (TIN-P8 and TIN P3), promoting community development and enhancement (TIN-P8 and TIN-P5), leading to transformed lives (TIN-P4), reducing dependency (TON-P5) increased agricultural yields, generates employment opportunities, and ultimately contributes to poverty eradication

> *"Knowledge sharing foster social cohesion in the community as everybody shares what they know. Because we will be sharing all we have with each other, we will progress together." TIN-P3*

> *"In this community, about three households migrated to the towns due to the lack of exposure to any new thing in the community. If knowledge that can help this community existed, they wouldn't have migrated. It will be great to get some people to come and enlighten us on certain areas. Migration should not be the only way out." TIN-P1*

TON-P6 added

> *"If you give me some knowledge and I also give it to another person, the knowledge will circulate through the whole village and the whole community will benefit"*

TON-P8 also said

> *"If you are patient enough to acquire knowledge of a certain skill and someone is also patient enough to learn from you, when that knowledge is applied, it will help to eradicate poverty. However, when you have knowledge and keep it to yourself, poverty eradication cannot be reached. However, it takes time for a person to benefit from the knowledge and it takes patience to fully benefit from knowledge shared."*

TON-P10 also exclaimed.

> *"Absence of knowledge can kill you!"*

The focus group discussions and direct observations below further affirmed the significant advantages of knowledge sharing, that which motivated them to continue exchanging knowledge.

> *"We are unable to talk because we have not been exposed to discussions like this where our views seem relevant." TIN-SP2*

"We are unable to talk because we have no work or any experience." TIN-SP3

"When we meet as women, we just sit to listen while only few women talk about their successes and instruct us." TON-SP1

"The culture of our community has also trained us to be quieter than contribute on issues." TON-SP2

"During our meetings, the only people who talk are those who have some knowledge and experience in sharing knowledge, while the rest listen." N-SP1

It was observed that only a limited number of rural women actively participated in the various focus group discussions. When inquired about their level of participation, it was revealed that the majority of vocal participants were those who had previously benefited from external knowledge sources or had attended workshops and training sessions tailored for rural women.

This aligns with Social Capital Theory, where trust-based reciprocity facilitates resource pooling and resilience. From an intellectual capital lens, rural women's practices generate human capital (skills, health knowledge), structural capital (community routines and savings schemes), and relational capital (trust-based ties). Together, these intangibles underpin the community's capacity for poverty alleviation (Ahmed, Seleim & Khalil, 2011). Evidence from other studies affirms these benefits. Ingutia and Sumelius (2022:149) linked group knowledge sharing with better market access and credit, while Sari, Kumalasari & Zunaidah (2021:753) found higher agricultural productivity. This study extends these findings by showing that KS also fosters migration resilience, as some participants argued that access to knowledge could reduce rural-urban migration (TIN-P1).

5. Recommendations for Improving Knowledge-Sharing Practices for Poverty Eradication Among Rural Women

The paper explored the knowledge-sharing practices for poverty eradication among rural women in Ghana's northern region to make recommendations that will enhance knowledge sharing. Although the findings revealed that rural women engage in a variety of knowledge-sharing practices, there were several draw backs detected in the knowledge sharing practices These limitations; such as overreliance on informal family ties, misinformation from self-proclaimed experts, irregular Communities of Practice, and hierarchical gatekeeping in village meetings highlight the need for interventions that strengthen both the quality and inclusiveness of knowledge flows. The following subsections present practical recommendations grounded in the empirical findings, linked to knowledge management frameworks and informed by relevant development policy models, including the UN Sustainable Development Goals (SDGs).

5.1 Formal Mentorship Centres

The findings indicated a heavy reliance on informal sources such as spouses and self-proclaimed experts for knowledge related to health, agriculture, water management, and sanitation. While such reliance aligns with tacit knowledge sharing mechanisms highlighted in Social Capital Theory (e.g., trust and relational proximity), it also exposes women to misinformation and limits their agency. To improve this, we recommend the establishment of community-based mentorship centres, designed to function as knowledge repositories (Fombad, 2018:9) and hubs for structured tacit-to-explicit knowledge conversion (Nonaka & Takeuchi, 1995). Such centres would also embody the idea of "community intellectual capital" (Bardy, Rubens & Eberle, 2017), where local wisdom is systematically integrated with external expertise to create sustainable development outcomes.

These centres should be embedded within Ghana's local governance structures and linked to District Assemblies and the Ministry of Gender, Children and Social Protection, thereby supporting the goals of SDG 5 (Gender Equality) and SDG 1 (No Poverty). Where formal centres are not feasible, mobile helpline projects, coordinated through partnerships between NGOs and local governments can offer timely, professional knowledge support (Papageorgiou, Singh, Papageorgiou, Chudasama, Bochtis & Stamoulis 2020). This also reinforces the KM enabler framework which emphasises the importance of technological access and organisational support structures in facilitating knowledge flows (Hislop, Bosua & Helms, 2018). For this to work effectively, infrastructure like electricity and mobile network coverage must be extended to underserved areas (UN Women, 2022; Amalba, Abantanga, Scherpbier & Mook, 2018:1).

5.2 Training and Motivational Programs

A recurring issue in the data was the negative attitudes of some extension officers, who displayed impatience or dismissiveness when rural women sought clarification. To address this, capacity-building programs should be implemented that go beyond technical training and include modules on gender sensitivity, participatory communication, and ethics of knowledge facilitation (Dike & Umunnakwe, 2010:227). From a KM perspective, this recommendation aligns with people-based enablers for knowledge-sharing, such as motivation, skill development and trust (Ekström & Dagfalk, 2020:5). As Ahmed, Seleim and Khalil (2011) argue, human and relational capital are central to knowledge creation—extension officers act as intermediaries in these flows and thus require sustained investment in their professional and ethical capacities.

Extension officers, as knowledge intermediaries, require ongoing professional development and incentive structures to maintain engagement in rural areas. These incentives may include career progression opportunities, financial and logistical support, and recognition for community service. Policy-wise, this recommendation supports the Ghana National Gender Policy's call for gender-responsive extension services and is consistent with the Agricultural Extension Policy Strategy under Ghana's Ministry of Food and Agriculture (Kweku et al., 2020). These frameworks promote inclusive knowledge dissemination as a tool for rural transformation. This, in turn, will facilitate the dissemination of knowledge, ultimately aiding rural women in their pursuit to alleviate poverty.

5.3 Critical Success Factors for Knowledge Sharing

Effective knowledge sharing requires more than access to information; it requires an enabling environment that activates social, cognitive and technological capital. Drawing on the findings, we identify several critical success factors consistent with KM system thinking and Social Capital Theory. In our paper on knowledge strategies for poverty eradication, we examined these critical factors under the theme "Driving Elements for Sharing Knowledge for Poverty Eradication" (Bonuedie & Fombad, 2024:13). We stress the same points here. Leadership and emotional intelligence training can enable women to mobilise knowledge resources, lead community initiatives and develop community-level knowledge leadership. Adult literacy programs enhance the ability to articulate and exchange knowledge, improving the quality of both explicit and tacit knowledge flows. This responds to individual-level barriers to knowledge sharing, such as self-efficacy and confidence (Sitar, Bogilović & Pahor, 2018). Cultural alignment and trust are essential. KM literature shows that trust, respect and mutual obligation (key tenets of Social Capital Theory) are foundational for successful tacit knowledge exchange (Appiah, Fadiji, Wissing & Schutte, 2021:9). This study reinforces that insight by demonstrating how women's cliques and family-based exchanges serve as reservoirs of bonding capital but require deliberate integration with bridging capital to avoid knowledge silos. Thus, knowledge-sharing practices must be culturally embedded rather than externally imposed. Gender equity campaigns should not only promote inclusion but also address structural power imbalances that affect access to and control over knowledge. Such campaigns support relational knowledge access, which is critical for overcoming entrenched barriers in patriarchal societies. Inkinen (2016) emphasises that intellectual capital thrives in contexts where social, human, and structural capital interact dynamically—suggesting that KM practitioners must design interventions that link trust, skills, and systems to unlock the full potential of women's KS practices.

5.4 Contribution to Knowledge Management Theory

By exploring how rural women share knowledge informally under resource constraints, the study broadens KM's application beyond corporate and organisational settings. It confirms that tacit knowledge sharing, as theorised in Nonaka's SECI model (Nonaka & Takeuchi, 1995) and Social Capital Theory (Putnam et al., 2004), is highly relevant in non-institutionalised, community-driven environments. The study extends current understanding of KM enablers by showing how trust, reciprocity, and cultural norms identified by Hislop, Bosua and Helms (2018) as critical KM enablers, function effectively in rural Ghanaian contexts where technological and structural resources are limited. It stresses the importance of integrating KM with development policy frameworks, positioning knowledge sharing as a socio-political process, not just an operational function.

5.5 Theoretical and Practical Contribution

Theoretically, this study contributes to the KM and intellectual capital literature by foregrounding informal, socially embedded knowledge-sharing practices in rural, non-corporate contexts. It critiques the corporate bias of mainstream KM, showing that gendered and indigenous knowledge systems—rooted in bonding and bridging social capital, represent vital forms of intellectual capital that generate social and economic value when shared effectively. Drawing on Bardy, Rubens and Eberle (2017), the study highlights how combining indigenous

knowledge with external resources can strengthen community intellectual capital, reinforcing KM's role as a developmental rather than purely organisational discipline.

In practical terms, the study offers insights for KM strategies in development practice. It demonstrates that interventions designed by NGOs, governments, and agencies must prioritise social trust, cultural embeddedness, and gender sensitivity as enabling conditions for knowledge flow. By illustrating how rural women use informal networks, cliques, and Communities of Practice as knowledge nodes, the findings show how KM enablers such as leadership, motivation, and supportive structures (Inkinen, 2016) can be adapted to non-western, resource-constrained contexts. Furthermore, the study positions informal knowledge-sharing systems as critical to achieving SDG 1 (No Poverty) and SDG 5 (Gender Equality), providing a blueprint for aligning KM strategies with global development policy.

In sum, this study expands KM theory by adapting it to non-western realities, critiques the dominance of corporate KM models, and demonstrates how intellectual and social capital can be mobilised through culturally grounded, gender-responsive knowledge-sharing practices to enhance poverty eradication.

6. Conclusion

This paper investigated the central research question: "What are the knowledge-sharing practices for poverty eradication among rural women in the northern region of Ghana?" The study focused on rural women in the Tintang, Tongnoli, and Nagbali communities in Ghana's northern region, and employed a qualitative methodology grounded in an interpretive paradigm. This approach enabled the collection of rich, context-specific insights, allowing rural women, most of whom are illiterate to express themselves in their dialects and communicate their lived experiences. In addressing the research objectives, the study demonstrated that informal networks such as family circles, social cliques, religious gatherings, and Communities of Practice serve as vital platforms for knowledge exchange and resource access among rural women. These practices are not only critical for daily survival but also for long-term poverty reduction and community resilience. The findings revealed a diverse range of knowledge-sharing practices, including interactions with extension officers, exchanges within family and social circles, engagement with self-proclaimed experts, participation in village meetings, involvement in Communities of Practice, and attendance at knowledge sessions led by religious institutions. While these practices were largely informal and community-driven, they reflect strong social capital dynamics and underscore the importance of relational networks in facilitating knowledge exchange. The paper further identified structural and individual barriers to effective knowledge-sharing, such as limited access to expert knowledge, technological challenges, and poor attitudes among some extension officers. The study offered three major recommendations: (1) the creation of formal mentorship and knowledge centers or mobile helplines staffed by qualified professionals; (2) improved training and motivational support for extension officers; and (3) investment in critical success factors such as adult literacy, leadership development, and accessible ICT tools. These recommendations are linked to both practical development models and knowledge management theories, particularly Social Capital Theory, which explains how trust, reciprocity, and informal networks facilitate the exchange of tacit knowledge crucial to rural development.

Theoretically, the study contributes to KM literature by foregrounding informal, socially embedded knowledge-sharing practices in non-corporate, rural contexts. It demonstrates that expanding KM theory to include indigenous and gendered practices enriches our understanding of how knowledge flows operate outside organisational settings. By applying Social Capital Theory and intellectual capital perspectives, the paper highlights how trust, reciprocity, and relational networks function as intangible assets that underpin rural women's livelihoods and poverty alleviation strategies.

Like all research, this study has limitations. Its findings are geographically bound to three communities in Ghana's northern region and may not be generalisable to other rural settings. The reliance on self-reported data also introduces the possibility of recall bias or social desirability effects. Future research should explore comparative studies across different regions and cultural contexts, employ mixed-method approaches to combine qualitative depth with quantitative breadth, and assess the measurable impact of knowledge-sharing practices on specific outcomes such as maternal health, food security, climate adaptation, and women's employment.

AI Declaration: No AI tools were utilized in the creation of this paper

Ethics Declaration: This document outlines the findings of a PhD student at the University of South Africa. The study was conducted in accordance with UNISA's ethical clearance standards, ensuring that all sources were

appropriately acknowledged, complete citations were provided, and a declaration affirming the originality of the work was signed. After receiving approval from the university, the researcher sought permission from the Mion District Assembly to carry out the study in three rural communities within their jurisdiction.

References

Abane, A.M., Mariwah, S., Owusu, S.A., Kasim, A., Robson, E. and Hampshire, K. (2021) 'Mobile phone use and the welfare of community health nurses in Ghana: An analysis of unintended costs', *World Development Perspectives*, **23**, p. 100317.

Adatara, P., Strumpher, J. and Ricks, E. (2019) 'A qualitative study on rural women's experiences relating to the utilisation of birth care provided by skilled birth attendants in the rural areas of Bongo District in the Upper East Region of Ghana', *BMC Pregnancy and Childbirth*, **19**(1), pp. 1–8.

Afolayan, G.E. (2021) *Non formal education as a tool for empowering girls and women in a religiously conservative context: The case of northern Nigeria*. Doctoral thesis. Murdoch University.

Agndal, H., & Nilsson, U. (2006). Generation of human and structural capital: Lessons from knowledge management. *Electronic Journal of Knowledge Management*, *4*(2), pp. 91-99.

Ahadzie, D., Dinye, I.N. and King, R.S. (2021) 'Weathering the storm', in Reframing the Urban Challenge in Africa. New York: *Routledge*, p. 152.

Ahinkorah, B.O., Seidu, A.A., Budu, E., Agbaglo, E., Appiah, F., Adu, C., Archer, A.G. and Ameyaw, E.K. (2021) 'What influences home delivery among women who live in urban areas? Analysis of 2014 Ghana demographic and health survey data', *PLOS ONE*, **16**(1), p. e0244811.

Ahmed A.S., Seleim, O. and Khalil E.M. (2011). Understanding the knowledge management intellectual capital relationship: a two-way analysis. *Journal of Intellectual Capital*. 12 (4): pp. 586-614.https://doi.org/10.1108/14691931111181742

Aji, H.K.D., Binowo, K., Sensuse, D.I. and Lusa, J.S. (2024) 'A case study on the critical success factors for knowledge management implementation', *Journal of System and Management Sciences*, **14**(3), pp. 466–483. Available at: https://www.aasmr.org/jsms/Vol14/No.3/Vol.14.No.3.27.pdf (Accessed: 8 June 2025).

Akhter, J. and Cheng, K. (2020) 'Sustainable empowerment initiatives among rural women through microcredit borrowings in Bangladesh', *Sustainability*, **12**, p. 2275.

Al Hilali, K.S., Mughairi, A.I., Kian, B.M., M.W. and Karim, A.M. (2020) 'Coaching and mentoring**:** concepts and practices in development of competencies: a theoretical perspective', *International Journal of Academic Research in Accounting, Finance and Management Sciences*, **10**(1), pp. 41–54.

Al-Alawi, A.I., Al-Marzooqi, N.Y. and Mohammed, Y.F. (2007) 'Organizational culture and knowledge sharing: critical success factors', *Journal of Knowledge Management*, **11**(2), pp. 22–42.

Alatinga, K.A., Affah, J. and Abiiro, G.A. (2021) 'Why do women attend antenatal care but give birth at home? A qualitative study in a rural Ghanaian district', *PLOS ONE*, **16**(12), p. e0261316.

Ali, L. and Avdic, A. (2015) 'A knowledge management framework for sustainable rural development: the case of Gilgit-Baltistan, Pakistan', *The Electronic Journal of Knowledge Management*, 13(2), pp. 103–165. Available at: https://academic-publishing.org/index.php/ejkm/article/view/1048 (Accessed: 15 November 2022).

Amalba, A., Abantanga, F.A., Scherpbier, A.J. and Van Mook, W.N.K.A. (2018) 'Working among the rural communities in Ghana – why doctors choose to engage in rural practice', *BMC Medical Education*, 18(1), pp. 1–9.

Amati, V., Meggiolaro, S., Rivellini, G. and Zaccarin, S. (2018) 'Social relations and life satisfaction: the role of friends', *Genus*, 74(1), pp. 1–18.

Ampofo, A.G., Adumatta, A.D., Owusu, E. and Awuviry-Newton, K. (2020) 'A cross-sectional study of barriers to cervical cancer screening uptake in Ghana: An application of the health belief model', *PLOS ONE*, 15(4), pp. 1–16.

Anshel, M.H. and Smith, M. (2014) 'The role of religious leaders in promoting healthy habits in religious institutions', *Journal of Religion and Health*, 53(4), pp. 1046–1059.

Antwi-Agyei, P. and Stringer, L.C. (2021) 'Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana', *Climate Risk Management*, 32, p. 100304.

Appiah, R., Fadiji, W.A., Wissing, M.P. and Schutte, L. (2021) 'Participants' experiences and impressions of a group-based positive psychology intervention programme for rural adults in Ghana', *International Journal of Qualitative Studies on Health and Well-being*, 16(1), p. 1891760.

Argote, L., Ingram, P., Levine, J.M. and Moreland, R.L. (2000) 'Knowledge transfer in organizations: Learning from the experience of others', *Organizational Behavior and Human Decision Processes*, 82(1), pp. 1–8.

Asiedu, N.K., Abah, M. and Dei, D.G.J. (2022) 'Understanding knowledge management strategies in institutions of higher learning and the corporate world: A systematic review', *Cogent Business & Management*, 9(1).

Available at: https://www.tksi.org/JOURNAL-KSI/PAPER-PDF-2014/2014-4-08.pdf (Accessed: 10 July 2021). Kucharska, W., & Bedford, D. (2024). The KLC Cultures' Synergy Power, Trust, and Tacit Knowledge for Organizational Intelligence. *Electronic Journal of Knowledge Management*, *22*(2), 18-35.

Bakari, A., Bell, A.J., Oppong, S., Woodford, J., Kaselitz, E. and Moyer, C.A. (2021) '"Asram" is really killing us here: attribution for pregnancy losses and newborn mortality in the Ashanti Region of Ghana', *Journal of Biosocial Science*, 53(4), pp. 497–507.

Banik, S., Sahu, D.P. and Bhattacharjya, H. (2022) 'Knowledge and practice regarding cervical cancer prevention among women in a rural area of Tripura, India', *International Journal of Community Medicine and Public Health*, 9(2), pp. 763–768.

Bardy, R., Rubens, A., & Eberle, P. (2017, March). Building intellectual capital for sustainable development: combining local wisdom and advanced knowledge. In *Proceedings of the European Conference on Intellectual Capital* (Vol. 3, pp. 18-25).

Bawah, A.A., Phillips, J.F., Asuming, P.O., Jackson, E.F., Walega, P., Kanmiki, E.W., Sheff, M.C. and Oduro, A. (2019) 'Does the provision of community health services offset the effects of poverty and low maternal educational attainment on childhood mortality? An analysis of the equity effect of the Navrongo experiment in Northern Ghana', *SSM - Population Health*, 7, p. 100335.

Bellerose, M., Alva, S., Magalona, S., Awoonor-Williams, K. and Sacks, E. (2021) 'Supervision of community health nurses in Ghana: A mixed-methods study on experiences and mentorship needs', *Health Policy and Planning*, 36(5), pp. 720–727.

Bishop, C. (2019) *Enabling young rural women to participate in rural transformation in East and Southern Africa*. Rome: FAO. Available at: https://www.fao.org/3/CA3434EN/ca3434en.pdf (Accessed: 19 June 2020).

Boateng, H. (2018) *Knowledge creation and knowledge flow within Ghana's Kente industry: a social capital perspective*. Doctoral dissertation. University of Ghana, Legon, Ghana.

Bonuedie, B., & Fombad, M. (2025, August 29). *Types of knowledge shared among rural women in the Northern Region of Ghana for poverty eradication*. In *Proceedings of the 26th European Conference on Knowledge Management* (Vol. 1). https://doi.org/10.34190/eckm.26.1.3831

Bonuedie, B.M. and Fombad, M.C. (2024) 'Knowledge-sharing strategies for poverty eradication among rural women', *Libri*, 74(1), pp. 55–70.

Braun, V. and Clarke, V. (2006) 'Using thematic analysis in psychology', *Qualitative Research in Psychology*, 3(2), pp. 77–101. DOI: 10.1191/1478088706qp063oa.

Canadian International Development Agency (CIDA) (2003) *Knowledge sharing methods, meetings and tools*. Available at: http://www.km4dev.org/forum/topics/knowledge-sharing-methods-1 (Accessed: 17 May 2019).

Christensen, B. (2018). The process of creating value with intellectual capital practice as an intangible asset in communities of practice in the SME: An empirical case study. *Electronic Journal of Knowledge Management*, *16*(2), pp. 73-83.

Chua, A. (2002) 'The influence of social interaction on knowledge creation', *Journal of Intellectual Capital*, 3, pp. 375–392.

Committee for Economic Development (CED) (2003) *Reducing global poverty: the role of women in development: a statement by the research and policy committee of the Committee for Economic Development*. New York: CED. Available at: http://www.ced.org/docslrenort/reportglobalizationwomen.Pdf (Accessed: 10 July 2024).

Cronkleton, P., Evans, K., Addoah, T., Dumont, S.E., Zida, M. and Djoudi, H. (2021) 'Using participatory approaches to enhance women's engagement in natural resource management in northern Ghana', *Sustainability*, 13, 7072.

Cummings, S., Seferiadis, A.A., Maas, J., Bunders, J.F.G. and Zweekhorst, M.B.M. (2019) 'Knowledge, social capital and grassroots development: insights from rural Bangladesh', *The Journal of Development Studies*, 55(2), pp. 161–176.

Cyr, S. and Choo, C.W. (2010) 'The individual and social dynamics of knowledge sharing: an exploratory study', *Journal of Documentation*, 67(1), pp. 824–826.

Dadzie, S.K., Ndebugri, J., Inkoom, E.W. and Akuamoah-Boateng, S. (2022) 'Social networking and risk attitudes nexus: implication for technology adoption among smallholder cassava farmers in Ghana', *Agriculture & Food Security*, 11(1), p. 41.

Davenport, T. and Prusak, L. (1998) *Working knowledge: how organizations manage what they know*. Boston, MA: Harvard University Press.

Dery, J.D. (2018) 'Assessing the role of the assembly member in promoting local level development in the Lawra district of Upper West Region, Ghana', MA term paper, University for Development Studies, Ghana.

Désilets, L. and Fernet, M. (2019) *Exploring the impacts of women's economic empowerment initiatives on domestic violence*. Oxfam Research Reports.

Dike, C. and Umunnakwe, G. (2010) 'Role of academic seminars, conferences & workshops in the professional development of librarians'. Available at: https://www.researchgate.net/publication/334537714_Role_of_academic_seminars_Conferences_workshops_in_the_professional_Development_of_Librarians (Accessed: 19 May 2019).

Dixon, N.M. (2000) *Common knowledge: how companies thrive by sharing what they know*. Boston, MA: Harvard Business School Press.

Durand, F., Richard, L., Beaudet, N., Fortin-Pellerin, L., Hudon, A.M. and Tremblay, M.C. (2022) 'Healthcare professionals' longitudinal perceptions of group phenomena as determinants of self-assessed learning in organizational communities of practice', *BMC Medical Education*, 22(1), pp. 1–11.

Economic Commission for Latin America and the Caribbean (ECLAC). (2010). Knowledge management for development: towards a practical approach for the Caribbean. https://repositorio.cepal.org/bitstream/handle/11362/38264/1/LCCARL234Rev1_en.pdf (Accessed 17 May 2025).

Eger, C., Miller, G. and Scarles, C. (2018) 'Gender and capacity building: a multi-layered study of empowerment', *World Development*, 106, pp. 207–219.

Eldo, D.H.A.P., Habibullah, A., Zainudin, A. and Tasirin, T. (2022) 'Good village governance: analysis implementation good governance in the village Kupu, Brebes Regency', in *2nd International Conference on Social Science, Humanities, Education and Society Development (ICONS 2021)*, pp. 212–219. Atlantis Press.

Ewen, H.H., Dassel, K.B., Chahal, J.K., Roberts, A.R. and Azugbene, E. (2019) 'Social lives and cliques within senior housing communities', *Housing and Society*, 46(3), pp. 129–143.

Food and Agriculture Organization (FAO) (2011) *Communicating gender for rural development: integrating gender in communication for development*. Belgium. Available at: http://www.fao.org/3/am319e/am319e00.pdf (Accessed: 7 July 2019).

Food and Agriculture Organization (FAO) (2019a) *Agricultural extension manual*, Khalid, S.M.N. and Sherzad, S. (eds). Apia.

Food and Agriculture Organization (FAO) (2019b) *Legal measures to eradicate rural poverty. Legal Brief for Parliamentarians in Africa No. 7*. Available at: https://www.fao.org/3/ca3524en/ca3524en.pdf (Accessed: 17 July 2020).

Food and Agriculture Organization (FAO) and ECOWAS (2018) *National gender profile of agriculture and rural livelihoods – Ghana*. Country gender assessment series, Accra. Available at: http://www.fao.org/3/am307e/am307e00.pdf (Accessed: 24 June 2019).

Fox, L., Wiggins, S., Ludi, E. and Mdee, A. (2018) *The lives of rural women and girls: what does an inclusive agricultural transformation that empowers women look like?* ODI Report, pp. 1–145. Available at: https://www.odi.org/sites/odi.org.uk/files/resource-documents/12466.pdf (Accessed: 15 July 2019).

Frias-Navarro, R. and Montoya-Restrepo, L.A. (2020) 'Understanding knowledge creation processes among rural communities in post-conflict settings in Colombia', *Knowledge Management & E-Learning: An International Journal*, 12(2), pp. 231–255.

Frimpong, A.A., Williams, K.A., Akinbobola, B.A., Kyeremeh, E.A. and Kwarteng, N.A. (2018) 'Organizational performance: a case of Techiman Municipal Assembly, Ghana', *European Journal of Business and Management*, 10(29), pp. 37–50.

Gamble, J. (2020) 'Tacit vs explicit knowledge as antecedents for organizational change', *Journal of Organizational Change Management*. Ahead-of-print. Available at: https://www.researchgate.net/publication/344842754_Tacit_vs_explicit_knowledge_as_antecedents_for_organizational_change (Accessed: 15 July 2020).

Gassara, G. and Chen, J. (2021) 'Household food insecurity, dietary diversity, and stunting in Sub-Saharan Africa: a systematic review', *Nutrients*, 13(12), p. 4401.

Ghana Living Standards Survey Round 7 (GLSS 7) (2018) *Poverty trends in Ghana 2005-2017*. Ghana Statistical Service. Available at: http://www2.statsghana.gov.gh/docfiles/publications/GLSS7/Poverty%20Profile%20Report_2005%20-%202017.pdf (Accessed: 27 April 2019).

Ghana Statistical Service (2021) *2021 Population and Housing Census: Summary Report of Final Results*. Available at: https://statsbank.statsghana.gov.gh

Ghana Statistical Service (GSS) (2014) *District analytical report, Mion district*. Available at: http://www2.statsghana.gov.gh/docfiles/2010_District_Report/Northern/Mion.pdf (Accessed: 2 August 2019).

Ghana's Decentralization Policy (2010). Ministry of Local Government and Rural Development, Government of Ghana.

Harris-Fry, H., Saville, N.M., Paudel, P., Manandhar, D.S., Cortina-Borja, M. and Skordis, J. (2022) 'Relative power: explaining the effects of food and cash transfers on allocative behaviour in rural Nepalese households', *Journal of Development Economics*, 154, p. 102784.

Hendricks, B. (2021) 'Knowledge sharing: definition & process'. Available at: https://study.com/academy/lesson/knowledge-sharing-definition-process.html (Accessed: 20 April 2021).

Hislop, D., Bosua, R. and Helms, R. (2018) *Knowledge management in organizations: a critical introduction*. Oxford: Oxford University Press.

Hlongwane, Z.T., Slotow, R. and Munyai, T.C. (2021) 'Indigenous knowledge about consumption of edible insects in South Africa', *Insects*, 12(1), p. 22.

Hooff, B. and Ridder, J. (2004) 'Knowledge sharing in context: the influence of organizational commitment, communication climate and CMC use on knowledge sharing', *Journal of Knowledge Management*, 8(6), pp. 117–130. https://doi.org/10.1108/13673270410567675.

Igbinovia, MO, Ikenwe IJ. (2017). 'Knowledge management: processes and systems. *Information impact: Africans Journal Online,* 8(3), pp.26-38.

Ingutia, R. and Sumelius, J. (2022) 'Do farmer groups improve the situation of women in agriculture in rural Kenya?', *International Food and Agribusiness Management Review*, 25(1), pp. 135–156.

Inkinen, H. (2016). Review of empirical research on knowledge management practices and firm performance. *Journal of knowledge management*, *20*(2), pp. 230-257.

International Institute for Sustainable Development (IISD) (2014) *Rural women, partner in the development process*. Available at: https://www.iisd.org/system/files/publications/rural_women_partner_developmentprocess.pdf (Accessed: 16 April 2021).

Jabeen, S., Haq, S., Jameel, A., Hussain, A., Asif, M., Hwang, J. and Jabeen, A. (2020) 'Impacts of rural women's traditional economic activities on household economy: changing economic contributions through empowered women in rural Pakistan', *Sustainability*, 12(7), p. 2731.

Kacperska, E. and Łukasiewicz, L. (2020) 'The importance of trust in knowledge sharing and the efficiency of doing business on the example of tourism', *Information*, 11(311), pp. 1–18.

Kambey, C.S., Campbell, I., Cottier-Cook, E.J., Nor, A.R., Kassim, A., Sade, A. and Lim, P.E. (2021) 'Evaluating biosecurity policy implementation in the seaweed aquaculture industry of Malaysia, using the quantitative knowledge, attitude, and practices (KAP) survey technique', *Marine Policy*, 134, p. 104800.

Khesal, S., Samadi, B., Andira, H., Musram, M. and Zohoori, M. (2013) 'The impact of trust on knowledge sharing', *Interdisciplinary Journal of Contemporary Research in Business*, 5, pp. 147–180.

Koloniari, M., Vraimaki, E. and Fassoulis, K. (2019) 'Factors affecting knowledge creation in academic libraries', *Journal of Librarianship and Information Science*, 51(1), pp. 20–33.

Kommey, R.E. (2020) *Knowledge sharing practices among rice farmers in the Eastern Region of Ghana*. Doctoral dissertation. Pretoria: University of South Africa.

Koranteng, F.N., Wiafe, I., Katsriku, F.A. and Apau, R. (2020) 'Understanding trust on social networking sites among tertiary students: an empirical study in Ghana', *Applied Computing and Informatics*. Emerald Publishing Limited.

Krumova, M.Y. and Milanezi, B.D. (2014) *Knowledge Sharing & Collaboration 2.0*.

Kweku, M., Manu, E., Amu, H., Aku, F.Y., Adjuik, M., Tarkang, E.E., Komesuor, J., Asalu, G.A., Amuna, N.N., Boateng, L.A. and Alornyo, J.S. (2020) 'Volunteer responsibilities, motivations and challenges in implementation of the community-based health planning and services (CHPS) initiative in Ghana: qualitative evidence from two systems learning districts of the CHPS+ project', *BMC Health Services Research*, 20(1), pp. 1–13.

Kwon, O.Y. (2019) 'Social trust: its concepts, determinants, roles, and raising ways', in *Social Trust and Economic Development: the case of South Korea*. Cheltenham: Edward Elgar Publishing Limited, pp. 19–49.

Liu, J., Qu, H., Huang, D., Chen, G., Yue, X., Zhao, X. and Liang, Z. (2014) 'The role of social capital in encouraging residents' pro-environmental behaviors in community-based ecotourism', *Tourism Management*, 41, pp. 190–201.

Lwoga, E.T., Stilwell, C. and Ngulube, P. (2010) 'The management of indigenous knowledge with other knowledge systems for agricultural development: challenges and opportunities for developing countries'. Available at: https://www.researchgate.net/publication/228789003 (Accessed: 3 July 2019).

Manamela, B.E. (2018) *Knowledge-sharing practices by legal information professionals at Hogan Lovells: law firm in South Africa and England*. Thesis. Pretoria: University of South Africa.

Mchombu, K.J. and Mchombu, C.M. (2014) 'The role of information and knowledge in poverty eradication in Africa: a case study of Namibia', *International Federation of Library Associations (IFLA)*, Lyon, France. Available at: http://library.ifla.org/id/eprint/996 (Accessed: 15 June 2019). DOI: 10.13140/2.1.3116.6244.

Morgan, F. 2016. Geometric measure theory: a beginner's guide. Academic press.

Mtega, W.P., Dulle, F.W. and Benard, R. (2013) 'Understanding the knowledge sharing process among rural communities in Tanzania: a review of selected studies', *Knowledge Management and E-learning*, 5(2), pp. 205–217. Available at: http://41.73.194.142/bitstream/handle/123456789/1159/Benard%201.pdf?sequence=1&isAllowed=y (Accessed: 16 June 2019).

Mullin, J.R. and Kotval, Z. (2022) 'William Wood, the American woolen company and the creation of a model mill village in Shawsheen, Massachusetts', *Journal of Urban History*. DOI: 00961442221076875.

Nachinab, G.T.E., Adjei, C.A., Ziba, F.A., Asamoah, R. and Attafuah, P.A. (2019) 'Exploring the determinants of antenatal care services uptake: a qualitative study among women in a rural community in northern Ghana', *Journal of Pregnancy*, p. 353274.

Nonaka, I, & Takeuchi H. 1995. *The Knowledge-Creating Company*, Oxford University .Press.

N-yanbini, N.N. and Owusu-Ansah, J.K. (2024) 'Women's land access and gendered outcomes in Northern Ghana', *Journal of Land and Rural Studies*, 12(2), pp. 198–218.

Ofori, D., Osei, A., Ato-Mensah, S. and Affum, E.K. (2015) 'Innovation and knowledge sharing: a new competitive advantage in the mobile telecommunication industry in Ghana', *Science Journal of Business and Management*, 3(5), pp. 157–163.

Ofosu-Baadu, B. (2012) 'Women in rural Ghana', 4th Global Forum on Gender Statistics, Dead Sea, Jordan, March 25–29.

Onofre, I. and Teixeira, L. (2022) 'Critical factors for a successful knowledge management implementation: evidence based on a systematic literature review', *Electronic Journal of Knowledge Management*, 20(2), pp. 1–93.

Osei, C.D. and Zhuang, J. (2020) 'Rural poverty alleviation strategies and social capital link: the mediation role of women entrepreneurship and social innovation', *Sage Open*, 10(2), p. 2158244020925504.

Panahi, S., Watson, J. and Partridge, H. (2012) 'Social media and tacit knowledge sharing: developing a conceptual model', *International Journal of Humanities and Social Sciences*, 6(4), pp. 648–655.

Papageorgiou, K., Singh, P.K., Papageorgiou, E., Chudasama, H., Bochtis, D. and Stamoulis, G. (2020) 'Fuzzy cognitive map-based sustainable socio-economic development planning for rural communities', *Sustainability*, 12(1), p. 305.

Plutshack, V., Merck, A. and Free, J. (2022) '"Women work particularly well in community organizations": cultivating community and consumerism in the Comanche County REA Women's Club, 1939–1940'.

PMA (Performance Monitoring for Action) (2015) *PMA 2020 SDG indicator brief, Ghana – Round 4*. Available at: https://www.pma2020.org/sites/default/files/SDG-Indicator%20brief%20ghana-v5-2017-04-17.pdf (Accessed: 27 May 2019).

Putnam, R., Ivan, L., Xavier, D.B., William, M.R., Avis, C.V., Hutchinson, J., Gress, J. and Woolcock, M. (2004) 'Using social capital to help integrate planning theory, research, and practice: preface', *Journal of the American Planning Association*, 70(2), pp. 142–192.

Qureshi, I., Sutter, C. and Bhatt, B. (2017) 'The transformative power of knowledge sharing in settings of poverty and social inequality', *Organization Studies*, 39(11), pp. 1575–1599. https://doi.org/10.1177/0170840617727777.

Rani, P. and Narang, H.S. (2022) 'Role of women in entrepreneurship and business management', *New Horizons in Business World*, 35.
Rusuli, M.S.C. and Tasmin, R. (2010) 'Knowledge sharing practice in organization', *International Conference on Ethics and Professionalism (ICEP 2010)*.
Sarfo, E.A., Yendork, J.S. and Naidoo, A.V. (2021) 'Examining the intersection between marriage, perceived maturity and child marriage: perspectives of community elders in the Northern region of Ghana', *Culture, Health & Sexuality*, 23(7), pp. 991–1005.
Sari, Y.K.P., Kumalasari, R.D. and Zunaidah, A. (2021) 'Social economic impact of communication network pattern of rural women community in Malang Regency', *Proceedings of the International Conference on Industrial Engineering and Operations Management Bangalore, India*, August 16–18, 2021.
Sayyadi, M. (2019) 'How effective leadership of knowledge management impacts organizational performance', *Business Information Review*, 36(1), pp. 30–38.
Serrat, O. (2017) 'Conducting peer assists', in *Knowledge Solutions*, pp. 815–821. Available at: https://www.adb.org/sites/default/files/publication/27574/conducting-peer-assists.pdf.
Shongwe, M. M. (2016). An analysis of knowledge management lifecycle frameworks: Towards a unified framework. *Electronic Journal of Knowledge Management*, *14*(3), pp140-153.
Sitar, A.S., Bogilović, S. and Pahor, M. (2018) 'The relationship between informal knowledge sharing network and individual learning in organizations: does the structuring of activities matter?'. Available at: https://hrcak.srce.hr/file/317168 (Accessed: 20 September 2021).
Sukadi, I., Ratomi, A. and Ningsih, M.R. (2021) 'Legal interpretation: critical reasoning for the development of an Islamic paradigm that is friendly to women and children', in *International Conference on Law, Technology, Spirituality and Society (ICOLESS)*, September 1, pp. 67–80.
Sumadi, S., Ardhiarisca, O., Wijayanti, R.R. and Putra, R. (2022) 'Evaluation of development planning in Kemuning Lor village, Arjasa District, Jember Regency', in *2nd International Conference on Social Science, Humanity and Public Health (ICOSHIP 2021)*, pp. 33–39. Atlantis Press.
Tahleho, T.E. and Ngulube, P. (2022) 'Knowledge sharing and the improvement of service delivery in an academic library', *International Journal of Knowledge Management (IJKM)*, 18(1), pp. 1–13.
Talwar, S., Dhir, A., Singh, D., Virk, G.S. and Salo, J. (2020) 'Sharing of fake news on social media: application of the honeycomb framework and the third-person effect hypothesis', *Journal of Retailing and Consumer Services*, 57, p. 102197.
Taylor, G.G. and Ramos, I.L. (2016) 'Women at the forefront of knowledge sharing', *ICT Update*, (81), p. 8. Available at: http://ictupdate.cta.int/2016/01/22/women-at-the-forefront-of-knowledge-sharing/ (Accessed: 10 May 2019).
UN Women (2022) 'In focus: international women's day'. Available at: https://www.unwomen.org/en/news-stories/in-focus/2022/03/in-focus-international-womens-day (Accessed: 14 March 2022).
United Nations (1995) *Report of the World Summit for Social Development*. Copenhagen, 6–12 March 1995. Available at: https://www.un.org/development/desa/socialperspectiveondevelopment/issues/poverty-eradication.html (Accessed: 16 September 2019).
United Nations (UN) (2017) *The sustainable development goals report 2017*. New York. Available at: https://reliefweb.int/report/world/sustainable-development-goals-report-2017 (Accessed: 11 May 2019).
United Nations Development Programme (UNDP) (2006) *Poverty in focus*. International Poverty Centre. Available at: https://ipcig.org/pub/IPCPovertyInFocus9.pdf (Accessed: 16 September 2019).
Upali, P. (2013) *Role of women in rural development*. Colombo, Sri Lanka. Available at: https://www.researchgate.net/publication/284887895 (Accessed: 14 June 2019).
USAID (2020) *USAID/Ghana gender analysis report 2020*. Available at: https://banyanglobal.com/wp-content/uploads/2020/05/USAID-Ghana-Gender-Analysis-Report.pdf (Accessed: 16 October 2021).
Valdés, J.H., Muñoz, E.M., Ruíz, G.B., Lirios, C.G., Crespo, J.E. and Sepúlveda, J.G.M. (2024) 'Knowledge management in the literature from 2021 to 2024', *International Journal Linguistics of Sumatra and Malay*, 2(2), pp. 67–75. https://doi.org/10.32734/ijlsm.v2i2.15544.
van Coller-Peter, S. and Cronjé, J. (2020) 'The contribution of coaching and mentoring to the development of participants in entrepreneurial development programmes', *International Journal of Evidence Based Coaching and Mentoring*, 18(2), pp. 51–67. DOI: 10.24384/bg74-fc70.
Varamezov, L. (2024) 'Knowledge sharing barriers in Bulgarian companies – an empirical study', *Strategies for Policy in Science and Education*, 32(3s), pp. 72–85. https://doi.org/10.53656/str2024-3s-7-kno.
Wang, K. and Ko, N. (2012) 'Knowledge sharing practices of project teams when encountering changes in project scope: a contingency approach', *Journal of Information Science*, 38(5), pp. 423–441. DOI: 10.1177/0165551512445240.
Webber, E. and Dunbar, R. (2020) 'The fractal structure of communities of practice: implications for business organization', *PLoS ONE*, 15(4), pp. 1–15.
Wendo, D.R., Duncan, A. and Bosire, E. (2025) 'Effectiveness of knowledge sharing practices among youth entrepreneurs engaged in small and medium enterprise (SMEs) in Kenya', *Information Development*. DOI: 02666669251330874.
Wijesinghe, P.R.D. and Kathriarachchi, R.P.S. (2022) 'Employee knowledge sharing behaviour: the role of workplace cyber incivility and personality traits', *IJRC*, pp. 59–68.Woods, H., Haruna, U., Konkor, I. and Luginaah, I. (2019) 'The influence of the Community-based Health Planning and Services (CHPS) program on community health sustainability

in the Upper West Region of Ghana', *The International Journal of Health Planning and Management*, 34(1), pp. e802–e816.

Xu, L. and Li, Z. (2022) 'Factors affecting the knowledge sharing behaviors of university teachers: an empirical study in China', *International Journal of Information and Education Technology*, 12(1), pp. 36–42.

Xue, C.T.S. (2017) 'Literature review on knowledge management in organizations', *Research in Business and Management*, 4(1), p. 30. Available at: http://dx.doi.org/10.5296/rbm.v4i1.10786 (Accessed: [insert access date]).

Zamiri, M. and Esmaeili, A. (2024) 'Methods and technologies for supporting knowledge sharing within learning communities: a systematic literature review', *Administrative Sciences*, 14(1), p. 17.

Zhang, Y. and Perkins, D.D. (2022) 'Toward an empowerment model of community education in China', *Adult Education Quarterly*. DOI: 07417136211062252.

Appendix A: Interview Guide

INTERVIEW GUIDE

Name of Interviewer	
Interview Date	
Place of Interview	
Category of Interviewee (Rural woman/Stakeholder)	
Age of Interviewee	

PURPOSE OF THE STUDY

To investigate knowledge sharing practices for poverty eradication amongst rural women in the northern region of Ghana.

Subject		Question
Introduction		Name and introduction of the researcher Can you please tell me about yourself; age, occupation, marital status, educational level and number of children?
Poverty assessment (measuring the level of poverty)		**When you hear the word poverty, what comes to mind?** Who provides for your family? Is your family able to spend an average of GHS10.92 Ghana cedis on each family member per day? What are the effects of you or your provider not being able to provide such daily needs for the family? What would you say are major factors that contribute to poverty amongst women in your community? What social amenities or resources are available in your District? e.g. safe drinking water, sanitary facilities, health facilities, jobs, schools/informal training institutes, credit access, electricity, information and access to services. Would you say you and other women in your community have been denied certain choicaes and resources or had your rights violated in ways that contributes to a life of poverty?
"Knowledge sharing" knowledge		What does knowledge sharing means to you?
Main Research Questions		
5.	**Knowledge sharing practices amongst rural women**	**What are the knowledge sharing practices for poverty eradication amongst women here?** Whom do you depend on for knowledge on your health, agricultural activities, nutrition, water management, migration, education and employment amongst others? In your opinion, how does knowledge sharing help eradicate poverty amongst women in your community? How often do women in your community meet to share knowledge for poverty reduction? In what way does knowledge sharing benefit women in your community in terms of poverty eradication?

		Would you say a lack of knowledge sharing has contributed to increased poverty amongst women in your community? How will knowledge sharing help in eradicating poverty amongst women in your community?

Thank You!

7. Appendix B: Focus Group Guide

FGD GUIDE

Name of Interviewer	
FGD Date	
Place of FGD	
Category of Interviewee (Rural woman/Stakeholder)	
Number of Participants	

PURPOSE OF THE STUDY

To investigate knowledge sharing practices for poverty eradication amongst rural women in the Northern region of Ghana.

Topic Focus	Core Questions	Prompts and Expansion material
Opening	Name and introduction of the researcher as well as a round introduction of participants. Can each of you please tell me your name and occupation?	
Poverty assessment (measuring the level of poverty)	**When you hear the word poverty, what comes to mind?** What would you say are major factors that contribute to poverty amongst women in this community? What social amenities or resources are available in this community? e.g. safe drinking water, sanitary facilities, health facilities, jobs, schools/informal training institutes, credit access, electricity, information and access to services.	Denied choices and resources as well as violated rights? Role of parents, siblings, relations, friends, government, NGOs, church leaders
"Knowledge sharing" knowledge	What does knowledge sharing means to you?	Formal and informal knowledge
Main Research Questions		
Knowledge sharing practices amongst rural women	**What are the knowledge sharing practices for poverty eradication amongst women here?** Whom do you depend on for knowledge on your health, agricultural activities, nutrition, water management, migration, education and employment amongst others? In your opinion, how does knowledge sharing help eradicate poverty amongst women in your community? How often do women in your community meet to share knowledge for poverty reduction? In what way does knowledge sharing benefit women in your community in terms of poverty eradication? Would you say a lack of knowledge sharing has contributed to increased poverty amongst women in your community? How will knowledge sharing help in eradicating poverty amongst women in your community?	

Mapping Key Competencies for the Knowledge Society Era

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Abstract: The growing conceptual complexity and persistent ambiguity surrounding the definition and measurement of the Knowledge Society/Knowledge Economy (KS/KE) and its associated competencies point to an unresolved research gap, which may contribute to fragmented and insufficiently coordinated policy responses. While numerous frameworks describing 21st-century skills and competencies exist, their linkage to macro-level indicators capturing the performance of knowledge-based economies remains limited and methodologically underexplored. This paper addresses this gap by examining the methodological viability of systematically deriving key competencies for the KS/KE from Knowledge Economy Index (KEI) indicators and by assessing whether the resulting competency model demonstrates conceptual congruence with established 21st-century competency frameworks. The primary objective of the study is to develop and apply a novel and robust methodological framework for constructing a key competency model tailored to the contemporary socio-economic context of the KS/KE. The proposed approach is grounded in a systematic content analysis of existing KEIs and their constituent indicators. Specifically, the methodology is applied to a dataset comprising 301 indicators derived from four internationally recognised KEIs: the Global Knowledge Index (GKI), the Global Innovation Index (GII), the European Innovation Scoreboard – Summary Innovation Index (EIS- SII), and the Digital Economy and Society Index (DESI). A central methodological contribution of the study lies in the uniform semantic categorisation of all indicators and their systematic division into input indicators, capturing structural prerequisites and investments, and output indicators, reflecting achieved results and performance. This analytical structure enables the identification of key competencies that mediate the transformation of invested resources into measurable and socially desirable outcomes within KE. To assess the conceptual robustness of the proposed model, the resulting key competency model for KS/KE is validated against a reference database of competencies synthesised from authoritative policy and strategic documents issued by organisations such as the OECD, UNESCO, the European Commission, the Council of the European Union, the World Economic Forum, and the Partnership for 21st Century Learning. The validation confirms a high degree of conceptual alignment between the empirically derived competencies and established 21st-century competency frameworks. In addition, the study exploits an extensive longitudinal dataset of KEI indicators available since 2017 as the empirical basis for a model-based analysis of anticipated trends in key competency development over a forthcoming three-year horizon. Compared to traditional competency modelling approaches based on expert studies, job analyses, behavioural observations, Delphi methods, or surveys, the proposed model leverages dynamically updated KEI indicators, offering greater flexibility and responsiveness to rapid socio-economic change. At the societal level, the resulting KS/KE key competency model provides a foundation for preparing future knowledge workers, while at the organisational level it supports talent management practices and the development of organisation-specific competency models aimed at sustaining competitive advantage.

Keywords: Knowledge society, Knowledge economy, Knowledge index, Key competencies, Modelling methodology, Competency model, Prediction

1. Introduction

The major deployment of automation and scientific breakthroughs in the 1960s ended a long period of stability and marked the start of a phase of discontinuity that brought profound socio-economic changes—still ongoing today. Initially, the focus was on the growing role of computers and the increasing volumes of information, viewed positively as "energy for the work of the mind" (Drucker, 1992). This triggered prominent yet elusive socio-economic changes. Naming this phenomenon proved challenging. Early on, terms such as *information society, information revolution* (Robertson, 1990), *white collar revolution* (Gottmann, 1964), *post-industrial society* (Bell, 1973), *third wave society* (Toffler, 1980), etc. Later, the dark side—information overload—also became evident. Original expectations tied to the information society remained largely unfulfilled, likely due to a widespread failure to distinguish between information and knowledge. While an increase in knowledge and innovation was anticipated, digital information alone is only a prerequisite, not a sufficient condition, for such progress (Tsoukas, 1997; Cohen and Garasic, 2024). Competent individuals are needed to navigate this information and transform information into applicable knowledge and innovation (Sugiyama and Meyer, 2008; Nonaka and Takeuchi, 1995) at both the micro and macroeconomic levels. Among the required competencies,

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critical thinking is the most frequently emphasised, as it involves the analysis, evaluation, synthesis, and application of information to guide action (Scriven and Paul, 1987).

The issue of competencies is explored both at the general education level, aimed at identifying essential knowledge and skills, and at the organizational level, focusing on the specific competencies required within a company or field. Globalization and the specifics of the KE have shifted more attention from the organizational to the societal level, aiming to identify so-called *key competencies* (Rychen and Salganik, 2002).

The main *research question* guiding this paper is to what extent is it methodologically viable to systematically derive key competencies for the KS/KE from KEI indicators, and does the resulting key competency model for KS/KE demonstrate conceptual congruence with established 21st-century frameworks? The specific *objective* of this study is to devise a methodological framework for developing a key competency model tailored to the contemporary socio-economic context, grounded in an analysis of existing KEI and their constituent indicators. Subsequently, the study aims to apply this methodology to construct a pilot key competency model for the KS/KE, utilizing a dataset of 301 indicators derived from four identified KEIs. This model is then validated against a reference database of competencies synthesized from authoritative documents issued by organizations such as the OECD, UNESCO, the European Commission, the Council of the European Union, the World Economic Forum, and the Partnership for 21st Century Learning. A supplementary objective is to leverage the extensive longitudinal dataset of KEI indicators accumulated since 2017 to conduct a model-based analysis of anticipated trends in key competency development for the forthcoming three-year horizon.

2. Knowledge Economy

The fact that knowledge contributes in some way to economic growth has been discussed in professional circles for a long time. As early as 1776, Adam Smith pointed out in The Wealth of Nations that a man who all his life performs a few simple operations (division of labour) has no opportunity to make use of his invention in the search for solutions to eliminate (non-existent) difficulties. However, more analyses focused on the importance of knowledge in economics did not emerge until the twentieth century. The endogenous meaning of innovation was analysed as part of the concept of development, with an individual being merely the bearer of the mechanism of change (Schumpeter, 1934), and a little later the theory of knowledge was developed (Hayek, 1937; Hayek, 1945) which contributed significantly to economics and social science. Friedrich August von Hayek (1945) emphasised, among other things, that the most relevant knowledge for economic decisions is not general knowledge, but local, dispersed, fragmented, and often tacit knowledge of many individuals. Subjective or tacit knowledge also interested philosophers such as Gilbert Ryle (1949) who saw it as a disposition and a matter of competence, and Michael Polanyi (1962), who elaborated on the theory of inexpressible tacit knowledge. Polanyi described it as knowing more than we can tell, or knowing how to do something without thinking, like riding a bicycle (Polanyi, 1966). These are individual experiences, skills, ideas, values, intuition, emotions, etc., which are difficult to express and often integrated into complex competencies. Because of their intangible nature, this knowledge is rarely captured in socio-economic measurements, yet its importance continues to grow.

2.1 The Problem of a Uniform Definition

As soon as socio-economic changes began, experts writing about the “new” society and economy often failed to distinguish between information and knowledge. This was particularly visible in the early stages, but even today many still treat them as synonyms, creating semantic confusion. For instance, while Marc Porat (1977) measured the *information* economy and *information* work, Peter Drucker (1992) distinguished between the attributes of information (industry), as related to the times when first computers were made, and knowledge (industry), producing thoughts. In current terminology, new forms of economy are more often labelled in ways that highlight their essence. Alongside *knowledge* economy or *knowledge*-based economy scholars and institutions use related terms emphasizing specific pillars: *learning* economy (Lundvall, 1997; Lundvall and Johnson, 1994), *innovation* economy (Locke and Wellhausen, 2014; Tafti et al. 2012), or e-*economy* or *digital* economy (Fudenberg and Villas-Boas, 2012; Haltiwanger and Jarmin, 2000).

The main difficulty with defining the KE lies in the fluid nature of knowledge itself, which is semantically complex. The OECD report described knowledge as capricious: sometimes sticky, often slippery, rarely tangible, often silent, and extremely heterogeneous (OECD, 2000). Philosophically, epistemology approaches knowledge as universal and abstract, often as a normative reflection of reality or a method of valid inference, with truth as the central criterion. The classic definition of knowledge in philosophy is “justified true belief”, or “true opinion combined with reason” (Hilpinen, 1970). Within economic and management literature, the complexity of

knowledge has given rise to two main paradigms. The *objectivist* perspective on knowledge and *the practice-based* perspective (Hislop, 2013), sometimes referred to as knowledge as truth and knowledge as socially constructed (McAdam and McCreedy, 2002), or knowledge as asset and knowing as process (Empson, 2001). The second perspective emphasizes tacit and subjective knowledge, yet economic and sociological literature has focused primarily on explicit knowledge, as it is measurable and linked to innovation and science-based industries (Ducatel, 1998).

Because of these ambiguities, experts tend to analyse the pillars of KE rather than provide strict definitions. Commonly cited are information and communication technology (ICT), innovation, education, human resources, research and development (R&D), the economic incentive regime, and socio-economic sustainability. International organisations usually define KE in broad and abstract terms. For example, the Organisation for Economic Co-operation and Development (OECD, 1996) defined KE as an economy that is based directly on the production, distribution, and use of knowledge and information. The World Bank (Chen and Dahlman, 2006) views KE as one that utilises knowledge as the key engine of economic growth. It is an economy where knowledge is acquired, created, disseminated, and used effectively to enhance economic development. It is natural that the heterogeneous nature of the concept of knowledge, which must be aggregated and compared with caution, and consequently broad and abstract definitions of KE, also cause a problem with a uniform approach to measuring KE. We have discussed the development and current ways of measuring knowledge in detail in our paper on methods to measure KE (Katuščáková, Capková and Grečnár, 2023a).

2.2 The Problem of Measurement

As we mentioned in Katuščáková Capková and Grečnár (2023a), measurement may be understood as the assignment of scaled numbers to items in a way that reflects the relationships among the possible states of a variables (Andriessen, 2003). In the context of knowledge, measurement can be studied at two levels: the micro level, where firms assess stocks and flows of intellectual or knowledge capital (like Balanced Scorecards, Intangible Asset Monitor, Skandia Navigator, etc.), and the macroeconomic level, where measurement concerns national knowledge resources. Inevitably, such measurement is imperfect, as knowledge remains capricious and resistant to standardisation. The difficulty lies in comparing monetary inputs in research with intangible outcomes, such as professional networks disseminating tacit knowledge. As emphasised in the OECD report, less codified and personalised knowledge complicates quantification (OECD, 2000).

In early efforts to measure economic growth through technological progress, the 'growth accounting' method (Solow, 1957; Denison, 1962; Romer, 1986; Lucas, 1988) was used alongside 'national income accounting' (Kuznets, 1946), which relies on descriptive statistics and data on goods and services production. For example, Fritz Machlup used data from various sources in his calculations of knowledge production and distribution in the United States. He did not consider his work a statistically precise calculation, but rather a message that knowledge is a key economic entity (Godin, 2010). He included areas such as education, R&D, publishing, IT, personal and financial services, media, advertising, conventions, business services, and government. He focused on professional groups and distinguished white- and blue-collar workers (Machlup, 1962). Unlike Machlup, Marc Porat (1977) followed the national income accounting framework and preferred the concept of *information* over *knowledge*. He defined information activity as one primarily producing, processing, or transmitting economically valuable information. He further distinguished primary (market-oriented) and secondary (internally consumed) information sectors. Porat classified 422 occupations reported by the U.S. Census and the Bureau of Labor Statistics into information and non-information groups. His matrix showed that the information sector had grown from 15% of the workforce in 1901 to nearly 40% by 1970, with information workers earning over 53% of labour income in 1967, arguing that the U.S. had become an information-based economy (Porat, 1977).

As the KE's role grew, international organizations also joined the measurement efforts. The first major international initiatives came from the OECD and the World Bank. Since 1995, the OECD has developed indicators for the KE, largely adapted from the Industry and Technology Scoreboard. However, the search for relevant KE indicators and pillars changed frequently: five categories in 1999 (Knowledge-Based Economy, ICT, S&T Policies, Globalization, Output and Impact), four in 2001 (ICT, innovation and diffusion, human capital, entrepreneurship), and five again in 2003. In 2017, the OECD analysed six groups of indicators under a new structure, including digital transformation, skills, innovation, competitiveness, and society (OECD, 1999; OECD, 2001; OECD, 2003; OECD, 2017).

A major milestone was the World Bank's *Knowledge for Development* (K4D) programme launched in 1999, which introduced the *Knowledge Assessment Methodology* (KAM). KAM provides a cross-sectoral assessment of

countries' readiness for the KE using 80 variables grouped under four pillars: education, innovation, ICT, and economic/institutional regime, including gender equality. All indicators are normalised on a 0–10 scale, and 128 countries were ranked (Chen and Dahlman, 2006). Today, KE is increasingly measured using international indices, KEI, as we discussed in detail in (Katuščáková, Capková and Grečnár, 2023a).

3. Competencies

Contemporary society is characterised by discontinuity, requiring individuals to assume diverse roles, adapt to shifting contexts, and face unpredictable challenges throughout their working lives. Already in the late 1960s, with the onset of automation, debates emerged on the changing nature of work and the implications for education (Schumann et al. 1985). The initial focus on competencies was at the organizational level, where their identification is typically rooted in internal process analysis, superior performer behaviour modelling, and alignment with strategic goals to establish a competitive advantage (Prahalad and Hamel, 1990). Recent research highlights that competency modelling has evolved through the integration of best practices in analysing, structuring, and applying competency information, thereby strengthening talent management and aligning HR practices with organisational objectives (Campion et al. 2011). Competency models further function as strategic mechanisms that translate organisational strategy into employee behaviour and support sustained alignment between managerial intent and workforce priorities (Campion et al. 2019). Conceptual advances also emphasise the multidimensional nature of competencies, framing them as an interplay of individual, organisational, and contextual dimensions within enterprise management (Szafrański, 2019).

Later, processes of globalisation (segmentation and specialisation), networking (system rationalisation), and the rise of the KE (innovation, knowledge workers) reframed the discussion and largely shifted the emphasis of preparing competent workers from organisational to societal levels (Rychen and Salganik, 2002).

At the macroeconomic level, individual competencies, including knowledge and skills have been recognised as key drivers of productivity, competitiveness, employment, and innovation. They also underpin democratic participation, social cohesion, and social justice (Rychen and Salganik, 2002). Education thus represents a cornerstone of the KE. Developing human resources capable of transforming growing volumes of information into knowledge and innovation is therefore essential (Sugiyama and Meyer, 2008). Yet the question of which competencies define the "knowledge worker" remains contested (Rychen and Salganik, 2002).

Literature shows that this debate mirrors the conceptual ambiguity surrounding "knowledge" itself. Core terms such as competency, skill, qualification, standards, and literacy are often used interchangeably. Competency is described as tacit (Norris, 1991), fuzzy (van Klink and Boon, 2003), and context-dependent. Weinert (2001), within the OECD DeSeCo project, highlighted the multiple and sometimes contradictory meanings of competency. Likewise, Le Deist and Winterton (2005) argued that a unified theory is unattainable. Some traditions view competencies functionally, often in the plural, while others equate them with occupational competence (McClelland, 1998).

National approaches further illustrate these divergences. In the UK, Vocational Qualifications based on functional analysis were criticised for lacking theoretical depth (Mansfield and Mitchell, 1996), prompting a turn towards systematic knowledge acquisition. Since 1996, a more holistic model has emerged, integrating cognitive, functional, personal, ethical, and meta-competencies (Cheetham and Chivers, 1996). In continental Europe, particularly France and Germany, competency developed independently. Deist and Winterton (2005), notes that while the US focuses on individual behavioural traits and the UK on functional standards, France and Germany emphasize a multidimensional, analytically rich concept of competence. For this reason, it has become essential to initiate a discussion on key competencies that are context-independent and equivalent in their use and effectiveness across different institutions, tasks, and demand conditions, especially given that the KE is no longer confined to any specific economic sector (Unger, 2022).

3.1 Key Competencies

Similar terminological ambiguities arose when trying to determine key competencies. These include competencies such as oral and written mastery of the mother tongue, mathematical knowledge, reading competence for rapid acquisition and accurate processing of written information, knowledge of at least one foreign language, media competence, independent learning strategies, social competences, and divergent thinking, critical judgement, and self-criticism (Weinert, 2001).

International and national education systems often use terms like "key skills", "key competencies", "core competencies", "life skills", "essential/basic skills", or "21st century skills", though the semantic perception of

these concepts often differs from country to country. Efforts to define key competence uniformly and explore possibilities for its measurement were preceded by various initiatives in different countries. A significant milestone was the debate on "key qualifications" and competencies, launched in Germany in 1974 (Mertens, 1974), in response to labour market changes brought by the new economy (Dörge, 2010).

3.2 The Problem of a Uniform Definition

Similarly to the challenge of defining the "knowledge economy and society," the OECD has sought to establish a uniform conceptualisation of competencies, alongside internationally comparable indicators to capture their role in supporting individual, social, and economic prosperity. The growing interest in competencies and the demand for data on educational outcomes in OECD countries gave rise to numerous projects that were often independent and conceptually inconsistent. Salganik et al. (1999) highlighted the need for a unified theoretical basis for assessing skills and competencies. Against this background, the OECD launched the DeSeCo (Definition and Selection of Key Competencies) initiative, widely regarded as fundamental. Its objectives were to provide a coherent conceptual framework, identify the competencies required for successful life in democratic societies, and strengthen the theoretical foundation for more reliable measurement and interpretation (Salganik et al. 1999; Rychen and Salganik, 2003). The programme also stressed the importance of individual responsibility for continuous learning and subsequent action (Ananiadou and Claro, 2009).

The DeSeCo definition drew heavily on Weinert (2002), who prioritised measurability and the development of indicators. However, some scholars challenged this, arguing that competencies are not outcome-oriented and therefore cannot be fully measured (Rychen and Salganik, 2002).

DeSeCo sought to reconcile diverse conceptual approaches and expert views by incorporating insights not only from psychology but also from philosophy, sociology, anthropology, and economics. A key contribution of DeSeCo lies in its holistic view of competencies, which are not reducible to cognitive abilities. Competency and skill are not treated as synonyms; rather, competencies involve the mobilisation of cognitive and practical skills, creative capacities, and psychosocial resources such as attitudes, motivation, and values (Rychen and Salganik, 2003). Key competencies are defined as those that "involve a mobilisation of cognitive and practical skills, creative abilities and other psychosocial resources such as attitudes, motivation and values." More specifically, the OECD describes them using three "competency categories":

- *Using Tools Interactively*: including the use of language, symbols, and texts; knowledge and IT; and technology in interactive ways.
- *Interacting in Heterogeneous Groups*: encompassing the ability to relate well to others, cooperate, and manage or resolve conflicts.
- *Acting Autonomously*: covering the capacity to act within a broader context, pursue life plans and personal projects, and assert rights, interests, and needs (OECD, 2005).

3.3 Key Competencies for Knowledge Society

Despite the conceptual and methodological difficulties of defining both the KS/KE and key competencies, their interconnection requires systematic examination. A KS/KE cannot develop without adequately educated, skilled, and experienced people. Without such human capital, it would face stagnation and information overload, with individuals unable to transform vast amounts of digital information into usable knowledge - the primary economic and social asset of the new economy. This dynamic is reflected in the World Bank's Knowledge Economy Index (2009), which revealed that despite Slovakia's relatively high standing in ICT adoption compared to regional counterparts, the nation's lag in education metrics directly contributed to weaker overall output indicators, particularly in the domain of innovation (see Figure 1).

KAM 2009

Comparator: None 1995 2000

Sort by: Most recent 2000

Comparison Group: **All Countries**

Export to Excel

Country	KEI		Economic Incentive and Institutional Regime		Innovation		Education		ICT	
	recent	2000	recent	2000	recent	2000	recent	2000	recent	2000
Germany	8.96	8.98	9.06	9.02	8.94	9.08	8.36	8.79	9.47	9.02
Hungary	8.00	7.64	8.35	7.76	8.21	8.04	7.73	7.52	7.70	7.26
Czech Republic	7.97	7.45	8.17	7.10	7.78	7.51	8.23	7.55	7.70	7.63
Slovak Republic	7.47	7.12	7.78	6.48	6.89	7.09	7.26	7.39	7.95	7.52

Figure 1: Result of a comparison of the KEIs of four countries in the World Bank database of 2009 (recent) and 2000

The relationship between competencies and KE was explicitly addressed by the OECD (Pont, 2001). Drucker's (1992) prediction from the 1960s materialised: white-collar and highly skilled jobs (knowledge workers) became the main drivers of employment growth across industries. This prompted the OECD to ask which competencies and skills were most essential for the KS/KE. From the perspective of education, the goal was to ensure the highest possible attainment levels and the development of broad, transferable competencies for lifelong learning. From the labour market perspective, however, emphasis was placed on ICT skills, problem solving, teamwork, and continuous learning. The OECD (Pont, 2001) stressed the importance of foundational education and literacy as prerequisites for knowledge work, while also identifying further skills increasingly required in the new economy. Based on expert analyses and employers' hiring criteria, three clusters of competencies were highlighted:

- Interpersonal skills: teamwork, leadership, collaboration.
- Intrapersonal skills: motivation, learning ability, problem solving, communication, analytical skills, systems thinking.
- Technological/ICT skills.

Generally, the identification of key competencies relies on methods such as analyses of professional literature, job descriptions, behavioural studies, expert consultations (e.g., Delphi studies), focus groups, or empirical surveys (Zhu et al. 2024; Batt, Tavares and Williams, 2019; Geng et al. 2018). In our research on competencies for KS/KE, we applied a different methodological approach, aiming to capture more precisely the interplay between competencies and the dynamics of the KS/KE.

4. Methodology

The initial part of the methodology delineates the framework for constructing a key competency model for the KS/KE. This framework is subsequently operationalized in the Results section through its pilot application utilizing data derived from four KEIs to construct the pilot key competency model for the KS/KE. The second part details the procedural approach and findings regarding the anticipation of key competency trends for the forthcoming three-year horizon.

4.1 Methodological Framework for the Development of the Key Competency Model for KS/KE

Identification of relevant economic indices

The initial phase of the research addressed the methodological step designated as the Identification of relevant economic indices. The primary objective of this phase was to select specific economic indices, developed and published by respected international authorities, which demonstrate alignment with the established main pillars of the KE. In our specific application, this analysis was initiated in 2017, focusing on the evaluation of measurement initiatives that correlate with the core pillars of the World Bank framework (Chen and Dahlman, 2006).

Construction of a tailored database of indicators

The subsequent phase entails the extraction of indicators from the identified indices to populate a proprietary database structured according to specific research objectives. A critical imperative in this phase is the continuous and incremental archiving of data, as retrospective access to historical datasets within source repositories is often limited or subject to removal.

To address these requirements, a customised dataset was developed, comprising the variables index, country, year, value, and rank. This structured approach enabled robust longitudinal and comparative analyses across different KE indicators.

Content analysis and categorization

Indicators derived from the selected KEI must be subjected to content analysis, followed by semantic categorization. This analytical step is indispensable for establishing a unified categorization of all indicators into the designated KE pillars, particularly because identical indicators can be classified divergently across different KEIs or presented under slightly varying nomenclatures.

We employed the method of intellectual and cognitive categorisation from the field of knowledge organisation to group related entities and phenomena into shared categories. Unlike strict classification, which requires exclusive membership, categorisation is flexible and allows associations based on perceived similarities among entities. Category composition may vary across contexts, which constitutes the core strength of cognitive categorisation. Moreover, the possibility of assigning an entity to multiple categories (Jacob, 2004) was considered essential for the objective categorisation of semantically related indicators.

This approach facilitates the grouping of related entities based on recognised similarities. Each indicator was assessed in terms of its definitional scope, measurement method, and contextual application, before being assigned to a category.

Division into input and output indicators

A critical subsequent procedural step involves the dichotomization of identified indicators within each KE pillar into two distinct categories: input and output indicators. This classification process must strictly adhere to a defined conceptual framework to ensure analytical rigor. Input indicators (resources and investments) - these metrics quantify the volume of invested resources, the availability of enabling infrastructure, and the latent potential within a specific domain. Conceptually, inputs are regarded as essential antecedents and investments that serve as precursors to performance. Output Indicators (results and outcomes) - these metrics evaluate the resultant efficacy, tangible outcomes, or broader impacts generated by the preceding investments. Outputs represent the realized performance and actualized value within a given domain.

Compilation of required key competencies

A subsequent methodological recommendation involves the parallel continuous compilation of a reference key competency database. This can be achieved through the systematic extraction and categorization of competencies derived from authoritative international documents that conceptualize or define such frameworks. Crucially, this process necessitates semantic harmonization to address the challenge of diverse nomenclature.

Mapping of key competencies to KE categories

The primary objective of this phase is to identify specific competencies that facilitate the effective conversion of input indicators into high-performing output indicators within each KE pillar. Achieving this mapping necessitates a systematic content analysis of official documentation and definitions encompassing both the KE

indicators and the targeted key competencies. This mapping also facilitated evaluation of the representativeness of competencies identified by the model in comparison with established frameworks.

Model visualization

The methodological process can culminate in the visualization of key competency model for the KS/KE. We recommend that the graphical representation explicitly delineates the functional role of competencies as mediating mechanisms that facilitate the transformation of KE resource inputs into tangible performance outputs.

4.2 Model-based Analysis of Anticipated Trends in Key Competency Development for the Forthcoming Three-Year Period

Recognising the dynamic nature of the KS/KE, the study also sought to incorporate a forward-looking perspective. The aim was to forecast the development of KE-related factors likely to influence society over the next three years, integrating these assumptions into the competency model.

Data from KE indicators served as the basis for predictive modelling in RapidMiner software. Multiple prediction techniques were tested, including: Generalised Linear Model (GLM), Deep Learning, Decision Tree, Random Forest, Gradient Boosted Trees, Support Vector Machine (SVM). Performance of these models was evaluated according to relative error rates (RE) and standard deviation (STDEV). Results indicated that the Generalised Linear Model (GLM) provided the most effective performance, with RE = 0.4% and STDEV = 0.1%. Despite its conceptual simplicity, GLM proved suitable for predicting short-term economic and competency-related trends. Its assumption of a linear relationship between input and output variables is often a reasonable approximation in economic contexts, thereby reinforcing its applicability to the forecasting task.

5. Results

In this section, we present a specific pilot application of our methodology, utilizing data derived from four relevant KEIs and official documents analysing 21st-century key competencies, culminating in the construction of the key competency model for the KS/KE.

5.1 Pilot Construction of the Key Competency Model for the KS/KE

Identification of relevant economic indices

The selection of these four aforementioned indices was predicated upon a preliminary evaluation of several salient structural determinants, encompassing: the core conceptual framework and institutional custodianship; the scope of national coverage; the hierarchical index architecture, ranging from constituent indicators to defined pillars/sub-indices; the evolution of indicator properties (i.e., selection, enumeration, and weighting) alongside overall structural modifications; and the underlying principles that govern index aggregation. The following indices met the selection criteria: Global Knowledge Index (GKI) and Global Innovation Index (GII) from global indices; European Innovation Scoreboard – Summary Innovation Index (EIS- SII), and Digital Economy and Society Index (DESI) from European indices.

The creators of GKI state that because the World Bank's KAM measurements (KEI, KI) have been discontinued, GKI is the sole index measuring knowledge at the global level (UNDP and MBRF, 2019)The EIS -SII and GII indices are primarily perceived as innovation indices but can also be seen as KE indices, as they capture key KE drivers and use indicators such as employment in knowledge-intensive activities. Our view is supported by authors like Karahan (2012) and Leogrande (2022). DESI was included because, at the beginning of our analysis in 2017, it extended beyond ICT to cover research, innovation, and education. An initial comparison showed that, despite shared thematic orientation, the indices differ considerably in the selection of pillars, sub-pillars, weighting of indicators, and interpretation of KE concepts.

Construction of a tailored database of indicators

A dataset was built using data collected since 2017 from all indicators of the four identified KE indices. Much of the data used since 2017 is no longer publicly available, making it important to continuously build our own dataset (Github), structured as: index, country, year, value, rank (Katuščáková, Capková and Grečnár, 2023b). The data used in this research is from 2022, consisting of 301 indicators from the Global Knowledge Index, Global Innovation Index, and European Innovation Scoreboard – Summary Innovation Index, recorded as: indicator name, description, parent index, and assigned weight, based on 2022 data.

Content analysis and categorization

After constructing the database, we carried out a comprehensive content analysis of the 301 indicators. The analysis revealed varying levels of granularity in indicator categorisation across indices, accompanied by notable semantic differences, even among identical indicators. Several unique and newly introduced indicators were identified, including university - industry collaboration, exports of knowledge and creative services, development of creative industries (film, media, gaming, Wikipedia editors), as well as environment, health, and gender equality. Furthermore, the indices applied different weights to similar or overlapping indicators and frequently revised their methodologies, underscoring divergent interpretations of KE principles. This demonstrated the necessity of applying semantic categorisation through a uniform framework.

Drawing on the content analysis of KE indices and their internal structures (sub-pillars, pillars, sub-indices), in combination with relevant scholarly literature on fundamental KE pillars, we derived four, or in some cases five, shared core KE categories observable across all indices—though under different names or levels of detail. These largely correspond to the KE pillars defined by the World Bank in 2005/2006 (Chen and Dahlman, 2006).

The shared categories identified were: (1) Research, development, and innovation; (2) Education; and (3) ICT. In response to rapid developments in KE-related areas, a fourth category, Others (lately renamed to Society & Environment), was created to cover contextual indicators potentially influencing KE performance. Finally, a fifth category, Economy, was introduced to encompass broader indicators not assignable elsewhere. Categorisation was thus based on semantic similarities within each group.

The Education category included both formal and informal learning; quality and accessibility of pre-university and higher education; PISA results; lifelong learning; and graduate employability. Research, development, and innovation encompassed state and private R&D expenditure, scientific publications, patents, university–industry cooperation, quality of research institutions, employment rate in knowledge-intensive activities, and business innovation. ICT covered internet access and usage, digital skills, ICT employment, and software investment. The Other (lately renamed to Society & Environment) category addressed specific or emerging KE-related dimensions, while Economy included indicators such as GDP per capita, foreign direct investment, business density, industrial diversification, and export complexity.

In order to identify the principal indicators for each of the five KE pillars, we had to address several challenges like intersecting or semantically linked indicators. Such indicators were assigned to all relevant categories, with its weight divided by the number of categories, in which it was included, to increase the objectivity of categorisation. Examples include indicators focused on doctoral students, which can be categorised in both Education and Research, development and innovation, or the digital skills indicator, which can be categorised in both ICT and Education; the Enterprises providing ICT training indicator can be categorised in both Education and ICT, or the Female ICT specialists indicator can be categorised into Others (gender equality), ICT and Education. This means that in the case of assigning an indicator to one category, the indicator is added to that category with its weight assigned in the given index together with the name of the index, from which it originates. If an indicator is assigned to more than one category, that indicator is assigned to each relevant category, along with the corresponding fraction of its original weight. In the first round of classification, indicators were assigned to one of the four primary categories: Research, development, and innovation; Education; ICT; or Others (lately renamed to Society & Environment). When this was not feasible, they were placed in the Economy category. This approach enabled consistent categorisation of all 301 indicators. Within Education, further subcategories were created: primary and secondary schooling, Technical and Vocational Education and Training (TVET), and tertiary education.

Input and output indicator sets

Our classification was theoretically grounded in a rigorous semantic analysis of indicator definitions and their functional role within the KE value chain. For instance, within the ICT pillar input indicators included parameters such as financial investments, infrastructure quality, and accessibility metrics. These metrics measure the deployment of resources. Output indicators comprised measurable achievements, such as ICT employment rates, the number of ICT patents, and the number of PhDs in ICT. These reflect the actual performance.

Compilation of required key competencies

In parallel with the database of KE indices, we developed a database of key competencies. These were extracted from authoritative documents addressing key competencies, core competencies, life skills, essential/basic skills, and 21st-century skills, produced by organizations such as the OECD (2005; 2019), UNESCO (2015; 2017; 2018),

the European Commission (Council of the European Union 2018), the World Economic Forum (2020), and the Partnership for 21st Century Learning (Battelle for Kids, 2019). As definitions and categories of competencies differ across these sources, overlaps and terminological inconsistencies were frequent. Therefore, after building the database, we conducted an analysis and semantic clustering of competencies. The contextual orientation of the documents was also considered, as some were sector-specific (e.g., education, employment, civic engagement) and contained corresponding competences.

Mapping of key competencies to KE categories

Following the preparation of both the indicator and competency databases, we proceeded to the crucial task of mapping competencies to the respective KE indicators and categories. We systematically analysed the functional description of each KE indicator. If an indicator required specific knowledge, skill, or attitude for its successful realization or improvement, the corresponding key competency was mapped to that indicator.

Since many competencies are relevant across multiple pillars, we structured the model progressively, beginning with education and R&D as foundational domains and moving towards competencies specific to ICT, the economy, and socio-environmental contexts.

In *education* and *R&D*, the key competencies identified as central to knowledge processes include:

- Basic literacy (particularly in primary and secondary education), recognized as foundational building blocks that enable children to develop to their full potential (UNESCO, 2015; OECD, 2005; Council of the European Union, 2018)
- Cognitive competencies: analytical, creative, critical, and abstract thinking; problem-solving; information and media literacy; mathematical and data literacy; domain-specific knowledge; and systems thinking (OECD, 2005, 2018; WEF, 2020; Battelle for Kids, 2019). These reflect both higher education and research needs.
- Soft skills: intrapersonal competencies such as self-motivation, curiosity, attention to detail, resilience, and flexibility (WEF, 2020, 2023; OECD, 2019); and interpersonal competencies including teamwork, communication, leadership, empathy, and lifelong learning (WEF, 2020, 2023; Council of the European Union, 2018).
- Ethics: essential in handling sensitive data, developing AI, and aligning with social justice and sustainability (OECD, 2005, 2019; UNESCO, 2015).

In *ICT*, competencies span digital and technical skills, from basic usage to programming, networking, big data, cloud computing, and artificial intelligence, again complemented by ethical considerations (WEF, 2020).

In the *economic* sphere, key competencies include economic and financial literacy, strategic and innovative thinking, and ethics (OECD, 2018; Council of the European Union, 2018). In the *social* and *natural* environment, essential competencies include active citizenship, intercultural knowledge, tolerance, environmental awareness, sustainability, health literacy, and ethics (UNESCO, 2015, 2017; Council of the European Union, 2018).

Drawing on these findings, we created a Key Competency Model for the KS/KE, linking competencies to the transformation of KE inputs into outputs. This model aligns with Weinert's and the OECD DeSeCo project's recommendations, emphasising a holistic and dynamic perspective. It integrates both cognitive and non-cognitive elements and reflects the complexity of knowledge processes in contemporary societies.

Representativeness of the Key Competency Model for KS/KE:

An important finding was that the database of extracted key competencies was sufficient to cover all categories of KE, which confirms the overlap of the currently required key competencies and the main areas of KE, but mainly that the model of key competencies generated by the proposed method can be considered sufficiently representative.

Model visualization (see Figure 2)

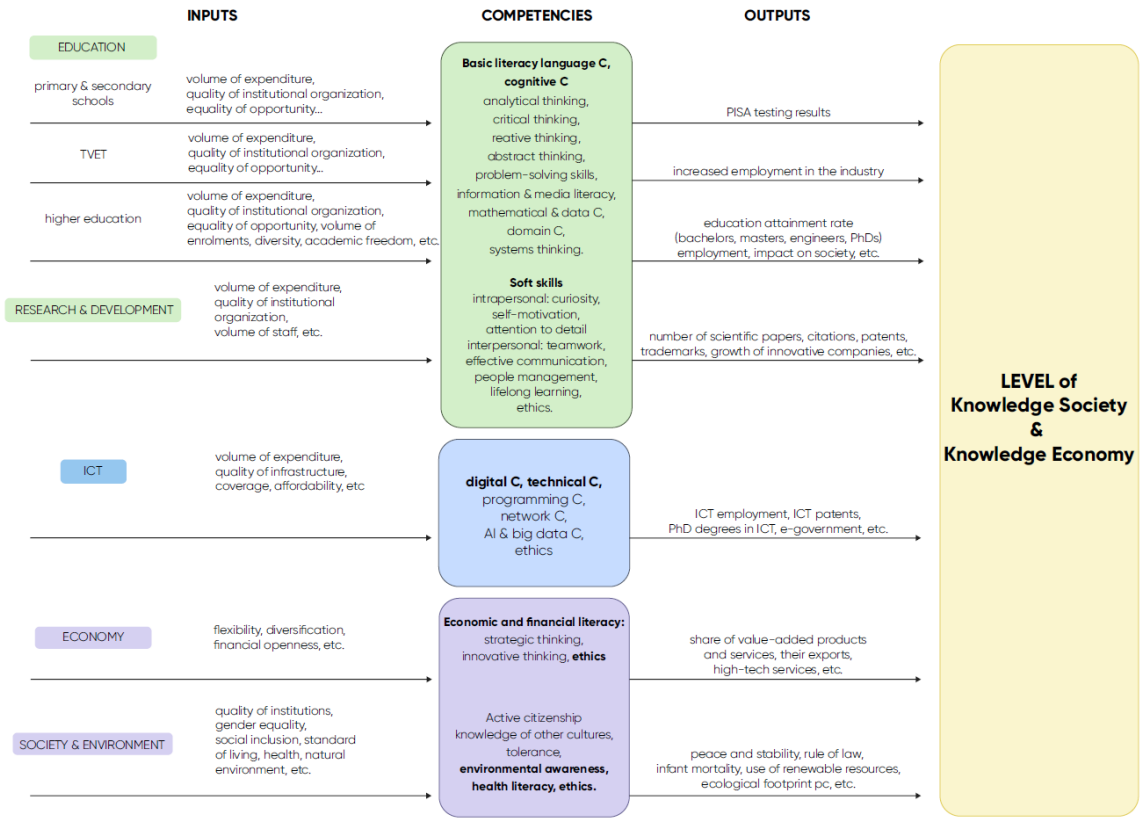

Figure 2: Key Competency Model for KS/KE

5.2 Model-based Analysis of Anticipated Trends in Key Competency Development for the Forthcoming Three-Year Period

Given the continuous evolution of indices and their indicators, variations in the key competencies required to transform input into output indicators can be anticipated. To address this, we forecasted the future development of the KS/KE and the factors most likely to influence it in the coming years. For this purpose, we used data from our repository (2017–2022) derived from four indices: the *Global Knowledge Index*, *Global Innovation Index*, *European Innovation Scoreboard – Summary Innovation Index*, and *Digital Economy and Society Index*. These data were used to train predictive models in RapidMiner, including generalized linear models (GLM), deep learning, decision trees, and support vector machines. The GLM (Nelder and Wedderburn 1972; Faraway 2016) proved most effective, yielding the lowest relative error and standard deviation.

Based on the selected model, the most significant predictors of future performance in knowledge indices are: ***research, development and innovation*** (w: 0.499); (current level) ***economy*** (w: 0.368) and (current level) ***ICT*** (w: 0.351); (current level) ***technical and vocational education*** (w: 0.332); (future level) ***secondary education level*** (w: 0.331) (future level). At the same time, we calculated the factors with the greatest impact on the quality of the prediction, where the factors of ***research, development and innovation*** and ***ICT and technical and vocational education*** were identified as the most important ones.

To complement our analysis, we also drew on forecasts from the *World Economic Forum* (2023) for 2023–2027. Based on a survey of 803 companies employing 11.3 million people across 45 economies, the WEF identified technology adoption and the expansion of digital access as the main drivers of business transformation. Over 75% of companies reported high adoption potential for big data, cloud computing, and AI. The World Economic Forum bases its forecasts on a large-scale employer survey (Future of Jobs Survey), complemented by expert judgement, internationally standardised occupational and skills classification frameworks (ISCO and ONET), and analytical extrapolation of expected trends contextualised with external labour market data.

From the perspective of the KS/KE, most technologies are expected to have a slightly positive impact on jobs. In particular, big data analytics, climate and environmental management technologies, and cybersecurity are likely to play key roles.

The World Economic Forum also identified the competencies most in demand for 2023–2027. Cognitive skills, notably analytical and creative thinking, are paramount. Creative thinking, ranked tenth in 2015, has risen to second place. Interpersonal competencies—resilience and flexibility, self-motivation, and curiosity with lifelong learning—are also projected to be crucial, particularly in navigating labour market disruptions. Additional competencies include technological literacy, reliability and attention to detail, empathy, active listening, and managerial abilities such as quality control.

Therefore, we have tried to innovate our model to include a forecast of the KS/KE development and the necessary key competencies, considering the results of prediction using the GLM model together with the WEF forecasts over a five-year horizon. We expect that the main factors influencing the future level of the KS/KE will be the internally interconnected areas of ***R&D*** and ***ICT*** (see Figure 3), while their impact on society's transformation will gradually strengthen.

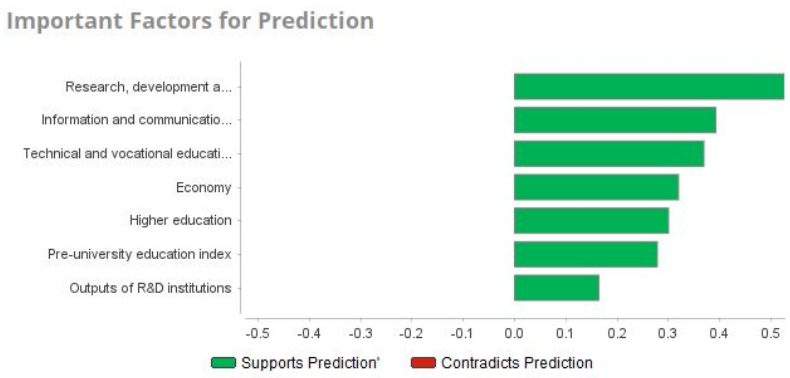

Figure 3: Important Factors for Prediction (Rapid Miner)

At the same time, the key competencies forecasting model (see Figure 4) highlighted those competencies that are linked to the development of science and research and ICT, and that overlap with the competencies that will be most important in the 2023-2027 horizon according to WEF: basic *literacy*, *language* competencies, *cognitive* competencies, especially *analytical* thinking, *creative* thinking, *abstract* thinking, *problem-solving* capability, *soft* skills such as *curiosity*, *self-motivation*, *lifelong learning*, *digital* and *technical* competencies.

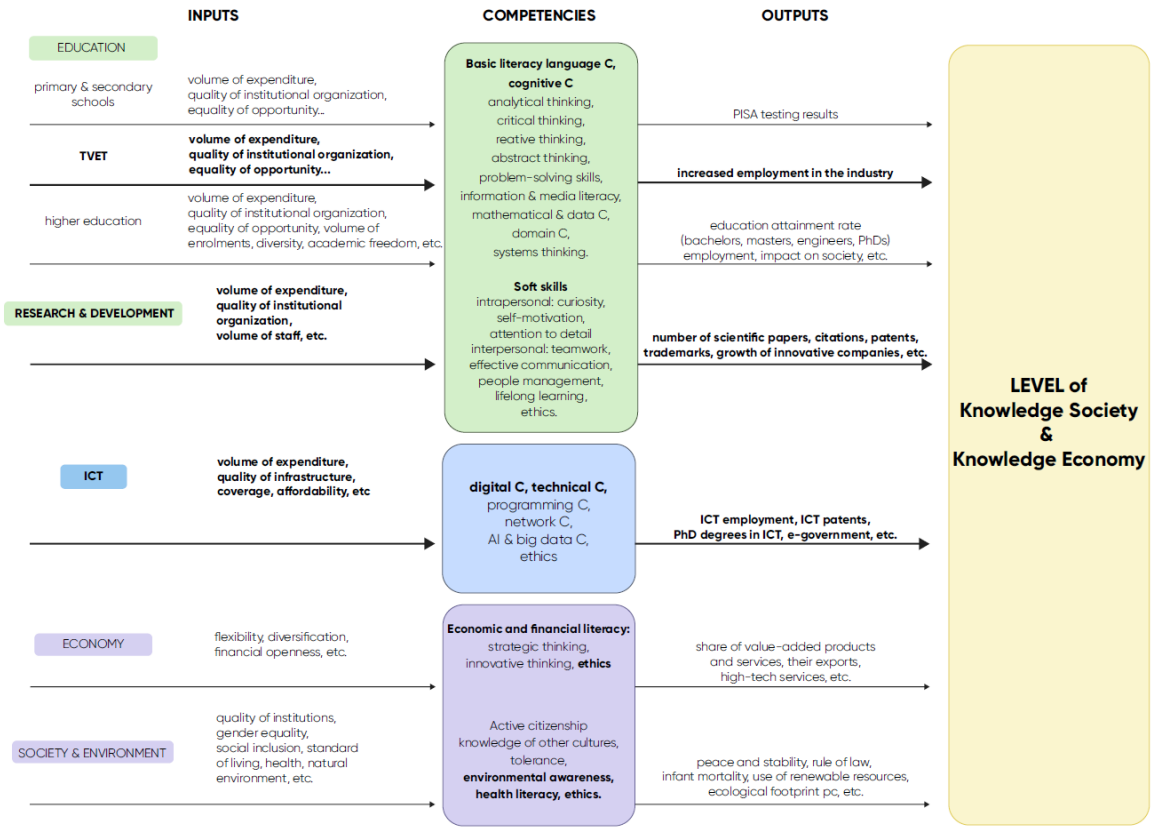

Figure 4: Key Competencies Forecasting Model

6. Discussion and Conclusion

Our analysis of key performance metrics revealed that certain countries significantly outperform their neighbours in information society measures but simultaneously lag behind in critical KS/KE outputs, such as patents, trademarks, and high-impact publications. This demonstrable disparity underscored the essential role of human competencies in effectively transforming information and invested resources (inputs) into measurable knowledge-based outcomes (outputs). Consequently, this paper aims to interconnect the concepts of the KS/KE, KE indices, and the specific key competencies required for this transformation, thereby linking these concepts through the development of a unified model directly derived from the KE indices.

This study advances the research landscape by contributing to the development of a novel methodological framework for constructing a model of key competencies specific to the KS/KE. This framework is systematically built upon the content analysis of indicators derived from major, internationally recognized KEI. The core methodological innovation resides in the uniform and empirically justified categorization of all analysed KEI indicators, which culminated in their systematic division into input (quantifying prerequisites and investments) and output (quantifying achieved results and performance) subsets. This crucial segmentation enabled the precise and structured mapping of key competencies, identifying those, that are demonstrably responsible for mediating the transformation of invested resources (inputs) into measurable and desirable outcomes (outputs).

The key competency model for KS/KE derived from our collected and analysed KEI indicator data was subsequently subjected to a validation process. Specifically, the generated model was benchmarked against a comprehensive, authoritatively curated compilation of required key competencies. This compilation was meticulously extracted from influential documents addressing key competencies, core competencies, life skills, essential/basic skills, and 21st-century skills, produced by leading global organizations such as the OECD, UNESCO, the European Commission, the Council of the European Union, the World Economic Forum, and the Partnership for 21st Century Learning.

The comparative analysis confirmed that the competencies contained within this compilation were sufficiently broad and exhaustive to cover all categories identified within our KE framework. This alignment confirmed that the model of key competencies generated by the proposed methodology can be considered sufficiently representative and valid for addressing the competency requirements across the entire spectrum of the KS/KE.

Furthermore, the resultant key competencies model was subsequently utilized to perform a model-based analysis of anticipated trends in competency development, thereby providing actionable insights into the strategic skill demands required by the KS/KE for the forthcoming three-year period.

The methodological framework development encountered several challenges. For instance, the selection of four prominent KE indices, while based on declared objectives, necessitates researchers to prioritize indices whose goals align with the KE. Essential for data integrity was the construction of a dedicated, custom database (Katuščáková, Capková and Grečnár 2023b), mitigating issues arising from frequent index revisions and obscure methodologies. A critical challenge was the non-uniform categorization of identical indicators across different indices. To overcome this, we implemented a precise, uniform approach to categorization.

Compared to traditional competency modelling approaches based on expert studies, job analyses, behavioural observations, Delphi methods, or surveys*, the proposed model* leverages indicators from KEI, enabling *greater flexibility and responsiveness to rapid socio-economic change*. Unlike conventional models, which are typically developed over extended periods and tend to stabilise competencies over time, the use of dynamically updated indicators and shifting weights allows the model to continuously reflect evolving societal, technological, and economic conditions. However, this approach is inherently dependent on the availability, quality, and conceptual validity of macro-level indicators, which may limit its ability to capture context-specific or tacit competencies at the organisational or individual level.

Moreover, the practical significance of this type of key competency model is that, by processing the KEI indicators, individual countries can identify which input and, more importantly, output indicators are performing poorly. This allows them to strategically focus their solutions not only on supporting the input indicators within that KE pillar but also on targeting the development of specific competencies necessary to improve the performance of those output indicators.

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References

Andriessen, D. (2003) Making sense of intellectual capital: Designing a method for the valuation of intangibles. 1st ed. Boston, MA: Butterworth-Heinemann.

Ananiadou, K. and Claro, M. (2009) '21st century skills and competences for new millennium learners in OECD countries', OECD Education Working Papers, 41. https://doi.org/10.1787/218525261154.

Batt, A., Tavares, W. and Williams, B. (2019) 'The development of competency frameworks in healthcare professions: A scoping review', Advances in Health Sciences Education, 25, pp. 913–987. https://doi.org/10.1101/19003475.

Battelle for Kids (2019) Framework for 21st century learning definitions. Partnership for 21st Century Learning. Available at: https://www.battelleforkids.org/networks/p21.

Bell, D. (1973) The coming of post-industrial society: A venture in social forecasting. New York, NY: Basic Books.

Campion, M.A., Fink, A.A., Ruggeberg, B.J., Carr, L., Phillips, G.M. and Odman, R.B. (2011) 'Doing competencies well: Best practices in competency modeling', Personnel Psychology, 64(1), pp. 225–262. https://doi.org/10.1111/j.1744-6570.2010.01207.x.

Cohen, N. and Garasic, M.D. (2024) 'Informed ignorance as a form of epistemic injustice', Philosophies, 9(3). https://doi.org/10.3390/philosophies9030059.

Council of the European Union (2018) 'Council Recommendation of 22 May 2018 on key competences for lifelong learning (2018/C 189/01)', Official Journal of the European Union, C 189, pp. 1–13. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32018H0604(01).

Cheetham, G. and Chivers, G. (1996) 'Towards a holistic model of professional competence', Journal of European Industrial Training, 20(5), pp. 20–30. https://doi.org/10.1108/03090599610119692.

Chen, D.H.C. and Dahlman, C.J. (2006) The knowledge economy, the KAM methodology and World Bank operations. Washington, DC: World Bank Institute. Available at: https://documents1.worldbank.org/curated/en/695211468153873436/pdf/358670WBI0The11dge1Economy01PUBLIC1.pdf.

Denison, E.F. (1962) The sources of economic growth in the United States and the alternatives before us. New York, NY: Committee for Economic Development.

Dörge, C. (2010) 'Competencies and skills: Filling old skins with new wine', in Key competencies in the knowledge society. Berlin/Heidelberg: Springer (IFIP), pp. 78–89. Available at: https://link.springer.com/content/pdf/10.1007/978-3-642-15378-5.pdf.
Drucker, P. (1992) The age of discontinuity. 2nd ed. New Brunswick, NJ: Transaction/Routledge.
Ducatel, K. (1998) Learning and skills in the knowledge economy. DRUID Working Paper 98–2. Copenhagen: DRUID, Copenhagen Business School/Aalborg University. Available at: https://econpapers.repec.org/RePEc:aal:abbswp:98-2.
Empson, L. (2001) 'Introduction: Knowledge management in professional service firms', Human Relations, 54(7), pp. 811–817. https://doi.org/10.1177/0018726701547001.
Faraway, J.J. (2016) Extending the linear model with R: Generalized linear, mixed effects and nonparametric regression models. 2nd ed. Boca Raton, FL: Chapman & Hall/CRC.
Fudenberg, D. and Villas-Boas, J. (2012) 'Price discrimination in the digital economy', in Oxford handbook of the digital economy. Oxford: Oxford University Press, pp. 254–272. https://doi.org/10.1093/oxfordhb/9780195397840.001.0001.
Geng, Y., Zhao, L., Wang, Y., Jiang, Y., Meng, K. and Zheng, D. (2018) 'Competency model for dentists in China: Results of a Delphi study', PLOS ONE, 13. https://doi.org/10.1371/journal.pone.0194411.
Godin, B. (2010) 'The knowledge economy: Fritz Machlup's construction of a synthetic concept', in Viale, R. and Etzkowitz, H. (eds) The capitalization of knowledge. Cheltenham: Edward Elgar, pp. 261–290. https://econpapers.repec.org/RePEc:elg:eechap:13300_10.
Gottmann, J. (1964) Megalopolis: The urbanized northeastern seaboard of the United States. Cambridge, MA: MIT Press. Available at: https://direct.mit.edu/books/book/5083/chapter/3034794/The-White-Collar-Revolution.
Haltiwanger, J. and Jarmin, R. (2000) 'Measuring the digital economy', in Understanding the digital economy: Data, tools and research. Cambridge, MA: MIT Press, pp. 13–33. https://doi.org/10.7551/mitpress/6986.001.0001.
Hayek, F.A. (1937) 'Economics and knowledge', Economica, 4(13), pp. 33–54. https://doi.org/10.2307/2548786.
Hayek, F.A. (1945) 'The use of knowledge in society', American Economic Review, 35(4), pp. 519–530. Available at: https://www.jstor.org/stable/1809376.
Hilpinen, R. (1970) 'Knowing that one knows and the classical definition of knowledge', Synthese, 21(2), pp. 109–132.
Hislop, D. (2013) Knowledge management in organizations: A critical introduction. 3rd ed. Oxford: Oxford University Press.
Jacob, E.K. (2004) 'Classification and categorization: A difference that makes a difference', Library Trends, 52(3), pp. 515–540.
Katuščáková, M., Capková, E. and Grečnár, J. (2023a) 'How to measure knowledge economy', Electronic Journal of Knowledge Management, 21(2), pp. 87–102. https://doi.org/10.34190/ejkm.21.2.3025.
Katuščáková, M., Capková, E. and Grečnár, J. (2023b) Knowledge economy. GitHub repository. Available at: https://github.com/Mediamatika/knowledge-economy/.
Karahan, Ö. (2012) 'Input–output indicators of knowledge-based economy and Turkey', Journal of Business, Economics and Finance, 1(1), pp. 21–36.
Klink, M.R. van der and Boon, J. (2003) 'Competencies: The triumph of a fuzzy concept', International Journal of Human Resources Development and Management, 3(2), pp. 125–137. https://www.inderscienceonline.com/doi/abs/10.1504/IJHRDM.2003.002415.
Kuznets, S. (1946) National income: A summary of findings. New York, NY: National Bureau of Economic Research. Available at: https://econpapers.repec.org/bookchap/nbrnberbk/kuzn46-2.htm.
Le Deist, F.D. and Winterton, J. (2005) 'What is competence?', Human Resource Development International, 8(1), pp. 27–46. https://doi.org/10.1080/1367886042000338227.
Leogrande, A. (2022) 'Workers in the knowledge economy in Europe', MPRA Paper, 112538. Munich: University Library of Munich. Available at: https://ideas.repec.org/p/pra/mprapa/112538.html.
Locke, R.M. and Wellhausen, R.L. (eds) (2014) Production in the innovation economy. Cambridge, MA: MIT Press.
Lucas, R.E. (1988) 'On the mechanics of economic development', Journal of Monetary Economics, 22(1), pp. 3–42. https://doi.org/10.1016/0304-3932(88)90168-7.
Lundvall, B.-Å. (1997) The social dimension of the learning economy. Rochester, NY: SSRN. https://doi.org/10.2139/ssrn.66537.
Lundvall, B.-Å. and Johnson, B. (1994) 'The learning economy', Journal of Industry Studies, 1(2), pp. 23–42. https://doi.org/10.1080/13662719400000002.
Machlup, F. (1962) The production and distribution of knowledge in the United States. Princeton, NJ: Princeton University Press.
Mansfield, B. and Mitchell, L. (1996) Towards a competent workforce. Aldershot: Gower.
McAdam, R. and McCreedy, S. (2002) 'A critique of knowledge management: Using a social constructionist model', New Technology, Work and Employment, 15(2), pp. 155–168. https://doi.org/10.1111/1468-005X.00071.
McClelland, D.C. (1998) 'Identifying competencies with behavioural-event interviews', Psychological Science, 9(5), pp. 331–339. https://doi.org/10.1111/1467-9280.00065.
Mertens, D. (1974) 'Schlüsselqualifikationen. Thesen zur Schulung für eine moderne Gesellschaft', Mitteilungen aus der Arbeitsmarkt- und Berufsforschung, 7(1), pp. 36–43.
Nelder, J.A. and Wedderburn, R.W.M. (1972) 'Generalized linear models', Journal of the Royal Statistical Society: Series A (General), 135(3), pp. 370–384. https://doi.org/10.2307/2344614.

Nonaka, I. and Takeuchi, H. (1995) The knowledge-creating company: How Japanese companies create the dynamics of innovation. New York, NY: Oxford University Press.
Norris, N. (1991) 'The trouble with competence', Cambridge Journal of Education, 21(3), pp. 331–341. https://doi.org/10.1080/0305764910210307.
OECD (1996) The knowledge-based economy. Paris: OECD/STI. Available at: https://one.oecd.org/document/OCDE/GD(96)102/en/pdf.
OECD (1999) The knowledge-based economy: A set of facts and figures. Paris: OECD.
OECD (2000). Knowledge management in the learning society. Paris: OECD Publishing. Available at: https://www.oecd.org/content/dam/oecd/en/publications/reports/2000/02/knowledge-management-in-the-learning-society_g1gh266b/9789264181045-en.pdf.
OECD (2001) OECD science, technology and industry scoreboard 2001: Towards a knowledge-based economy. Paris: OECD. https://doi.org/10.1787/sti_scoreboard-2001-en.
OECD (2003) OECD science, technology and industry scoreboard 2003. Paris: OECD. Available at: https://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-scoreboard-2003_sti_scoreboard-2003-en.
OECD (2005) The definition and selection of key competencies: Executive summary. Paris: OECD. Available at: https://one.oecd.org/document/EDU/EDPC/ECEC/RD(2010)26/en/pdf.
OECD (2017) OECD science, technology and industry scoreboard 2017: The digital transformation. Paris: OECD. https://doi.org/10.1787/9789264268821-en.
OECD (2019) OECD future of education and skills 2030: OECD learning compass 2030. Paris: OECD.
Polanyi, M. (1962) 'Tacit knowing: Its bearing on some problems of philosophy', Reviews of Modern Physics, 34(4), pp. 18–20.
Polanyi, M. (1966) The tacit dimension. Garden City, NY: Doubleday.
Pont, B. (2001) 'Competencies for the knowledge economy', in Education policy analysis. Paris: OECD, pp. 99–118. Available at: https://one.oecd.org/document/DEELSA/ED/CERI/CD(2000)12/PART4/REV2/en/pdf.
Porat, M.U. (1977) The information economy. OT-SP-77-12(1). Washington, DC: U.S. Department of Commerce, Office of Telecommunications. Available at: https://files.eric.ed.gov/fulltext/ED142205.pdf.
Prahalad, C.K. and Hamel, G. (1990) 'The core competence of the corporation', Harvard Business Review, 68(3), pp. 79–91.
Robertson, D.S. (1990) 'The information revolution', Communication Research, 17(2), pp. 235–254. https://doi.org/10.1177/009365090017002005.
Romer, P.M. (1986) 'Increasing returns and long-run growth', Journal of Political Economy, 94(5), pp. 1002–1037.
Salganik, L.H. et al. (1999) Definition and selection of competencies (DeSeCo): Projects on competencies in the OECD context: Analysis of theoretical and conceptual foundations. Paris: OECD/SFSO. Available at: https://www.deseco.ch/bfs/deseco/en/index/02.parsys.53466.downloadList.62701.DownloadFile.tmp/1999.projectsoncompetenciesanalysis.pdf.
Rychen, D.S. and Salganik, L.H. (2002) Definition and selection of competences (DeSeCo): Theoretical and conceptual foundations: Strategy paper. Paris: OECD/DEELSA. Available at: https://www.voced.edu.au/content/ngv%3A9408.
Rychen, D.S. and Salganik, L.H. (eds) (2003) Key competencies for a successful life and a well-functioning society. Seattle, WA: Hogrefe & Huber Publishers / VOCEDplus.
Ryle, G. (1949) The concept of mind. Chicago, IL: University of Chicago Press.
Scriven, M. and Paul, R. (1987) 'Critical thinking as defined by the National Council for Excellence in Critical Thinking', paper presented at the 8th Annual International Conference on Critical Thinking and Education Reform, Sonoma State University, Rohnert Park, CA. The Foundation for Critical Thinking. Available at: https://www.criticalthinking.org/pages/defining-critical-thinking/766.
Schumann, M., et al. (1985) Industriearbeit und Arbeiterbewußtsein: Eine empirische Untersuchung über den Einfluss der aktuellen technischen Entwicklung auf die industrielle … Frankfurt am Main.
Schumpeter, J.A. (1934) The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle. Cambridge, MA: Harvard University Press (Harvard Economic Studies, 46).
Smith, A. (1776) An inquiry into the nature and causes of the wealth of nations. London: W. Strahan and T. Cadell.
Solow, R.M. (1957) 'Technical change and the aggregate production function', Review of Economics and Statistics, 39, pp. 312–320.
Sugiyama, K. and Meyer, B. (2008) 'Knowledge process analysis: Framework and experience', Journal of Systems Science and Systems Engineering, 17(1), pp. 86–109. https://doi.org/10.1007/s11518-008-5069-7.
Szafrański, M. (2019) 'Threefold nature of competences in enterprise management: A qualitative model', in Tomé, E., Cesário, F. and Soares, R.R. (eds) Proceedings of the 20th European Conference on Knowledge Management, Universidade Europeia de Lisboa, Lisbon, Portugal, 5–6 September 2019, Vol. 2, pp. 1006–1015.
Tafti, S.F., et al. (2012) 'Explaining evolutionary trend of strategic planning from traditional economy to innovation economy', Procedia – Social and Behavioral Sciences, 58, pp. 56–65.
Toffler, A. (1980) The third wave. New York, NY: William Morrow.
Tsoukas, H. (1997) 'The tyranny of light: The temptations and the paradoxes of the information society', Futures, 29 (9), pp. 827–843. https://doi.org/10.1016/S0016-3287(97)00035-9.
UNDP and MBRF (2019) Global knowledge index 2019. Dubai: UNDP/MBRF.

UNESCO (2015) Education 2030: Incheon declaration and framework for action for the implementation of Sustainable Development Goal 4. Paris: UNESCO. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000245656.
UNESCO (2017) Education for sustainable development goals: Learning objectives. Paris: UNESCO. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000247444.
UNESCO (2018) ICT competency framework for teachers. Version 3. Paris: UNESCO. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000265721.
Unger, R.M. (2022) The knowledge economy. London: Verso.
Weinert, F.E. (2001) 'Concepts of competence: A conceptual clarification', in Defining and selecting key competencies: Theoretical and conceptual foundations. Göttingen: Hogrefe & Huber, pp. 45–66.
Weinert, F.E. (2002) 'Vergleichende Leistungsmessung in Schulen – eine umstrittene Selbstverständlichkeit', in Leistungsmessungen in Schulen. Weinheim: Beltz (2., unveränd. Aufl.), pp. 17–31. Available at: https://bibliographie.ub.uni-due.de/servlets/DozBibEntryServlet?id=ubo_mods_000046878.
World Economic Forum (2020) The future of jobs report 2020. Geneva: WEF. Available at: https://www.weforum.org/reports/the-future-of-jobs-report-2020.
World Economic Forum (2023) The future of jobs report 2023. Geneva: WEF. Available at: https://www.weforum.org/publications/the-future-of-jobs-report-2023/.
Zhu, Y., Sun, X., Cai, M., Shi, J. and Li, X. (2024) 'Construction of a competency evaluation model for clinical research coordinators in China: A study based on the Delphi method and questionnaire survey', BMJ Open, 14. https://doi.org/10.1136/bmjopen-2024-083957.

Green Performance in SMEs: The Nexus of Knowledge Management and Cultural Infrastructure under Transformational Leadership

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Abstract: Escalating global environmental challenges have intensified pressure on businesses to adopt sustainable practices, particularly within Small and Medium-sized Enterprises (SMEs). While leadership is recognized as a pivotal driver of this transition, the specific internal organizational mechanisms through which leadership influences green outcomes remain underexplored. This study examined the impact of transformational leadership on green business performance in SMEs, focusing specifically on the mediating roles of knowledge management practices and cultural infrastructure. A quantitative research design was employed, utilizing survey data collected from 135 SMEs across diverse manufacturing and service sectors in Southeast Asia. Structural equation modeling was used to test the hypothesized relationships in the study. The findings indicate a significant positive relationship between transformational leadership and green business performance. Crucially, both knowledge management practices and cultural infrastructure were found to mediate this relationship significantly, both individually and in concert. This study underscores the strategic importance of nurturing robust knowledge management systems and a supportive cultural environment to translate transformational leadership initiatives into tangible green outcomes within SME. This study contributes to a more nuanced understanding of the pathways through which leadership fosters sustainability, offering interdisciplinary insights relevant to management, economics, and environmental studies.

Keywords: Transformational leadership, Green business performance, SMEs, Knowledge management, Cultural infrastructure

1. Introduction

Green Business Performance has emerged as a multifaceted construct encompassing the environmental, economic, and social dimensions of sustainability within an organizational context (Berberoglu, Kazancoglu and Sagnak, 2023). It extends beyond simple pollution control to include eco-innovation, resource efficiency, waste reduction, and integration of environmental considerations into core business strategies (Patwary *et al.*, 2024). Achieving superior green business performance is increasingly recognized as a critical factor for firms seeking to thrive in an environmentally conscious market (Wang *et al.*, 2023).

Small and Medium-sized Enterprises (SMEs) constitute approximately 90% of businesses worldwide and generate between 60% and 70% of employment across OECD countries (OECD, 2023). In developing economies, formal SMEs contribute up to 40% of the GDP, with these figures being significantly higher when informal businesses are included (World Bank, 2025). Despite their smaller scale, the collective environmental footprint of SMEs is substantial, accounting for approximately 60-70% of global industrial pollution (United States Environmental Protection Agency, 2025). Recent estimates suggest that SMEs collectively account for nearly 50% of global carbon emissions from business activities and consume more than 13% of the total global energy supply. The environmental impact of SMEs varies significantly across sectors and regions. Manufacturing SMEs, particularly in resource-intensive industries such as textiles, food processing, and metal fabrication, often generate disproportionate environmental impacts relative to their size (Chaudhry, Kumar and Chaudhary, 2025). In the emerging economies of Southeast Asia, where this study is situated, SMEs account for over 97% of all enterprises and employ 69% of the labor force, while contributing approximately 41% of GDP (United Nations, 2021). However, environmental compliance rates among these enterprises remain low, with only 30% of SMEs implementing systematic environmental management practices.

Leadership has emerged as a pivotal driver of sustainability transitions in this challenging landscape. Empirical research has established that leadership approach significantly influences an organization's environmental

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orientation and performance, with transformational leadership demonstrating robust correlations with successful sustainability outcomes (Zafar, Suseno and Ho, 2023). A 2023 global survey of SME managers found that organizations with transformational leaders were 2.7 times more likely to successfully implement comprehensive sustainability initiatives than those with transactional leadership styles. Existing scholarly work has extensively explored the direct and indirect links between transformational leadership and various aspects of environmental performance, including eco-innovation, sustainable practices and employee green behavior. A consistent positive correlation has been established, indicating that leaders who inspire and intellectually stimulate their teams are more likely to achieve environmentally friendly outcomes. However, many studies demonstrating a direct link between transformational leadership and positive outcomes, including green performance, often treat internal organizational processes as a "black box" (Bui, 2024). While transformational leadership is a known driver, how it translates vision into tangible green actions frequently depends on the intermediate mechanisms. This implies the need to open the black box by investigating the specific pathways through which leadership influences green outcomes, providing a more granular understanding of the causal chain. The literature has highlighted the importance of effective knowledge management practices in improving environmental performance (Velte, 2023). Through enhanced knowledge acquisition, sharing, and utilization, organizations can foster eco-innovation, solve environmental problems more efficiently, and optimize resource use, leading to tangible green results (Ullah Khan *et al.*, 2023). Similarly, the role of organizational culture in fostering environmental responsibility and sustainability initiatives is well documented (Chang and Hung, 2021). A culture that values environmental stewardship can significantly influence employee attitudes and behaviors, thereby promoting the adoption of green practices (Su *et al.*, 2020).

The relationship between transformational leadership and green business performance has been established in multiple contexts (Awan *et al.*, 2023; Niazi *et al.*, 2023); however, a critical research problem persists: we lack a comprehensive understanding of the specific organizational mechanisms through which transformational leadership translates into tangible environmental outcomes in SMEs. This represents both theoretical and practical challenges. From a theoretical perspective, existing research has predominantly examined knowledge management practices and cultural infrastructure as isolated mediators rather than as interacting components of a complex system. Ullah Khan *et al.* (2023); Makhloufi (2024) have demonstrated the mediating role of knowledge management between leadership and sustainability outcomes, reporting effect sizes ranging from 0.31 to 0.47. Concurrently, research by Pradana *et al.* (2022); Fok *et al.* (2023) has established cultural infrastructure as a significant mediator in environmental performance models. However, these parallel research streams have primarily developed independently, resulting in a fragmented understanding of the interaction of these internal capabilities. This fragmentation is particularly problematic, given the empirical evidence suggesting potential synergistic effects between knowledge systems and organizational culture. Kirschning and Mrożewski (2024) reported that knowledge sharing effectiveness increased by 37% in organizations with supportive cultural elements compared to those with strong knowledge systems but weak cultural support. Similarly, Rafi *et al.* (2022) found that cultural elements moderated the relationship between knowledge practices and organizational agility, suggesting complex interdependencies that remain under-theorized in sustainability contexts. From a practical perspective, this research has significant implications for SMEs attempting to enhance their environmental performance.

This study addresses this research problem by examining how knowledge management practices and cultural infrastructure function independently and synergistically as mediators of the transformational leadership-green performance relationship in SMEs. By investigating these complex interactions through the lens of Dynamic Capability Theory (Teece, 2016), this study moves beyond identifying simple linear relationships to understanding how these capabilities combine to create higher-order dynamic capabilities that are essential for environmental adaptation in resource-constrained contexts. This integrated approach responds to calls from scholars (Khan *et al.*, 2023)(Khan et al., 2023; Kelly & Howard, 2022) for more sophisticated models of sustainability transformation that reflect the complex, systemic nature of organizational change processes. The findings of this study have significant implications for both theory development in the sustainability leadership domain and practical applications for SME managers seeking to enhance their organizations' green performance despite resource constraints. By illuminating the internal mechanisms that translate leadership vision into tangible environmental outcomes, this study contributes to a nuanced understanding of organizational sustainability transformation within the critical yet understudied SME context.

2. Literature Review and Hypotheses Development

2.1 Dynamic Capability Theory

Traditional resource-based view (RBV) perspectives have been criticized for their static orientation, focusing on resources as fixed assets rather than adaptable capabilities (Barney, 1991; Wernerfelt, 2006). This limitation is particularly problematic when examining environmental performance, which requires continuous adaptation to rapidly evolving stakeholder expectations, regulatory frameworks, and technological innovations (Teece, 2018). In response to these limitations, Dynamic Capability Theory (DCT) has emerged as a more robust theoretical lens for understanding how organizations achieve sustainable competitive advantages in volatile environments through their ability to "integrate, build, and reconfigure internal and external competences" (Teece, Pisano and Shuen, 1997).

While DCT has gained significant traction in strategic management research, its application in environmental sustainability contexts remains underdeveloped, particularly for SMEs. Scholars such as Jiang *et al.* (2018) have begun to explore how environmental dynamic capabilities manifest in entrepreneurial ventures. However, as Alkaraan *et al.* (2024) note, there remains an insufficient understanding of the specific micro-foundations that constitute these capabilities. This represents a critical gap, as theories developed primarily through studies of large organizations may not adequately capture the unique resource constraints and organizational flexibility characteristics of SMEs (Crossley, Elmagrhi and Ntim, 2021).

Several contradictions exist in the current DCT applications for sustainability. For example, while Kuuluvainen (2012) emphasized the importance of formalized sensing and seizing routines, Amoah *et al.* (2022) found that successful green SMEs often rely on informal, leader-driven processes for environmental adaptation. Similarly, Gui, Lei and Le (2024) highlight knowledge codification as essential for capability development, whereas Harsono *et al.* (2025) suggest that tacit knowledge embedded in organizational culture may be more valuable for SMEs' environmental performance. These contradictions suggest the need for a more nuanced theoretical framework that accounts for both the formal and informal elements of capability development in resource-constrained contexts.

This study addresses these theoretical contradictions by conceptualizing transformational leadership, knowledge management practices, and cultural infrastructure not as isolated resources but as interconnected micro-foundations of dynamic capabilities that enable SMEs to sense environmental challenges, seize green opportunities, and transform their operations accordingly. This perspective extends DCT by examining how these elements function both independently and synergistically to enhance SME's adaptive capacity for environmental performance. The theoretical model is shown in Figure 1.

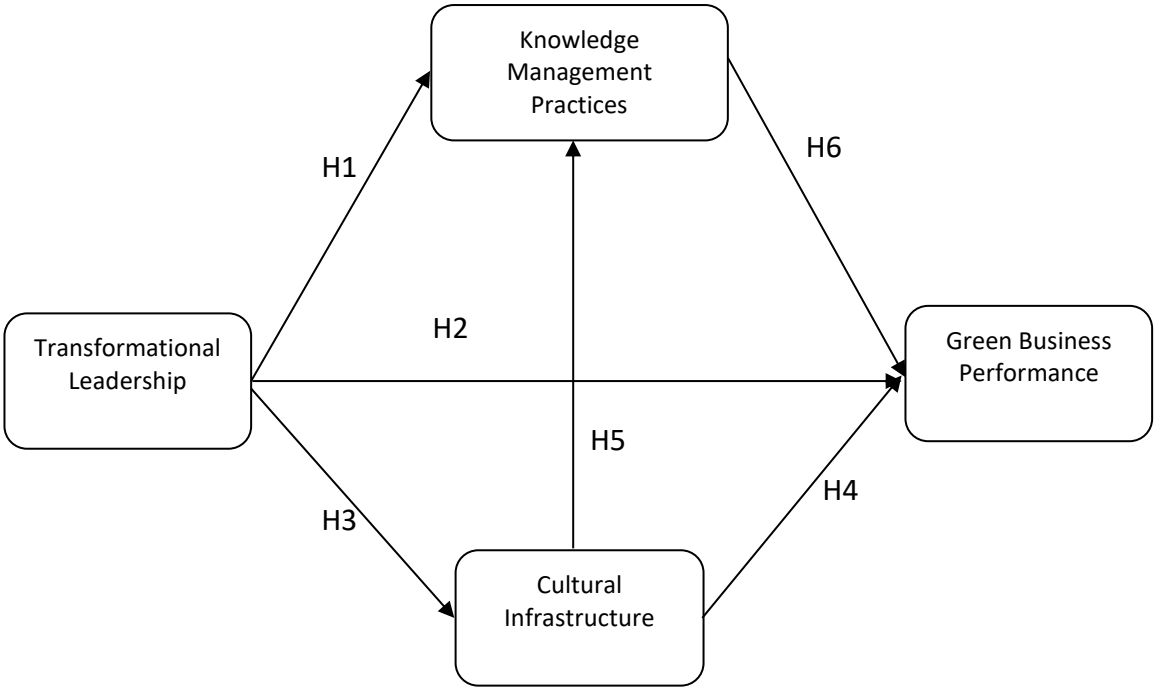

Figure 1: Theoretical model

2.2 Research Hypotheses Development

Transformational leadership (TL) is widely recognized for its profound influence on various organizational processes, including knowledge management (KM) (Harsono *et al.*, 2025). Leaders exhibiting idealized influence serve as role models, inspiring trust and respect, which are foundational for fostering an environment conducive to knowledge sharing and creation (Al-Husseini, El Beltagi, and Moizer, 2021). When employees perceive their leaders as credible and trustworthy, they are more likely to engage in open communication and share valuable insights, even tacit knowledge that might otherwise remain siloed (Kılıç and Uludağ, 2021). This trust reduces the perceived risks associated with knowledge sharing, such as the fear of losing a competitive advantage or being exploited (Al-Husseini, El Beltagi,. Furthermore, inspirational motivation, a core component of TL, involves articulating a compelling vision and setting high expectations, which can energize employees to actively participate in knowledge-related activities (Nguyen, Shen and Le, 2022). By linking knowledge management initiatives to broader organizational goals and a shared purpose, transformational leaders can enhance employee motivation to contribute to and utilize organizational knowledge. This shared vision can transform knowledge sharing from a mere task into a collective endeavor aimed at achieving common objectives, such as improving efficiency and fostering innovation (Bui, 2024).

The direct link between transformational leadership and various aspects of organizational performance, including environmental and green outcomes, has been a consistent theme in recent management literature (Zhao and Huang, 2022). Transformational leaders are uniquely positioned to champion sustainability initiatives and drive green business performance (GBP) because of their inherent characteristics (Niazi *et al.*, 2023). Through idealized influence, transformational leaders serve as powerful role models for promoting environmental responsibility (Awan *et al.*, 2023). When leaders demonstrate a genuine commitment to sustainability, employees are more likely to internalize these values and integrate them into their daily work practices (Majali *et al.*, 2022). This moral and ethical appeal can inspire employees to go beyond their prescribed duties and engage in discretionary pro-environmental behaviors such as conserving resources, reducing waste, and suggesting eco-friendly improvements (Le *et al.*, 2024). Their credibility and trustworthiness make their environmental vision more compelling and actionable (Tosun *et al.*, 2022).

Organizational culture, also known as cultural infrastructure (CI), represents the shared values, beliefs, norms, and assumptions that guide behavior within an organization (Christopher Mittelstaedt, 2024). Transformational leadership is widely acknowledged as a powerful force in shaping and transforming the organizational culture (Hofstede, 2011; Khoa and Huynh, 2024). Through their actions and communication, leaders can significantly influence prevailing cultural norms and values (Madi Odeh *et al.*, 2023). Through idealized influence, transformational leaders embody the values and behaviors they wish to see in their organizations (Velarde *et al.*, 2022). By consistently demonstrating a commitment to specific values, such as environmental responsibility, innovation, or collaboration, they serve as powerful role models, encouraging employees to adopt these values as their own (Virgiawan, Riyanto and Endri, 2021). Consistent modeling helps embed desired cultural traits within the organizational fabric (Qalati *et al.*, 2022). For instance, a leader who consistently prioritizes sustainability in decision-making sends a clear message about the importance of green values, thereby fostering a pro-environmental culture (Ismail, 2025). Therefore, this study proposes the following three hypotheses.

H1: Transformational Leadership positively impacts the Knowledge Management practices of SME.

H2: Transformational Leadership positively impacts the Green Business Performance of SME.

H3: Transformational Leadership positively impacts the cultural infrastructure of SMEs.

A cultural infrastructure that prioritizes environmental stewardship and sustainability can significantly enhance an SME's green business performance (Pradana *et al.*, 2022). A pro-environmental cultural infrastructure instills shared values and beliefs that emphasize ecological responsibility among employees (Abbas and Khan, 2023). When environmental protection is deeply embedded in organizational values, it becomes an intrinsic part of daily operations rather than a mere compliance requirement (Fok *et al.*, 2023). This leads to a collective commitment to green initiatives and fosters a sense of shared ownership of environmental outcomes (Begum *et al.*, 2023). Employees are more likely to proactively identify opportunities for waste reduction, energy efficiency, and eco-innovation when their actions align with their workplace's core values (Kamran *et al.*, 2025).

The relationship between cultural infrastructure and knowledge management practices is well-established and symbiotic in organizational theory (Rafi *et al.*, 2022). A supportive cultural infrastructure is a prerequisite for effective knowledge management, as it shapes employees' attitudes and behaviors towards knowledge creation, sharing, and utilization (Khoa and Huynh, 2023). A cultural infrastructure that values openness, trust, and

collaboration is fundamental to fostering knowledge sharing (Kirschning and Mrożewski, 2024). In an environment where employees trust their colleagues and leaders, they are more willing to share their tacit and explicit knowledge, knowing that their contributions will be valued and not exploited (Mojibi, Khojasteh and Khojasteh-Ghamari, 2015). Conversely, a culture characterized by distrust or competition can lead to knowledge hoarding, severely impeding effective KMP (Lam *et al.*, 2021). A collaborative culture encourages cross-functional communication and teamwork, which are essential for integrating diverse knowledge sets and solving complex problems (Azeem *et al.*, 2021). Hence, two hypotheses are proposed:

H4: Cultural Infrastructure positively impacts the Green Business Performance of SME.

H5: Cultural Infrastructure positively impacts Knowledge Management Practices of SME.

Effective Knowledge Management Practices are increasingly recognized as critical enablers for organizations seeking to improve their environmental performance and achieve superior green business performance (Abbas and Khan, 2023; Sahoo, Kumar and Upadhyay, 2023). The systematic creation, acquisition, sharing, and application of knowledge enables organizations to gain the necessary insights and capabilities to address environmental challenges and capitalize on green opportunities (Nasir *et al.*, 2024). Robust KMP facilitates the acquisition and creation of environmental knowledge (Makhloufi, 2024). This includes knowledge of new eco-friendly technologies, sustainable production processes, environmental regulations, market demands for green products, and best practices in waste management (Al-Husain *et al.*, 2025). By actively seeking and generating such knowledge, SMEs can identify areas for environmental improvement and innovation (Shehzad *et al.*, 2024). For example, acquiring knowledge of circular economy principles can lead to significant reductions in waste and resource consumption (Yin, Yu and Zhang, 2024). Hence, this study proposes the following hypothesis:

H6: Knowledge Management Practices positively impact the Green Business Performance of SME.

Transformational leadership inspires followers to go beyond transactional goals and internalize a broader organizational vision, often emphasizing innovation, learning, and sustainability. Transformational leaders foster a culture of knowledge sharing through intellectual stimulation and individualized consideration (Bass and Avolio, 1989). Such leaders encourage employees to create, share, and apply knowledge that supports environmental initiatives and green innovation (Dat *et al.*, 2025). Knowledge management practices (KMP), including knowledge acquisition, sharing, and application, serve as a critical mechanism linking leadership behaviors to performance outcomes (Nonaka, Toyama, and Konno, 2000). Through effective KMP, organizations can translate leaders' visions into actionable environmental strategies, such as eco-efficient production, sustainable supply chain management, and green product development. Nguyen and Sharma (2024); Chen *et al.* (2025) have shown that KMP mediates the effect of transformational leadership on innovation performance. Extending this to the environmental domain, it is reasonable to argue that transformational leaders enhance green business performance by establishing effective KMP systems that promote continuous learning, problem solving, and eco-innovation. Hence, this study proposes the following hypothesis:

H7: Knowledge Management Practices positively mediates the relationship between Transformational Leadership and Green Business Performance.

A strong cultural infrastructure can transform the visionary messages of transformational leaders into a collective commitment toward environmental goals. Transformational leaders, through idealized influence and inspirational motivation, instill pro-environmental values and encourage employees to align their behaviors with the organization's sustainability vision (Getzner, 2024). In this context, cultural infrastructure serves as a mediating mechanism by embedding green values into organizational routines, rituals, and decision-making processes (Christopher Mittelstaedt, 2024). When leaders promote trust, empowerment, and ethical responsibility, these values become integral to the organization's cultural fabric, which in turn drives long-term green performance outcomes—such as reduced environmental impact, compliance with environmental regulations, and an enhanced stakeholder reputation. Empirical evidence suggests that leadership styles can shape an organization's culture, which subsequently influences environmental and innovation outcomes (Khan *et al.*, 2020; Jain and Sharma, 2025). Therefore, hypothesis H8 was proposed:

H8: Cultural Infrastructure mediates positively the relationship between Transformational Leadership and Green Business Performance

3. Method

All constructs in this study were measured using established scales adapted from prior validated research to ensure reliability and validity within the specific context of Vietnamese SMEs. A 7-point Likert scale, ranging from

1 (Strongly Disagree) to 7 (Strongly Agree), was utilized for all items, a common practice in social science research for capturing nuanced perceptions and attitudes (Nunnally and Bernstein, 1994; Hair *et al.*, 2019). This scale format provides sufficient granularity for statistical analysis while being easily comprehensible to respondents.

Transformational leadership (TRL) was measured using a 5-item scale adapted from the Multifactor Leadership Questionnaire (MLQ) developed by Bass and Avolio (1989), a widely recognized and empirically robust instrument for assessing transformational leadership behaviors (Nguyen and Sharma, 2024; Chen *et al.*, 2025). The MLQ's dimensions of idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration are well-suited to capture the essence of leaders who inspire and empower their followers. Knowledge management practices (KMP) were assessed using a 4-item scale derived from the work of Khoa and Huynh (2023); Khoa (2024), which focuses on the processes of knowledge creation, sharing, and application within an organization. This scale was chosen for its comprehensive coverage of key KM dimensions relevant to organizational performance and innovation. Cultural infrastructure (CUI) was measured using a 4-item scale adapted from Denison and Mishra (1995); Tsetim, Adegbe and Agema (2020), focusing on cultural traits such as adaptability, consistency, involvement, and mission, particularly as they relate to environmental values and openness to change. This scale is theoretically grounded in organizational culture literature and has been widely used to assess cultural dimensions that influence organizational effectiveness. Green Business Performance (GBP) was measured using a 4-item scale adapted from previous studies on environmental performance and sustainability outcomes (e.g., Ullah Khan *et al.* (2023); Phu and Khoa (2025)). This scale captures various facets of GBP, including eco-innovation, resource efficiency, and waste reduction. To ensure content validity, the questionnaire was reviewed by three academic experts and two industry practitioners. A pilot test with 30 participants was conducted to refine wording and clarity. Reliability was assessed through Cronbach's alpha and composite reliability (CR), both exceeding the 0.70 threshold. Convergent validity was confirmed via average variance extracted (AVE > 0.50), and discriminant validity was evaluated using the Fornell–Larcker criterion and the HTMT ratio, both within recommended limits (HTMT < 0.85).

A non-probability sampling strategy, specifically a combination of convenience sampling and snowball sampling, was employed to select 153 SME managers. Convenience sampling was initially used to access a readily available group of managers through professional networks and business associations in major economic hubs of Vietnam (e.g., Ho Chi Minh City, Hanoi, Danang). All procedures followed the ethical standards of academic research and the Institutional Review Board of the Industrial University of Ho Chi Minh City. Participation was voluntary, and respondents were assured of anonymity and confidentiality throughout the study. Informed consent was obtained at the beginning of the survey, and no identifiable personal data were collected. Participants were informed that the data would be used solely for academic purposes and that they could withdraw at any time without consequences. Ethical clearance was granted prior to data collection.

Data collection spanned from January to May 2025. Upon receipt, all collected data underwent a rigorous cleaning process, including checking for missing values, outliers, and potential response biases (e.g., straight-lining). Incomplete questionnaires or those with clear patterns of inconsistent responses were excluded from the final dataset, resulting in a robust sample of 153 valid responses for analysis. The sample size of 153 managers is considered adequate for conducting Partial Least Squares Structural Equation Modeling (PLS-SEM), particularly given the number of constructs and indicators in the model, which adheres to the general guidelines for minimum sample sizes in PLS-SEM (Hair et al., 2017). The sample size was determined based on both statistical power analysis and methodological recommendations for PLS-SEM. Following the "10-times rule" (Hair et al., 2019), the minimum required sample equals ten times the most significant number of structural paths directed at any construct in the model. Since the most complex construct in this model had four predictors, a minimum of 40 respondents was required to ensure statistical power. However, to enhance statistical power and generalizability, 153 valid responses were collected, which far exceeded the minimum requirement for this study.

Additionally, a priori power analysis using G*Power 3.1 confirmed that this sample size achieves a power level above 0.95 for detecting medium effect sizes ($f^2 = 0.15$) at $\alpha = 0.05$. The demographic profile of the 153 SME managers who participated in the study is summarized in Table 1. The sample represents a diverse range of firm sizes, primary industries, and green application fields, providing a comprehensive overview of the SME landscape in Vietnam.

Table 1: Respondent Descriptive Statistics (N=153)

Characteristic	Category	Frequency	Percentage (%)
Firm Size	Small (10-49 employees)	85	55.6
	Medium (50-250 employees)	68	44.4
Primary Industry	Manufacturing	62	40.5
	Services	58	37.9
	Retail/Wholesale	21	13.7
	Agriculture/Food Processing	12	7.8
Green Application Field	Waste Reduction/Recycling	55	35.9
	Energy Efficiency	48	31.4
	Sustainable Product/Service Development	30	19.6
	Green Supply Chain Management	20	13.1

Smart PLS 4.0 was selected as the primary analytical tool for several reasons. First, Partial Least Squares Structural Equation Modeling (PLS-SEM) is particularly appropriate for exploratory and prediction-oriented research, especially when the conceptual model involves multiple mediating constructs (Hair et al., 2021). Second, PLS-SEM is suitable for complex models with latent variables measured by multiple indicators and does not require data to meet strict normality assumptions. Third, compared with covariance-based SEM (e.g., AMOS or LISREL), PLS-SEM is more robust for smaller to moderate sample sizes and for models emphasizing variance explanation rather than model fit (Sarstedt et al., 2019). Given that the study focused on predictive relationships and mediation effects rather than theory confirmation, Smart PLS was deemed more suitable.

Given that all data were self-reported and collected from a single source, potential standard method bias (CMB) was carefully addressed. Procedurally, CMB was minimized by assuring respondent anonymity, varying item order, and using different response formats. Statistically, Harman's single-factor test revealed that no single factor accounted for more than 40% of the total variance. Additionally, a full collinearity test (VIF < 3.3) in Table 4 confirmed the absence of substantial CMB, following Kock's (2015) guidelines. Before analysis, skewness and kurtosis values were examined, indicating that the data did not fully meet multivariate normality assumptions. Accordingly, PLS bootstrapping procedures with 5,000 resamples were applied to estimate standard errors and significance levels, as recommended by Hair et al. (2021). Bootstrapping enhances the robustness of path estimates and provides bias-corrected confidence intervals, thereby ensuring the reliability of hypothesis testing results.

4. Results

Convergent validity assesses the extent to which items that are theoretically related are, in fact, related in the empirical data. It is typically evaluated using Cronbach's Alpha (α), Composite Reliability (CR), Average Variance Extracted (AVE), and Outer Loadings. For good convergent validity, Cronbach's Alpha and CR values should ideally be above 0.70, indicating internal consistency and reliability of the scales (Hair *et al.*, 2019). AVE values should be above 0.50, signifying that a latent construct accounts for more than half of the variance of its indicators (Fornell and Larcker, 1981). Outer loadings (OL) of individual items should be above 0.70, indicating that the items are strongly associated with their respective constructs. Table 2 presents the results of convergent validity for all constructs. As evidenced in Table 2, all constructs demonstrate excellent convergent validity. The Cronbach's Alpha values range from 0.763 (KMP) to 0.909 (TRL), all of which are well above the recommended threshold of 0.70, confirming the high internal consistency and reliability of the measurement scales. Similarly, the Composite Reliability (CR) values, ranging from 0.849 (KMP) to 0.931 (TRL), further reinforce the reliability of the constructs, indicating that the items consistently measure their respective latent variables. The Average Variance Extracted (AVE) values for all constructs are also robust, ranging from 0.584 (KMP) to 0.769 (CUI), all of which exceed the 0.50 criterion. This indicates that more than 70% of the variance in the indicators is explained by their respective constructs, demonstrating strong convergent validity.

Furthermore, the outer loadings for all individual items fall within the range of 0.732 to 0.965, consistently above the 0.70 threshold. This confirms that each item contributes significantly to its respective construct, providing strong empirical support for the measurement model's convergent validity. These results collectively affirm that

the scales used in this study are reliable and accurately measure the intended constructs within the context of Vietnamese SMEs.

Table 2: Convergent Validity Results

Items	Outer loading				α	CR	AVE
	CUI	GBP	KMP	TRL			
CUI1	0.813				0.899	0.93	0.769
CUI2	0.867						
CUI3	0.856						
CUI4	0.965						
GBP1		0.776			0.864	0.909	0.715
GBP2		0.805					
GBP3		0.825					
GBP4		0.963					
KMP1			0.760		0.763	0.849	0.584
KMP2			0.732				
KMP3			0.801				
KMP4			0.762				
TRL1				0.825	0.909	0.931	0.729
TRL2				0.804			
TRL3				0.861			
TRL4				0.860			
TRL5				0.915			

Discriminant validity ensures that a construct is truly distinct from other constructs in the model. It confirms that a construct measures something unique and not merely a reflection of other constructs. This study assessed discriminant validity using the Heterotrait-Monotrait Ratio (HTMT) criterion, which is considered a more robust method than the Fornell-Larcker criterion, particularly in PLS-SEM (Henseler, Ringle and Sarstedt, 2014). As presented in Table 3, all HTMT values are well below the conservative threshold of 0.85 (and also below 0.90). The highest HTMT value observed is 0.707 (between GBP and CUI), which is comfortably within the acceptable range. This indicates that each construct in the model is empirically distinct from the others, confirming strong discriminant validity. The low inter-construct correlations, as indicated by the HTMT ratios, suggest that the measurement model effectively differentiates between the latent variables. This robust discriminant validity provides confidence that the study's findings are based on distinct conceptualizations and measurements of transformational leadership, knowledge management practices, cultural infrastructure, and green business performance, thereby strengthening the credibility of the subsequent structural model analysis.

Table 3: Discriminant validity Results

	CUI	GBP	KMP	TRL
CUI				
GBP	0.707			
KMP	0.519	0.561		
TRL	0.366	0.469	0.445	

Based on the updated data in Table 4, the structural model demonstrates moderate explanatory power and strong predictive relevance across all endogenous constructs. The R^2 values indicate that Transformational Leadership (TRL) and Cultural Infrastructure (CUI) explain 25.0% of the variance in Knowledge Management Practices (KMP), while TRL accounts for 13.4% of the variance in Cultural Infrastructure (CUI). Green Business Performance (GBP) shows a higher R^2 value of 0.480, indicating that TRL, KMP, and CUI together explain 48.0% of its variance. Although these R^2 values fall within the low to moderate range, they still reflect meaningful explanatory contribution within the model. The f^2 effect sizes further clarify the relative influence of each

predictor. TRL has minor effects on KMP ($f^2 = 0.082$), CUI ($f^2 = 0.154$), and GBP ($f^2 = 0.038$), suggesting that while TRL contributes to each construct, its influence is modest. KMP shows a medium effect on GBP ($f^2 = 0.203$), highlighting its important role in enhancing green business performance. Similarly, CUI contributes a small-to-medium effect on GBP ($f^2 = 0.139$), reinforcing its relevance as a predictor of green business outcomes. The Q^2_predict values for KMP (0.125), CUI (0.108), and GBP (0.206) are all well above zero, confirming the model's predictive relevance. Notably, GBP exhibits the strongest predictive accuracy, consistent with its higher R^2 value. Overall, despite moderate explanatory strength, the model demonstrates solid predictive capability, indicating that the relationships among TRL, KMP, CUI, and GBP are meaningful in forecasting future outcomes, particularly in the context of green business performance.

Table 4: R^2, f^2, and Q^2 Values

Endogenous Construct	R^2	f^2 (from TRL)	f^2 (from KMP)	f^2 (from CUI)	Q^2_predict
Knowledge Management Practices (KMP)	0.250	0.082	-	0.132	0.125
Cultural Infrastructure (CUI)	0.134	0.154	-	-	0.108
Green Business Performance (GBP)	0.480	0.09	0.038	0.319	0.206

Table 5 presents the PLS-SEM path coefficients and VIF values for all relationships. Additionally, Variance Inflation Factor (VIF) values were checked to ensure the absence of multicollinearity, with VIF values below 3 indicating the absence of multicollinearity issues (Hair Jr *et al.*, 2016). All hypotheses were accepted, as indicated by significant p-values (typically < 0.05) and t-values greater than 1.96 (for a two-tailed test at 5% significance level).

Table 5: Path Coefficients, VIF, and f^2 Values

Hypothesis	Relationship	Beta (β)	Std. Error	t-value	p-value	VIF	Outcome
H1	TRL -> KMP	0.266	0.087	3.094	0.002	1.154	Accepted
H2	TRL -> GBP	0.241	0.059	6.894	0.000	1.249	Accepted
H3	TRL -> CUI	0.366	0.088	4.139	0.000	1.000	Accepted
H4	CUI -> GBP	0.466	0.066	6.894	0.000	1.306	Accepted
H5	CUI -> KMP	0.338	0.119	2.892	0.005	1.154	Accepted
H6	KMP -> GBP	0.162	0.078	2.079	0.038	1.334	Accepted

Beyond direct effects, this study also investigated the indirect effects of transformational leadership on green business performance through the mediating roles of cultural infrastructure. Mediation analysis was conducted using the bootstrapping procedure in SmartPLS software, which is robust for estimating indirect effects (Preacher, Rucker, &. Table 6 presents the results of the mediation analysis. Among the examined pathways, cultural infrastructure emerges as a significant mediator, as evidenced by the positive and statistically significant indirect effect of TRL → CUI → GBP (β = 0.123, p = 0.022). This finding suggests that transformational leadership primarily enhances green business performance by fostering a supportive cultural environment that reinforces sustainability-oriented values, norms, and behaviors.

In contrast, knowledge management practices do not independently mediate the TRL–GBP relationship, as the indirect effect through KMP is small and non-significant (β = 0.043, p = 0.13).

Additionally, the sequential mediation pathway TRL → CUI → KMP → GBP does not reach significance (β = 0.02, p = 0.235), suggesting that although CUI contributes to KMP, the accumulated indirect influence is insufficient to translate leadership effects into performance gains through both mediators simultaneously. Nevertheless, the total indirect effect of TRL on GBP remains significant, indicating that transformational leadership has a meaningful indirect influence on green performance, with cultural infrastructure playing a central mediating role in this process. This highlights the importance of cultivating a sustainability-oriented culture as the primary mechanism linking leadership behaviors to enhanced environmental outcomes.

Table 6: Mediation Analysis Results (Indirect Effects)

Relationship	Indirect effect (β)	Std. Error	t-value	p-value	Outcome
TRL -> KMP -> GBP	0.043	0.028	1.516	0.130	No Mediation
TRL -> CUI -> GBP	0.123	0.054	2.283	0.022	Significant Mediation

Relationship	Indirect effect (β)	Std. Error	t-value	p-value	Outcome
TRL -> CUI -> KMP -> GBP	0.020	0.017	1.188	0.235	No Mediation
Total Effect (TRL -> GBP)	0.233	0.061	3.819	0.000	Significant

5. Discussion

The research result was presented in Figure 2. Our results strongly support H1, demonstrating that Transformational Leadership has a significant and positive impact on Knowledge Management Practices in SMEs (β = 0.266, p < 0.01). This aligns seamlessly with prior research that posits transformational leaders, through their idealized influence and intellectual stimulation, foster an environment of trust and open communication that is conducive to knowledge creation and sharing (Al-Husseini, El Beltagi and Moizer, 2021). In the unique landscape of SMEs, where formal knowledge systems might be less developed, the personal influence of a transformational leader becomes even more critical. Their ability to inspire a shared vision for learning and to provide individualized consideration for employee development directly translates into more effective knowledge acquisition, dissemination, and application (Al-Husseini, El Beltagi and Moizer, 2021). This finding extends the literature by empirically validating this relationship within a specific, under-researched context, emphasizing how the human element of leadership can overcome structural limitations in smaller firms to cultivate a vibrant knowledge ecosystem. This is particularly relevant in emerging economies like Vietnam, where informal networks often play a more significant role than formalized structures in knowledge transfer (Kılıç and Uludağ, 2021).

The direct positive impact of Transformational Leadership on Green Business Performance (H2: β = 0.241, p < 0.001) is consistent with a growing body of literature that links visionary leadership to improved environmental outcomes (Niazi *et al.*, 2023). Transformational leaders, by inspiring commitment and stimulating innovation, directly motivate employees to engage in pro-environmental behaviors and seek out green solutions (Awan *et al.*, 2023). This direct effect highlights the leader's pivotal role in driving sustainability, even before considering the mediating internal mechanisms (Le *et al.*, 2024). However, the relatively smaller effect size compared to the indirect pathways (as seen in the R^2 and f^2 values for GBP and the mediation analysis) suggests that while direct leadership is important, its full potential is realized when channeled through robust internal capabilities. This finding subtly reinforces the "black box" argument from the introduction, indicating that while a direct link exists, the *how* is equally, if not more, important for a comprehensive understanding of leadership's impact on green performance.

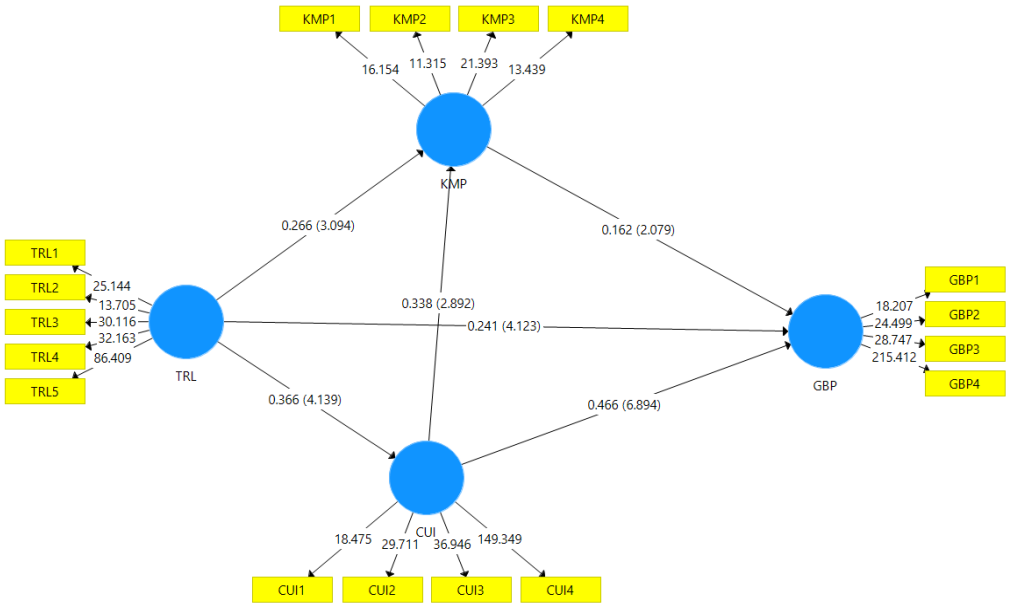

Figure 2: The PLS-SEM result

Similarly, H3, which posited a positive impact of Transformational Leadership on Cultural Infrastructure, was strongly supported (β = 0.366, p < 0.001). This result aligns with established theories on the role of leadership in shaping organizational culture (Hofstede, 2011; Khoa and Huynh, 2024). Transformational leaders, by

embodying desired values (idealized influence) and articulating a compelling future (inspirational motivation), effectively instill a cultural fabric that is adaptable, collaborative, and mission-driven (Madi Odeh *et al.*, 2023). For SMEs, the leader's direct engagement and pervasive influence mean that their values and vision are more readily absorbed into the nascent or evolving cultural infrastructure (Qalati *et al.*, 2022). This study explicitly highlights how transformational leaders can cultivate a pro-environmental cultural infrastructure, a critical precursor to green initiatives, by consistently prioritizing sustainability and encouraging employees to adopt eco-friendly norms (Ismail, 2025). This extends the cultural leadership literature by focusing on the specific outcome of a green-oriented culture, demonstrating that leaders are not just agents of general cultural change but can specifically steer culture towards sustainability.

Hypothesis H4, confirming that Cultural Infrastructure positively impacts Green Business Performance ($\beta = 0.466$, $p < 0.001$), underscores the profound influence of an organization's underlying values on its environmental actions. A pro-environmental and adaptable culture fosters a collective commitment to sustainability, encouraging employees to proactively engage in environmentally friendly behaviors and adopt eco-friendly initiatives (Abbas and Khan, 2023). This cultural alignment ensures that green strategies are not merely superficial or top-down mandates but are organically integrated into the daily operations and decision-making processes of the SME (Pradana *et al.*, 2022). The significant R^2 value for GBP (0.480) further emphasizes the combined explanatory power of TRL, KMP, and CUI. This high R^2 suggests that these three constructs, particularly through their mediating interplay, account for a substantial portion of the variance in green business performance, indicating a robust and comprehensive model.

Crucially, the study's findings illuminate the significant mediating roles of KMP and CUI. H5, confirming that Cultural Infrastructure has a positive impact on Knowledge Management Practices ($\beta = 0.338$, $p < 0.01$), aligns with the understanding that culture provides fertile ground for knowledge to flourish (Kirschning and Mrożewski, 2024). A culture of trust, openness, and collaboration, fostered by transformational leaders, directly facilitates knowledge sharing and creation, thereby reducing barriers to information flow and encouraging collective learning (Mojibi, Khojasteh and Khojasteh-Ghamari, 2015). This is particularly vital in SMEs, where informal knowledge networks are often more prevalent than formal systems; a supportive culture ensures these informal channels are effective and productive (Lam *et al.*, 2021). This finding reinforces the sequential nature of some organizational capabilities, where culture can precede and enable effective knowledge management, providing a deeper understanding of the antecedents of robust KM systems.

Furthermore, H6, which established a positive impact of Knowledge Management Practices on Green Business Performance ($\beta = 0.162$, $p < 0.05$), is strongly supported. This finding is consistent with the literature, which emphasizes KMP as a critical enabler for eco-innovation and environmental problem-solving (Nasir *et al.*, 2024). When SMEs effectively acquire, share, and apply environmental knowledge—regarding new green technologies, waste reduction techniques, or sustainable supply chain practices—they are better equipped to implement tangible improvements in their green performance (Abbas and Khan, 2023; Sahoo, Kumar and Upadhyay, 2023). This is particularly relevant for resource-constrained SMEs, where efficient knowledge utilization can compensate for limited financial resources in their pursuit of sustainability (Makhloufi, 2024). The ability to leverage existing and newly acquired knowledge efficiently becomes a strategic asset for SMEs navigating environmental demands.

The study's most significant finding is that Cultural Infrastructure serves as the primary mediating mechanism between Transformational Leadership and Green Business Performance ($\beta = 0.123$, $p = 0.022$). This finding strongly aligns with Dynamic Capability Theory (Teece, 2016), which emphasizes how organizational culture serves as a foundational micro-foundation for adaptive capabilities. This finding is particularly relevant in the Vietnamese context, where collectivist cultural values traditionally emphasize group harmony and shared responsibility (Hofstede, 2011). Vietnamese SMEs operate within a cultural framework where leadership influence is often more pronounced due to hierarchical respect and collective decision-making processes (Khoa and Huynh, 2024). The significant mediation effect suggests that Vietnamese managers who demonstrate transformational leadership can leverage these cultural tendencies to embed environmental values deeply within their organizations, creating what Abbas and Khan (2023) describe as "organizational green culture." Contrary to theoretical expectations, Knowledge Management Practices did not significantly mediate the transformational leadership-green performance relationship ($\beta = 0.043$, $p = 0.130$). This finding challenges much of the existing literature, which positions knowledge management as a critical pathway for leadership influence on performance outcomes (Al-Husseini, El Beltagi and Moizer, 2021). However, this result makes practical sense within the Vietnamese SME context. Many Vietnamese SMEs operate with informal knowledge-sharing systems rather than formalized knowledge management structures (Lam *et al.*, 2021). The limited financial resources

and technical expertise characteristic of Vietnamese SMEs may constrain their ability to develop sophisticated knowledge management practices that can effectively mediate leadership influence, as Kirschning and Mrożewski (2024) note. Knowledge sharing effectiveness may depend more on supportive cultural elements than on formal knowledge systems, which aligns with this study's findings. The non-significant mediation suggests that in Vietnamese SMEs, transformational leaders may need first to establish cultural foundations before knowledge management practices can become effective mediators. This interpretation is supported by the significant direct relationship between Cultural Infrastructure and Knowledge Management Practices ($\beta = 0.338$, $p < 0.01$), indicating that culture precedes and enables effective knowledge management in this context.

The study found that sequential mediation through Cultural Infrastructure to Knowledge Management Practices was not significant ($\beta = 0.020$, $p = 0.235$). This finding reveals important insights about the complexity of organizational transformation in Vietnamese SMEs. While Cultural Infrastructure influences both Green Business Performance directly and Knowledge Management Practices indirectly, the accumulated effect through both pathways does not create additional synergistic benefits. This result contrasts with Dynamic Capability Theory's emphasis on interconnected micro-foundations (Teece, Pisano and Shuen, 1997), suggesting that in the Vietnamese SME context, cultural and knowledge-based pathways may operate more independently than theoretically expected. The practical implication is that Vietnamese SME managers should prioritize cultural transformation as the primary mechanism for implementing green initiatives, while treating knowledge management as a secondary capability that emerges from, rather than amplifies, cultural change.

6. Conclusion

6.1 Theoretical Contributions

Firstly, this research significantly advances Dynamic Capability Theory by empirically demonstrating how specific micro-foundations—namely, Transformational Leadership, Knowledge Management Practices, and Cultural Infrastructure—function as critical dynamic capabilities or their enablers in driving Green Business Performance within SMEs. While DCT has been widely applied at the firm level, this study provides a granular understanding of the internal organizational mechanisms through which firms sense, seize, and transform their resources for environmental adaptation (Teece, 2016). By demonstrating that TRL fosters KMP and CUI, which in turn drive GBP, we illustrate a clear pathway for how leadership cultivates the adaptive capacities necessary for achieving a sustainable competitive advantage. This moves beyond abstract discussions of dynamic capabilities to concrete, measurable organizational processes, offering a more complete picture of how firms build resilience and responsiveness to environmental pressures.

Secondly, the study enriches leadership theories, particularly transformational leadership, by elucidating its indirect pathways to green business performance. While direct links between TRL and various performance outcomes are well-documented, our findings highlight the crucial individual and sequential mediating roles of CUI. This "opening of the black box" provides a more sophisticated understanding of *how* transformational leaders translate their vision and inspiration into tangible environmental results. It suggests that TRL's effectiveness in driving sustainability is significantly amplified when it successfully cultivates a supportive organizational culture. This multi-layered model provides a more comprehensive framework for understanding the influence of leadership on complex organizational outcomes, such as green performance. It encourages future research to explore similar mediating mechanisms in other contexts and to consider the interplay between multiple internal capabilities.

Thirdly, this research makes a unique contribution to the literature on green business performance, specifically addressing the challenges and opportunities within the SME context. Much of the existing sustainability research tends to focus on large corporations, often overlooking the distinct operational realities of SMEs, such as resource constraints and informal structures. By focusing exclusively on Vietnamese SMEs, this study provides context-specific empirical evidence that these internal capabilities are not only relevant but are critical for SMEs to achieve their green objectives. It demonstrates that even with limited resources, SMEs can leverage effective leadership, knowledge management, and a supportive culture to improve their environmental footprint and economic sustainability significantly. This contextualized understanding is vital for developing theories that are truly applicable and actionable for the vast majority of businesses globally, particularly in emerging markets where SMEs are the backbone of economic growth and environmental impact.

6.2 Practical Contributions

For SME managers, the research underscores the paramount importance of adopting a transformational leadership style. Leaders should actively articulate a clear and inspiring vision for environmental sustainability,

emphasizing its long-term benefits for the business and society. Beyond vision, managers must intellectually stimulate their teams, encouraging employees to challenge existing processes and propose innovative, eco-friendly solutions. Providing individualized support and development opportunities for employees to acquire green skills and knowledge is also crucial. By embodying these transformational behaviors, managers can directly and indirectly drive their SME's green transition, fostering a proactive and engaged workforce committed to sustainability. This leadership approach is convenient in SMEs due to the closer proximity and direct influence leaders have on their teams.

Furthermore, SME managers should prioritize the development of robust knowledge management practices. This does not necessarily require expensive, formal IT systems but rather a culture that encourages open communication, informal knowledge sharing, and learning from both successes and failures in green initiatives. Managers should create platforms, even simple ones like regular brainstorming sessions, internal knowledge-sharing forums, or cross-departmental project teams, where employees can exchange ideas on waste reduction, energy efficiency, and sustainable product development. Actively applying this acquired knowledge to improve operational processes and product design will directly translate into enhanced green business performance. Investing in training programs that focus on practical environmental knowledge and its application can yield significant returns.

The study also highlights the critical role of cultural infrastructure. SME managers must actively cultivate a pro-environmental organizational culture where sustainability is not just a policy but a deeply embedded value. This involves leading by example, integrating environmental considerations into daily decision-making, and celebrating green achievements. Fostering a culture of trust, collaboration, and openness to change will further enhance the effectiveness of knowledge management practices and ensure that all employees enthusiastically embrace green initiatives. A supportive culture can act as a powerful internal driver, compensating for external resource limitations often faced by SMEs, by fostering collective ingenuity and commitment towards shared environmental goals.

For policymakers in Vietnam and other developing nations, these findings suggest the need for targeted interventions that support the development of transformational leadership capabilities and internal organizational capacities within SMEs. This could include offering subsidized leadership training programs focused on sustainability, establishing knowledge-sharing platforms or industry clusters for green technologies and best practices, and providing incentives for SMEs to adopt pro-environmental cultural values. Policies that facilitate access to environmental knowledge and encourage collaborative networks among SMEs could significantly accelerate their green transformation, contributing to broader national sustainability goals and fostering a more resilient and environmentally responsible economy.

6.3 Limitations and Future Research

Despite its significant contributions, this study is subject to several limitations that offer fertile ground for future research. Firstly, its cross-sectional design, while suitable for identifying relationships, precludes definitive causal inferences. Future research could employ longitudinal designs to track the evolution of these relationships over time and establish stronger causality between transformational leadership, knowledge management practices, cultural infrastructure, and green business performance. Secondly, the study focused on SMEs in Vietnam, and while this provides valuable context-specific insights, the generalizability of these findings to SMEs in other cultural or economic contexts (e.g., developed nations, different regulatory environments) may be limited. Comparative studies across diverse regions would enhance the external validity of the model. Thirdly, the reliance on self-reported survey data introduces the potential for common method bias. Future studies could mitigate this by incorporating multi-source data (e.g., objective performance metrics, peer ratings of leadership, archival data) or employing experimental designs. Fourthly, while the chosen scales are well-established, their adaptation to the Vietnamese SME context, though carefully executed, might have introduced subtle nuances; future research could further validate these adapted scales or develop new ones specifically tailored to this context. Finally, this study examined specific mediating roles; future research could explore additional mediators (e.g., green innovation, employee engagement in sustainability, technological readiness) or moderating factors (e.g., industry type, competitive intensity, government support) that might influence these relationships, thereby building more complex and comprehensive models of green business performance in SMEs. Investigating potential negative impacts or challenges that hinder these relationships would also provide valuable insights for practitioners.

References

Abbas, J. and Khan, S.M. (2023) 'Green knowledge management and organizational green culture: an interaction for organizational green innovation and green performance', *Journal of Knowledge Management*, 27(7), pp. 1852-1870.

Al-Husain, R.A., Jasim, T.A., Mathew, V., Al-Romeedy, B.S., Khairy, H.A., Mahmoud, H.A., Liu, S., El-Meligy, M.A. and Alsetoohy, O. (2025). 'Optimizing sustainability performance through digital dynamic capabilities, green knowledge management, and green technology innovation', *Scientific Reports*, 15(1), p. 24217.

Al-Husseini, S., El Beltagi, I. and Moizer, J. (2021) 'Transformational leadership and innovation: the mediating role of knowledge sharing amongst higher education faculty', *International Journal of Leadership in Education*, 24(5), pp. 670-693.

Alkaraan, F., Elmarzouky, M., Hussainey, K., Venkatesh, V., Shi, Y. and Gulko, N. (2024) 'Reinforcing green business strategies with Industry 4.0 and governance towards sustainability: Natural-resource-based view and dynamic capability', *Business strategy and the environment*, 33(4), pp. 3588-3606.

Amoah, J., Belas, J., Dziwornu, R. and Khan, K.A. (2022) 'Enhancing SME contribution to economic development: A perspective from an emerging economy', *Journal of International Studies*.

Awan, F.H., Dunnan, L., Jamil, K. and Gul, R.F. (2023) 'Stimulating environmental performance via green human resource management, green transformational leadership, and green innovation: a mediation-moderation model', *Environ Sci Pollut Res Int*, 30(2), pp. 2958-2976. Available at: https://doi.org/10.1007/s11356-022-22424-y

Azeem, M., Ahmed, M., Haider, S. and Sajjad, M. (2021) 'Expanding competitive advantage through organizational culture, knowledge sharing and organizational innovation', *Technology in Society*, 66, p. 101635. Available at: https://doi.org/10.1016/j.techsoc.2021.101635

Barney, J. (1991) 'Firm Resources and Sustained Competitive Advantage', *Journal of Management*, 17(1), pp. 99-120. Available at: https://doi.org/10.1177/014920639101700108

Bass, B.M. and Avolio, B.J. (1989). *Multifactor leadership questionnaire*. CA: Consulting Psychologists Press. Western Journal of Nursing Research.

Begum, S., Ashfaq, M., Asiaei, K. and Shahzad, K. (2023) 'Green intellectual capital and green business strategy: the role of green absorptive capacity', *Business strategy and the environment*, 32(7), pp. 4907-4923.

Berberoglu, Y., Kazancoglu, Y. and Sagnak, M. (2023) 'Circularity assessment of logistics activities for green business performance management', *Business strategy and the environment*, 32(7), pp. 4734-4749.

Bui, T.K. (2024) 'The Mediating Role of Environmental Knowledge Sharing on the Impact of Green Leadership on Innovation in Vietnamese Small and Medium Enterprises', *Dalat University Journal of Science*, 15(1), pp. 3-26. Available at: https://doi.org/10.37569/DalatUniversity.15.1.1294(2025)

Chang, T.-W. and Hung, C.-Z. (2021) 'How to Shape the Employees' Organization Sustainable Green Knowledge Sharing: Cross-Level Effect of Green Organizational Identity Effect on Green Management Behavior and Performance of Members', *Sustainability*, 13(2), p. 626. Available at: https://doi.org/10.3390/su13020626

Chaudhry, R., Kumar, R. and Chaudhary, K. (2025) 'Global Impacts and Sustainable Practices in Fast Fashion', *Global Impacts and Sustainable Practices in Fast Fashion.* IGI Global Scientific Publishing, pp. 97-126.

Chen, X., Chen, Y., Zhang, X. and He, Q. (2025) 'Green transformational leadership and green innovation in megaprojects: is green knowledge sharing a missing link?', *Engineering, Construction and Architectural Management*, 32(1), pp. 194-213.

Christopher Mittelstaedt, J. (2024) 'Culture for the masses: building grassroots cultural infrastructure in China', *Modern China*, 50(5), pp. 607-640.

Crossley, R.M., Elmagrhi, M.H. and Ntim, C.G. (2021) 'Sustainability and legitimacy theory: The case of sustainable social and environmental practices of small and medium-sized enterprises', *Business strategy and the environment*, 30(8), pp. 3740-3762.

Dat, T.V., Phu, N.T.C., Khoa, B.T. and Hoang, C.C. (2025) 'Knowledge Acquisition, Dissemination, and Utilization Drivers of Innovation and Distribution Performance in Hospitality Organizations', *Journal of Distribution Science*, 23(2), pp. 13-22. Available at: https://doi.org/10.15722/jds.23.02.202502.13

Denison, D.R. and Mishra, A.K. (1995) 'Toward a theory of organizational culture and effectiveness', *Organization Science*, 6(2), pp. 204-223.

Fok, L., Morgan, Y.-C., Zee, S. and Mock, V.E. (2023) 'The impact of organizational culture and total quality management on the relationship between green practices and sustainability performance', *International Journal of Quality & Reliability Management*, 40(6), pp. 1564-1586.

Fornell, C. and Larcker, D.F. (1981) 'Evaluating Structural Equation Models with Unobservable Variables and Measurement Error', *Journal of Marketing Research*, 18(1), pp. 39-50. Available at: https://doi.org/10.1177/002224378101800104

Getzner, M. (2024) 'Cultural infrastructure as part of social infrastructure: Perspectives of cultural policy and economics', *Handbook of Social Infrastructure.* Edward Elgar Publishing, pp. 232-248.

Gui, L., Lei, H. and Le, P.B. (2024) 'Fostering product and process innovation through transformational leadership and knowledge management capability: the moderating role of innovation culture', *European Journal of Innovation Management*, 27(1), pp. 214-232.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2019). *Multivariate data analysis*. Hampshire, United Kingdom: Cengage Learning.

Hair Jr, J.F., Hult, G.T.M., Ringle, C. and Sarstedt, M. (2016) *A primer on partial least squares structural equation modeling (PLS-SEM)*. Washington, DC: Sage Publications.

Harsono, T.W., Hidayat, K., Iqbal, M. and Abdillah, Y. (2025) 'Exploring the effect of transformational leadership and knowledge management in enhancing innovative performance: a mediating role of innovation capability', *Journal of Manufacturing Technology Management*, 36(1), pp. 227-250.

Henseler, J., Ringle, C.M. and Sarstedt, M. (2014) 'A new criterion for assessing discriminant validity in variance-based structural equation modeling', *Journal of the Academy of Marketing Science*, 43(1), pp. 115-135. Available at: https://doi.org/10.1007/s11747-014-0403-8

Hofstede, G. (2011) 'Dimensionalizing cultures: The Hofstede model in context', *Online readings in psychology and culture*, 2(1), pp. 2307-0919.1014.

Ismail, I.J. (2025) 'Transforming small business ventures for a greener tomorrow: The interplay between green transformational leadership, organizational green culture, and environmental sustainability', *Cogent Social Sciences*, 11(1), p. 2441400.

Jain, D. and Sharma, H. (2025) 'Does innovative work behavior and digital transformation drive employee performance? A sequential mediation approach', *International Journal of Productivity and Performance Management*, pp. 1-23.

Jiang, W., Chai, H., Shao, J. and Feng, T. (2018) 'Green entrepreneurial orientation for enhancing firm performance: A dynamic capability perspective', *Journal of Cleaner Production*, 198, pp. 1311-1323. Available at: https://doi.org/10.1016/j.jclepro.2018.07.104

Kamran, M.W., Zhu, Y., Gilal, F.G., Waseel, A.H. and Jiang, H. (2025). 'Leveraging Corporate Social Responsibility: The Mediating Role of Ambidextrous Green Innovation in Enhancing Green Performance', *Corporate Social Responsibility and Environmental Management*. Available at: https://doi.org/10.1002/csr.70056

Khan, M.A., Ismail, F.B., Hussain, A. and Alghazali, B. (2020) 'The interplay of leadership styles, innovative work behavior, organizational culture, and organizational citizenship behavior', *Sage Open*, 10(1), p. 2158244019898264.

Khan, R.U., Saqib, A., Abbasi, M.A., Mikhaylov, A. and Pinter, G. (2023) 'Green Leadership, environmental knowledge Sharing, and sustainable performance in manufacturing Industry: Application from upper echelon theory', *Sustainable Energy Technologies and Assessments*, 60, p. 103540. Available at: https://doi.org/10.1016/j.seta.2023.103540

Khoa, B.T. (2024) 'How to enhance customer retention in the electronic marketplaces: The role of knowledge management strategies', *Customer Relationship Management: Methods, Opportunities and Challenges.* Nova Science Publishers, Inc., pp. 1-15.

Khoa, B.T. and Huynh, T.T. (2023) 'The effectiveness of knowledge management systems in motivation and satisfaction in higher education Institutions: Data from Vietnam', *Data Brief*, 49, p. 109454. Available at: https://doi.org/10.1016/j.dib.2023.109454

Khoa, B.T. and Huynh, T.T. (2024) 'Knowledge-intensive teamwork development through social media adoption after the COVID-19 pandemic in higher education institutions', *Heliyon*, 10(4), p. e26210. Available at: https://doi.org/10.1016/j.heliyon.2024.e26210

Kılıç, M. and Uludağ, O. (2021) 'The effects of transformational leadership on organizational performance: testing the mediating effects of knowledge management', *Sustainability*, 13(14), p. 7981.

Kirschning, R. and Mrożewski, M. (2024) 'Revisiting the knowledge spillover paradox: the impact of infrastructure', *Small Business Economics*, 63(1), pp. 1-20.

Kuuluvainen, A. (2012) 'How to concretize dynamic capabilities? Theory and examples', *Journal of Strategy and Management*, 5(4), pp. 381-392.

Lam, L., Nguyen, P., Le, N. and Tran, K. (2021) 'The relation among organizational culture, knowledge management, and innovation capability: Its implication for open innovation', *Journal of Open Innovation: Technology, Market, and Complexity*, 7(1), p. 66.

Le, T.T., Chau, T.L.Q., Ngoc, L.T.T. and Tieu, T.T. (2024). How does green transformational leadership drive environmental performance and firm performance? Empirical evidence from an emerging economy, *Corporate Social Responsibility and Environmental Management*, 31(6), pp. 5504-5523.

Madi Odeh, R.B., Obeidat, B.Y., Jaradat, M.O., Masadeh, R. and Alshurideh, M.T. (2023) 'The transformational leadership role in achieving organizational resilience through adaptive cultures: the case of Dubai service sector', *International Journal of Productivity and Performance Management*, 72(2), pp. 440-468.

Majali, T., Alkaraki, M., Asad, M., Aladwan, N. and Aledeinat, M. (2022) 'Green transformational leadership, green entrepreneurial orientation and performance of SMEs: The mediating role of green product innovation', *Journal of Open Innovation: Technology, Market, and Complexity*, 8(4), p. 191.

Makhloufi, L. (2024) 'Do knowledge sharing and big data analytics capabilities matter for green absorptive capacity and green entrepreneurship orientation? Implications for green innovation', *Industrial management & data Systems*, 124(3), pp. 978-1004.

Mojibi, T., Khojasteh, Y. and Khojasteh-Ghamari, Z. (2015) 'The role of infrastructure factors in knowledge management implementation', *Knowledge and Process Management*, 22(1), pp. 34-40.

Nasir, A., Zakaria, N., Do, N. and Velasquez, S. (2024) 'The impact of knowledge management on sustainable performance with mediation effect of green innovation in Malaysian SMEs', *VINE Journal of Information and Knowledge Management Systems*.

Nguyen, M. and Sharma, P. (2024) 'Interactive impact of transformational leadership and organizational innovation on online knowledge sharing: a knowledge management perspective', *Journal of Knowledge Management*, 28(4), pp. 1164-1182. Available at: https://doi.org/10.1108/jkm-09-2022-0758

Nguyen, T.N., Shen, C.H. and Le, P.B. (2022) 'Influence of transformational leadership and knowledge management on radical and incremental innovation: the moderating role of collaborative culture', *Kybernetes*, 51(7), pp. 2240-2258.

Niazi, U.I., Nisar, Q.A., Nasir, N., Naz, S., Haider, S. and Khan, W. (2023) 'Green HRM, green innovation and environmental performance: the role of green transformational leadership and green corporate social responsibility', *Environmental Science and Pollution Research*, 30(15), pp. 45353-45368.

Nonaka, I., Toyama, R. and Konno, N. (2000) 'SECI, Ba and leadership: a unified model of dynamic knowledge creation', *Long range planning*, 33(1), pp. 5-34.

Nunnally, J.C. and Bernstein, I. (1994) 'The assessment of reliability', *Psychometric theory*, 3(1), pp. 248-292.

Patwary, A.K., Tosun, C., Sharif, A., Ismail, N.A. and Abuelhassan, A.E. (2024) 'Measuring sustainable business performance in Malaysian hotels: The roles of green information, green innovation strategic orientation, and digital technology implementation', *International Journal of Hospitality Management*, 123, p. 103935.

Phu, N.T.C. and Khoa, B.T. (2025) 'Extending Legitimacy Theory for Sustainable Business Performance through the Lens of Green Innovation and Financial Synergy', *Evergreen*, 12(2), pp. 1369-1379. Available at: https://doi.org/10.5109/7363514

Pradana, M., Silvianita, A., Syarifuddin, S. and Renaldi, R. (2022) 'The implication of digital organisational culture on firm performance', *Frontiers in Psychology*, 13, p. 840699.

Qalati, S.A., Zafar, Z., Fan, M., Sanchez Limon, M.L. and Khaskheli, M.B. (2022) 'Employee performance under transformational leadership and organizational citizenship behavior: A mediated model', *Heliyon*, 8(11), p. e11374. Available at: https://doi.org/10.1016/j.heliyon.2022.e11374

Rafi, N., Ahmed, A., Shafique, I. and Kalyar, M.N. (2022) 'Knowledge management capabilities and organizational agility as liaisons of business performance', *South Asian Journal of Business Studies*, 11(4), pp. 397-417.

Sahoo, S., Kumar, A. and Upadhyay, A. (2023). 'How do green knowledge management and green technology innovation impact corporate environmental performance? Understanding the role of green knowledge acquisition, *Business strategy and the environment*, 32(1), pp. 551-569.

Shehzad, M.U., Zhang, J., Dost, M., Ahmad, M.S. and Alam, S. (2024) 'Knowledge management enablers and knowledge management processes: a direct and configurational approach to stimulate green innovation', *European Journal of Innovation Management*, 27(1), pp. 123-152.

Su, X., Xu, A., Lin, W., Chen, Y., Liu, S. and Xu, W. (2020) 'Environmental Leadership, Green Innovation Practices, Environmental Knowledge Learning, and Firm Performance', *Sage Open*, 10(2), p. 2158244020922909. Available at: https://doi.org/10.1177/2158244020922909

Teece, D.J. (2016) 'Dynamic capabilities and entrepreneurial management in large organizations: Toward a theory of the (entrepreneurial) firm', *European Economic Review*, 86, pp. 202-216.

Teece, D.J. (2018) 'Dynamic capabilities as (workable) management systems theory', *Journal of Management & Organization*, 24(3), pp. 359-368.

Teece, D.J., Pisano, G. and Shuen, A. (1997) 'Dynamic capabilities and strategic management', *Strategic Management Journal*, 18(7), pp. 509-533. Available at: https://doi.org/10.1002/(sici)1097-0266(199708)18:7<509::Aid-smj882>3.0.Co;2-z

Tosun, C., Parvez, M.O., Bilim, Y. and Yu, L. (2022) 'Effects of green transformational leadership on green performance of employees via the mediating role of corporate social responsibility: Reflection from North Cyprus', *International Journal of Hospitality Management*, 103, p. 103218.

Tsetim, J.T., Adegbe, O.B. and Agema, R.J. (2020) 'Knowledge management infrastructure capabilities and innovativeness of small and medium scale enterprises in Benue State, Nigeria', *Saudi Journal of Business and Management Studies*, 5(3), pp. 216-225.

Ullah Khan, R., Saqib, A., Abbasi, M.A., Mikhaylov, A. and Pinter, G. (2023) 'Green Leadership, environmental knowledge Sharing, and sustainable performance in manufacturing Industry: Application from upper echelon theory', *Sustainable Energy Technologies and Assessments*, 60, p. 103540. Available at: https://doi.org/10.1016/j.seta.2023.103540

United Nations (2021). *Small and Medium-Sized Enterprises are Crucial for Climate Action in Southeast Asia*. Available at: https://unfccc.int/news/small-and-medium-sized-enterprises-are-crucial-for-climate-action-in-south-east-asia (Accessed: September 20th).

United States Environmental Protection Agency (2025). *Sources of Greenhouse Gas Emissions*. Available at: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions (Accessed: October 15th).

Velarde, J.M., Ghani, M.F., Adams, D. and Cheah, J.-H. (2022) 'Towards a healthy school climate: The mediating effect of transformational leadership on cultural intelligence and organisational health', *Educational Management Administration & Leadership*, 50(1), pp. 163-184.

Velte, P. (2023) 'Determinants and financial consequences of environmental performance and reporting: A literature review of European archival research', *Journal of Environmental Management*, 340, p. 117916. Available at: https://doi.org/10.1016/j.jenvman.2023.117916

Virgiawan, A.R., Riyanto, S. and Endri, E. (2021) 'Organizational culture as a mediator of motivation and transformational leadership on employee performance', *Academic Journal of Interdisciplinary Studies*, 10(3), pp. 67-79.

Wang, W., Zhang, D., Wang, H., Zhu, Q. and Morabbi Heravi, H. (2023) 'How do businesses achieve sustainable success and gain a competitive advantage in the green era?', *Kybernetes*, 52(9), pp. 3241-3260.

Wernerfelt, B. (2006) 'A resource-based view of the firm', *Strategic Management Journal*, 5(2), pp. 171-180. Available at: https://doi.org/10.1002/smj.4250050207

World Bank (2025) *Small and Medium Enterprises (SMEs) Finance*. Available at: https://www.worldbank.org/en/topic/smefinance (Accessed: October 15th).

Yin, S., Yu, Y. and Zhang, N. (2024) 'The effect of digital green strategic orientation on digital green innovation performance: From the perspective of digital green business model innovation', *Sage Open*, 14(2), p. 21582440241261130.

Zafar, H., Suseno, Y. and Ho, J.A. (2023) 'Pro-environmental Behavior and GHRM: Effects of Organizational and Coworker Support for Environment', *Academy of Management Proceedings*. Academy of Management, Briarcliff Manor, NY 10510, pp. 15434. Available at: https://doi.org/10.5465/AMPROC.2023.15434

Zhao, W. and Huang, L. (2022) 'The impact of green transformational leadership, green HRM, green innovation and organizational support on the sustainable business performance: Evidence from China', *Economic research-Ekonomska istraživanja*, 35(1), pp. 6121-6141.

Appendix 1: Measurement Scales

1. Transformational Leadership (TRL)

Adapted from Bass and Avolio (1989) - Multifactor Leadership Questionnaire (MLQ)

TRL1: My leader serves as a role model for environmental responsibility and sustainability practices.

TRL2: My leader inspires and motivates employees with a compelling vision for environmental sustainability.

TRL3: My leader intellectually stimulates employees to think creatively about environmental problems and solutions.

TRL4: My leader provides individualized support and coaching to help employees develop green skills and knowledge.

TRL5: My leader demonstrates idealized influence by consistently prioritizing environmental values in decision-making.

2. Knowledge Management Practices (KMP)

Adapted from Khoa and Huynh (2023); Khoa (2024)

KMP1: Our organization actively acquires new environmental knowledge and green technologies from external sources.

KMP2: Our organization effectively shares environmental knowledge and best practices among employees.

KMP3: Our organization systematically creates new environmental knowledge through research and experimentation.

KMP4: Our organization successfully applies environmental knowledge to improve our green business practices.

3. Cultural Infrastructure (CUI)

Adapted from Denison and Mishra (1995); Tsetim, Adegbe and Agema (2020)

CUI1: Our organizational culture strongly emphasizes environmental stewardship and sustainability values.

CUI2: Our organizational culture promotes adaptability and openness to green innovations and changes.

CUI3: Our organizational culture encourages employee involvement in environmental initiatives and decision-making.

CUI4: Our organizational culture maintains consistency in pursuing environmental mission and green objectives.

4. Green Business Performance (GBP)

Adapted from Ullah Khan et al. (2023); Phu and Khoa (2025)

GBP1: Our organization has significantly improved its eco-innovation capabilities and green product development.

GBP2: Our organization has achieved substantial improvements in resource efficiency and energy conservation.

GBP3: Our organization has successfully reduced waste generation and improved waste management practices.

GBP4: Our organization has enhanced its overall environmental performance and sustainability outcomes.

A Systematic Literature Review on Ontology-driven Business Intelligence Components

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Abstract: This research undertakes a systematic literature review to explore the integration and application of ontologies within Business Intelligence (BI) components across a variety of domains. Ontologies, as formal representations of knowledge, have emerged as a key enabler in enhancing the functionality and intelligence of BI systems, particularly in the era of big data and digital transformation. The objective of this study is to analyze how ontologies are designed, implemented, and utilized to improve data integration, semantic interoperability, and system adaptability. The review draws upon data sources from Scopus, IEEE Explore, Science Direct, and Google Scholar, ensuring a rigorous and comprehensive coverage of relevant literature. Following a structured selection process based on inclusion and exclusion criteria, 27 peer-reviewed articles published between 2011 and 2024 were identified as meeting the quality and relevance standards for this study. The selected studies reveal that ontology-driven BI components offer several advantages, including the unification of heterogeneous data sources, improved semantic clarity, and enhanced reasoning capabilities for decision support. Moreover, ontologies contribute significantly to the flexibility and scalability of BI systems, facilitating the development of context-aware and domain-specific analytical tools. Despite these advantages, the review also highlights persistent challenges, such as difficulties in managing large-scale ontologies, real-time processing limitations, and organizational resistance to adoption due to complexity and integration costs. By synthesizing the existing body of knowledge, this review not only consolidates the current understanding of ontology-driven BI but also provides a conceptual framework for future research. It emphasizes the need for innovative approaches that address identified limitations and align ontology development with dynamic organizational requirements. The findings serve as a valuable resource for both researchers and practitioners, offering strategic insights into the design and deployment of advanced BI solutions. Ultimately, this study contributes to the evolving discourse on intelligent decision-making systems by bridging theoretical perspectives with real-world applications.

Keywords: Business intelligence components, Ontology integration, Ontology-based BI, Ontology-driven BI, Organizational knowledge management

1. Introduction

The creation of actionable knowledge to support business decision-making and strategic development is no longer an unattainable goal, particularly when considering the significant advancements in technology over the past two decades (De Oliveira and Rodrigues, 2021).

In the era of big data and digital transformation, organizations are increasingly relying on Business Intelligence (BI) systems to support data-driven decision-making. Traditional BI systems, however, often struggle with semantic heterogeneity, data integration challenges, and a lack of contextual understanding, especially when dealing with diverse, distributed, and unstructured data sources (Matar, Al-Jaber, & Matar, 2024). Nonetheless, traditional BI frameworks often face challenges in seamlessly integrating, analyzing, and interpreting diverse data sources, which restricts their flexibility and scalability. To overcome these obstacles, ontology-driven solutions have emerged as a promising approach, offering a semantic foundation that improves data integration, enhances contextual understanding, and supports advanced reasoning capabilities in BI systems (Moussas, Hafiane, & Achaba, 2024). To address these challenges, ontology-driven approaches have emerged as a promising paradigm, enabling the formal representation of domain knowledge and facilitating semantic interoperability across heterogeneous systems (Zhuoxun Zheng et al., 2022). Ontologies provide a shared vocabulary and structure for conceptualizing and integrating data, thereby enhancing the adaptability, reusability, and reasoning capabilities of BI frameworks. This has led to growing academic and industrial interest in the integration of ontologies with BI platforms, particularly within contexts such as healthcare, finance, manufacturing, and smart cities (Hussain, Al-Turjman and Sah, 2021).

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Despite the potential benefits, the adoption of ontology-driven BI components remains fragmented, with varying methodologies, tools, and frameworks reported in the literature. Additionally, while some studies have examined the role of ontologies in knowledge representation and semantic reasoning, few have systematically explored how ontology-driven BI systems contribute to knowledge sharing, reuse, and organizational learning. A systematic synthesis of existing research is critical to identify trends, evaluate technological advancements, and uncover gaps in the current body of knowledge. Previous studies have explored aspects of ontology-driven BI in isolation, such as data warehousing or semantic querying (Taelman, R et al., 2018), but a comprehensive review of the components, domains, and technologies underpinning ontology-driven BI is lacking.

Given the growing but fragmented body of research on ontology-driven approaches in Business Intelligence, a comprehensive synthesis is essential to consolidate current knowledge and guide future developments in the field. While previous studies have provided valuable insights into specific components—such as ontology modeling, semantic querying, and data warehousing—these efforts have remained largely domain-specific and disconnected. As a result, there is still no unified understanding of how ontology-driven BI systems are conceptualized, implemented, and applied across diverse organizational contexts. This fragmentation not only limits cumulative knowledge but also obscures the methodological and technological evolution of ontology-driven BI research. Therefore, a systematic and integrative review is required to bring coherence to the field by mapping existing findings, clarifying interrelationships among BI components, and identifying emerging patterns. Addressing this gap justifies the adoption of a Systematic Literature Review (SLR) approach, which offers a rigorous and transparent framework to evaluate the state of the art, synthesize theoretical and empirical contributions, and propose future research directions.

To address this gap, this study conducts a Systematic Literature Review (SLR) following the methodology proposed by Kitchenham et al. (2009). Review explicitly focused on ontology-driven Business Intelligence (BI) components, understood as BI elements whose design, integration, and analytical capabilities are guided by ontological models. Specifically, the study examines the evolution of research on ontology-driven BI components, the approaches and technologies employed in their design and implementation, the domains in which such components have been applied, and the evidence reported regarding their benefits, limitations, and operational characteristics. Together, these analytical dimensions define the scope of the review and provide a structured basis for synthesizing current knowledge on ontology-driven BI components and their interrelationships.The remainder of this paper is organized as follows: Section 2 outlines the research methodology employed for the systematic review. Section 3 presents the descriptive and thematic analysis of the reviewed studies. Section 4 discusses the main findings, emerging trends, and research challenges. Finally, Section 5 concludes the paper with recommendations for future work.

2. Literature Review

2.1 Ontologies and Semantic Technologies in Business Intelligence

Following the identification and screening phases of the SLR protocol, the reviewed studies consistently highlight the growing role of digital technologies in enhancing knowledge accessibility and usability within organizational contexts (Padeli, Pangil, & Kadir, 2025). Within Business Intelligence (BI), ontologies and Semantic Web Technologies (SWT) are repeatedly identified as core mechanisms for addressing semantic heterogeneity and interoperability challenges.

Studies such as Stănescu and Oprea (2025) demonstrate that ontologies enable formalized knowledge representation across disciplines, thereby supporting semantic integration and improved decision-making. At a foundational level, semantic standards such as RDF and OWL provide the representational infrastructure that underpins ontology-driven analytical processes. These findings establish ontologies as a recurring conceptual construct across the corpus of selected studies.

2.2 Taxonomy of Ontology-based and Ontology-driven BI Approaches

As recommended by Kitchenham's guidelines for SLRs, the included studies were subjected to a conceptual classification process to reduce heterogeneity and support analytical synthesis. This classification reveals a clear distinction between ontology-based and ontology-driven BI approaches.

Ontology-based BI studies typically employ ontologies as auxiliary semantic layers to support specific functions such as annotation, querying, or data integration, while retaining conventional BI architectures. In contrast, ontology-driven BI studies position ontologies as central design artifacts that guide data modeling, integration, reasoning, and analytical workflows.

Comparative studies (Pérez-Rey et al., 2022; Fensel et al., 2020) illustrate this distinction and confirm that, although hybrid solutions exist, ontology-driven approaches represent a more transformative paradigm. Consistent with the objectives and research questions of this review, only studies explicitly adopting an ontology-driven perspective were retained for in-depth synthesis.

2.3 Synthesis of Ontology-driven BI Components: Approaches, Technologies, and Tools

In line with the data extraction and synthesis phases of the SLR, ontology-driven BI studies were further categorized according to the types of components, approaches, and technologies they propose. Multiple studies emphasize the role of ontologies in structuring Data Warehouse (DW) processes and analytical pipelines (Antunes, Cardoso, & Barateiro, 2022; Masmoudi et al., 2024).

Ontology-driven multidimensional modeling emerges as a recurring theme. Abelló, Romero, and Zubcoff (2020) propose an ontology-driven framework for multidimensional data modeling, while Nebot and Berlanga (2021) and Kämpgen, Harth, and Stadtmüller (2020) demonstrate how RDF- and OWL-based representations enhance OLAP flexibility and expressiveness. The synthesis of these studies reveals a diverse set of design approaches and implementation technologies, but also highlights methodological fragmentation and a lack of standardized design practices across ontology-driven BI components.

2.4 Application Domains of Ontology-driven Business Intelligence

To address external validity and applicability, the reviewed studies were classified by application domain, as recommended in evidence-based review methodologies. Supply chain management (SCM) represents the most frequently investigated domain. Choi et al. (2020) identify ontologies as a central research focus in SCM, while Ahmed and Ahmed (2018) and Hasan, Shamsuddin, and Azmi (2021) demonstrate their use in semantic alignment and risk management.

Beyond SCM, ontology-driven BI frameworks have been applied sporadically in other organizational and decision-support contexts. However, the distribution of studies across domains remains uneven, limiting the generalizability of empirical findings.

2.5 Empirical Evidence, Reported Benefits, and Limitations

Following Kitchenham's recommendation to assess strength of evidence, the selected studies were analyzed with respect to reported benefits and limitations. Empirical findings suggest that ontology-driven BI components improve semantic interoperability, analytical flexibility, and decision support, particularly in heterogeneous data environments.

Ontology-based integration and matching techniques (Osman, Ben Yahia, & Diallo, 2021; Euzenat & Shvaiko, 2020; Doan, Halevy, & Ives, 2020) are frequently cited as enabling mechanisms. However, several limitations recur across studies, including ontology scalability (Gómez-Pérez, Fernández-López, & Corcho, 2021), evaluation complexity (Uschold & Gruninger, 2021), and insufficient standardization of ontology development processes (Guarino, Oberle, & Staab, 2020).

2.6 Scalability, Performance, and Usability Considerations

Performance-related aspects—particularly scalability, computational complexity, and usability—were explicitly examined during the synthesis phase due to their relevance to real-world deployment. Keet and Ławrynowicz (2021) identify reasoning complexity as a major barrier in large-scale ontologies and propose lightweight semantic models as a potential mitigation strategy.

Despite these contributions, the review reveals a notable lack of empirical evaluation of ontology-driven BI systems in large-scale or real-time environments, indicating a significant gap between conceptual development and operational validation.

2.7 Synthesis of Research Gaps and Research Questions

Although research on ontology-driven Business Intelligence (BI) has expanded considerably, several important limitations remain. The literature lacks a comprehensive synthesis of how ontology-driven BI components have been conceptualized and how they have evolved over time, leading to fragmented perspectives and underdefined conceptual boundaries. In addition, existing studies rely on heterogeneous methodological approaches, technologies, and tools, with limited consensus regarding standardization, which constrains comparability and cumulative knowledge building.

Furthermore, while numerous ontology-driven BI frameworks have been proposed, their application remains uneven across domains, and robust empirical evidence demonstrating their practical benefits and limitations is still scarce. Finally, critical issues related to scalability, performance, and usability—particularly in large-scale or real-time environments—are insufficiently examined, raising concerns about the feasibility of deploying such systems in operational contexts. Collectively, these gaps highlight the need for a systematic and structured review to clarify the evolution of ontology-driven BI components, assess prevailing design and implementation practices, and evaluate their empirical maturity and technological robustness.

3. Methodology

In this study, the systematic approach was employing to answer the research questions posited. As mentionned by Kitchenham and Charters (Budgen and Brereton, 2006), a systematic review is a structured and methodical process used to identify, evaluate, and interpret all available research relevant to a specific research question, topic or phenomenon. The procedure involves developing a review protocol, conducting a comprehensive and reproducible search, applying predefined inclusion and exclusion criteria, critically appraising the quality of selected studies, and systematically extracting and synthesizing relevant data. The process concludes with transparent reporting, ensuring rigor, reproducibility, and reliability of the findings. These steps illustrated in Figure 1 and described below.

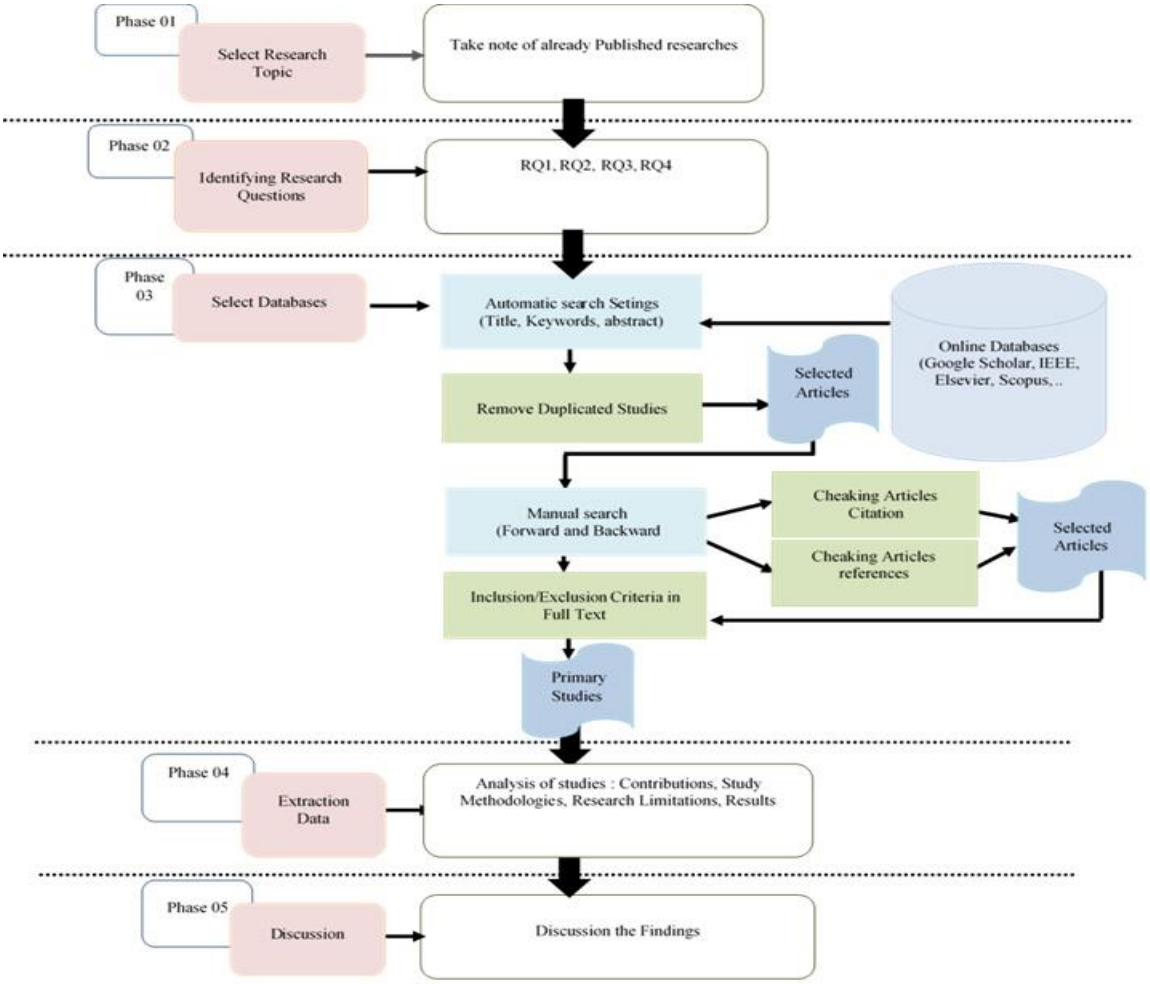

Figure1: Review Protocol

3.1 The Research Question

Based on preliminary scoping and analysis of the literature, three research gaps were identified:

Limited integration of ontology-driven BI components across organizational contexts, methodological fragmentation across prior studies, and insufficient attention to practical applications of the findings. From these gaps, the following research questions were formulated:

RQ1: How has research on ontology-driven BI components evolved over the past decade?

RQ2: What approaches, technologies, and tools have been employed to design and implement ontology-driven BI components, and how do they address standardization challenges?

RQ3: In which domains have ontology-driven BI frameworks been applied, and what empirical evidence supports their practical benefits and limitations?

RQ4: To what extent do ontology-driven BI systems achieve scalability, performance, and usability in large-scale or real-time environments?

3.2 Rearch Strategy

The research strategy followed PRISMA 2020 guidelines to ensure transparency and replicability. A comprehensive search was conducted in IEEE, IOS Press, Springer, Elsevier, ACM, Arxiv, Scopus and Google Scholar links. Search strings combined specific keywords across three clusters: ontologies (e.g., ontology, semantic web), business intelligence (e.g., business intelligence, decision support, data warehouse, OLAP, Datamining and ETL), and application terms like framework, integration, implementation) with Boolean operators to refine results. After importing results into a reference manager for duplicate removal, screening proceeded in three stages: title and abstract review, full-text eligibility assessment, and backward/forward citation tracking. . Initially, a total of 254 hits were found.

3.3 Inclusion and Exclusion Criteria

The purpose of this phase is to use a set of selection criteria to assess the relevance of each research for answering the review questions and discard those that do not meet the criteria (Denyer & Tranfield, 2009). In this research, the search was limited to articles published in English. The review covered only studies published between 2011 and 2024. With the application of these criteria, a total of 104 publications were selected out of the 239 initially identified. Afterward, the titles, abstracts, and keywords were reviewed to ensure alignment with the research question. During this process, considerable number of studies were identified that addressed ontology in isolation or business intelligence independently; however, as they did not examine the integration of both domains, they were excluded. A total of 27 publications were selected for further analysis.

The analysis and statistics of the selected papers, organized by publication year and publisher, are shown in Figure 2 and Figure 3.

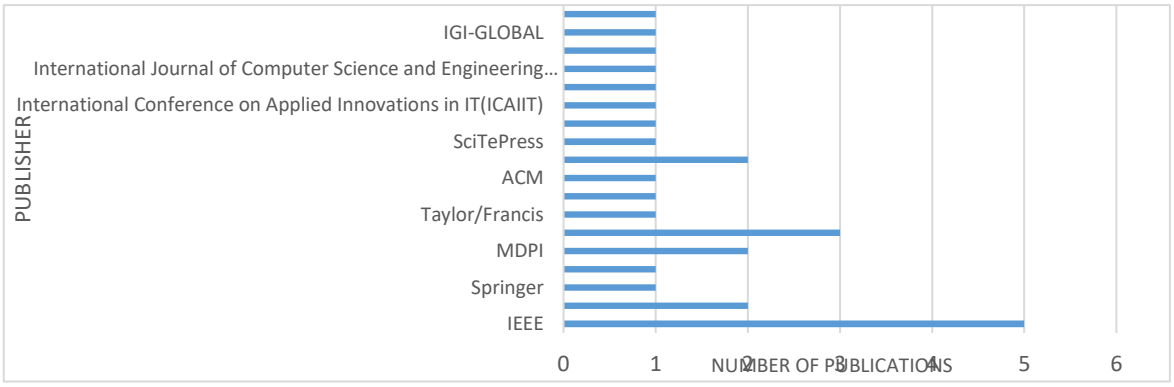

Figure 2: Selected Articles by Publisher

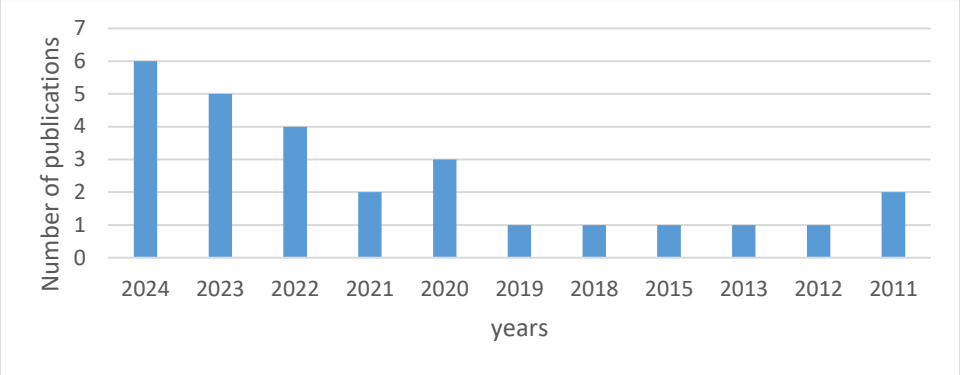

Figure 3: Selected Articles by Year

3.4 Extraction Data

To capture the current landscape of ontology-driven approaches in Business Intelligence (BI), a structured data extraction was performing. Table 1 summarizes key studies by outlining their domains, targeted BI components, ontological functions, methodologies, main contributions, and reported limitations. This synthesis reveals how ontology-based methods have been applied across diverse contexts, highlighting methodological variety, recurring challenges, and areas requiring further empirical validation and scalability testing.

Table 1: Extraction Data

Citation	Domain / Application	BI Component Targeted	Ontological Function	Methodology	Key Contributions	Reported Limitations
(Vahidnia, Minae and Behzadi, 2024)	Urban decision support (POIs)	Decision Support	Ontology for spatial reasoning	Ontology-based web DSS prototype	Improves semantic accuracy in POI recommendations	Limited to entertainment domain; scalability not tested
(Asogwa, et al. 2024)	Medical processes	Process Modeling / BI	Ontology-based representation of workflows	Intelligent process model with ontology mapping	Supports process reasoning in medical workflows	Lacks large-scale validation; domain-specific
(Antunes, 2024)	General BI systems	Data Warehouse & BI Integration	Semantic Web + Ontology alignment	Conceptual analysis and framework proposal	Highlights integration potential	Lacks empirical validation
(Bracons Cucó, et al, 2024)	Health data (DATOS-CAT)	ETL / Data Integration	Ontology-driven ETL vs traditional	Case study in CDM standardization	Improves data standardization, interoperability	Limited to CDM formats, domain constraint
(Bhattacharjee and Deb Nath, 2024)	Semantic DW	ETL Automation	Ontology-based ETL	Prototype "SETLonDEMAND"	Enables on-demand ETL for semantic DW	Needs performance evaluation

Citation	Domain / Application	BI Component Targeted	Ontological Function	Methodology	Key Contributions	Reported Limitations
(Aishwarya , et al. 2024)	Biomedical informatics	Datamining	Ontology-based semantic reasoning	Prototype and reasoning algorithms	Enables domain-specific insights	Early-stage; limited datasets
(Robson and Baek, 2023)	Health records	Datamining, ETL , OLAP	Ontology for longitudinal data	Ontology model for EHR mining	Scales data structuring for ML	Complexity in very large-scale adoption
(A.C.B. and Mahesh, 2023)	General BI	OLAP / Datamining	Ontology for ranking/interestingness	Systematic review	Consolidates approaches in ontology-based data interestingness	Review only; lacks new framework
(Nicholson, Giusti and Martos, 2023)	Cancer registry	Datamining	Ontology + AI patterns	Ontology + design constraints in data validation	Improves accuracy in registry validation	Focused on one domain
(Ascencion Arevalo, et al. 2023)	Hydrogen market	OLAP	Ontology for energy domain	Ontology modeling (HOLY)	Supports semantic representation of hydrogen market	Narrow scope; adoption challenges
(Fahad et al. 2022)	Business Intelligence	BI Governance / Collaboration	Collaborative BI Ontology	Ontology design, arXiv report	Defines CBIOnt framework	Lacks empirical deployment
(Antunes, et al. 2022)	Education	OLAP	Ontology-based content organization	Ontology development + gamification	Supports semantic gamified learning	Limited empirical validation
(Ghelani, 2022)	BI queries	OLAP	Ontology-based NL interface	Prototype system	Natural language queries over BI	Preprint; lacks evaluation
(Dhaouadi, et al. 2022)	Data warehousing	Data warehouse	Review of DW → ontology trends	Comparative review	Traces evolution of DW ontology methods	Descriptive, lacks empirical testing
(Asogwa et al. 2022)	Medical intelligence	Data Integration / Knowledge Management	Ontology-based and virtual data integration	Theoretical analysis and conceptual modeling of ontology-driven integration	Provides a conceptual foundation for integrating heterogeneous medical data sources	Empirical implementation or case validation; theoretical focus limits practical applicabili
(Castro et al. 2021)	Big Data Governance	Data Governance	Ontology-based governance model	Ontological framework	Improves governance and compliance	High complexity, not yet validated
(Popova et al. 2021)	Big Data	Multi-level analysis	Multilevel ontologies for processing	Conceptual framework	Supports layered ontology analysis	Lacks case validation
(Quamar et al. 2020)	Conversational BI	OLAP / Data Interaction	Ontology-driven chatbot BI	Prototype conversational BI	Natural BI queries via conversation	Performance and domain scope limits

Citation	Domain / Application	BI Component Targeted	Ontological Function	Methodology	Key Contributions	Reported Limitations
(Qusyairi et al. 2020)	Sales & Service	DW Design	Ontology + rule-based DW	Case study	Supports DW construction via ontology rules	Small dataset; domain-specific
(Zaman et al. 2020)	Digital Library	ETL process	Ontology in ETL	Case study	Improves data extraction/transfer	Limited to PDFs
(Guo & Liu, 2019)	Decision Support	DSS semantic resolution	Hierarchical Ontology Graph	Prototype	Handles semantic issues in DSS	Early work, limited evaluation
(Rogushina et al. 2018)	Big Data	Metadata Analysis	Ontologies for metadata	Theoretical framework	Ontology in metadata structuring	No case study
(Wongthongtham & Abu-Salih, 2015)	DW & BI	Data Warehouse	Ontology + trust for DW	State-of-art + prototype	Addresses trust in BI	Conceptual, limited adoption
(El Akkaoui et al. 2013)	ETL	Process modeling	Ontology + BPMN	Framework & case	Maintains ETL processes	Complexity in large DW
(Šmíd & Kouba , 2012)	Geospatial	Data Integration	Ontology-driven GIS integration	Prototype	Improves GIS search	Limited scalability
(Rodríguez-Muro and Calvanese, 2011)	OBDA	Data Access	Ontology-based data access	Dependencies framework	Makes OBDA practical	Complexity of constraints
(Mao & Li, 2011)	Spatial DSS	Decision Support	Ontology-driven web DSS	Prototype system	Supports spatial DSS	Narrow focus

3.5 Quality Assessment of Included Studies

To ensure the reliability and methodological soundness of this systematic literature review, each included study has been subjected to a structured quality assessment. This process aimed to evaluate the rigor, transparency, and relevance of the selected works by applying explicit and pre-defined criteria adapted from established SLR guidelines (Kitchenham & Charters, 2007; Denyer & Tranfield, 2009). Each study has been examined in terms of clarity of objectives, methodological coherence, contribution, transparency, limitations, and generalizability. This assessment provided a basis for judging the credibility of the evidence and for interpreting the synthesis results in light of each study's methodological robustness and potential weaknesses. Table 2 presents the results of this evaluation and summarizes the overall quality profile of the included studies.

Table 2: Quality assessment of included studies

Study	Clarity	Methodology	Contribution	Transparency	Limitations	Generaliza-bility
Vahidnia, Minae & Behzadi (2024)	High	High	Medium	Medium	Medium	Low
Asogwa et al. (2024)	High	High	High	Medium	Medium	Medium
Antunes (2024)	High	Medium	High	High	Medium	High

Study	Clarity	Methodology	Contribution	Transparency	Limitations	Generaliza-bility
Bracons Cucó et al. (2024)	High	High	Medium	High	Medium	Medium
Bhattacharjee & Deb Nath (2024)	Medium	High	Medium	High	High	High
Aishwarya et al. (2024)	High	High	High	High	High	High
Robson & Baek (2023)	High	Medium	High	Medium	High	High
A.C.B. & Mahesh (2023)	High	High	High	High	High	High
Nicholson, Giusti & Martos (2023)	High	High	High	High	High	High
Ascencion Arevalo et al. (2023)	Medium	High	Medium	Medium	High	Medium
Fahad, Darmont & Favre (2022)	High	High	High	Medium	High	Medium
Antunes et al. (2022)	Medium	Medium	High	Low	High	Low
Ghelani (2022)	Medium	High	High	Medium	High	Medium
Dhaouadi et al. (2022)	High	Medium	High	High	High	High
Asogwa E.C. et al. (2022)	High	Medium	High	High	High	Medium
Castro et al. (2021)	High	Medium	High	High	High	Low
Popova, Globa & ovogrudska (2021)	High	High	High	High	High	Medium
Quamar et al. (2020)	High	High	High	High	High	Medium
Qusyairi, Sudarma & Dharma (2020)	High	High	Medium	High	High	Low

Study	Clarity	Methodology	Contribution	Transparency	Limitations	Generaliza-bility
Zaman et al. (2020)	High	High	Medium	Medium	High	Medium
Guo & Liu (2019)	High	High	High	Medium	High	Medium
Rogushina, Gladun & Pryima (2018)	Medium	High	Medium	Low	High	High
Wongthongtham & Abu-Salih (2015)	Medium	High	Medium	Low	High	Medium
El Akkaoui et al. (2013)	High	Medium	Medium	Medium	Medium	Low
Šmíd & Kouba (2012)	High	Medium	Medium	Medium	Medium	High
Rodríguez-Muro & Calvanese (2011)	High	High	High	High	Medium	High
Mao & Li (2011)	Medium	Medium	Medium	Low	Medium	Medium

The figure 4 illustrates the overall distribution of quality ratings across the evaluated studies. Most studies scored highly in clarity, methodological rigor, and contribution, reflecting well-defined objectives and robust research designs. Moderate ratings were more frequent in transparency and generalizability, suggesting that although methods and findings were generally well reported, their applicability across different contexts remains limited. Lower scores, though less common, were observed mainly in the discussion of limitations, indicating a tendency to underreport potential biases or constraints. Overall, the figure demonstrates a high level of methodological quality among the included studies, while also revealing areas for improvement in transparency and external validity.

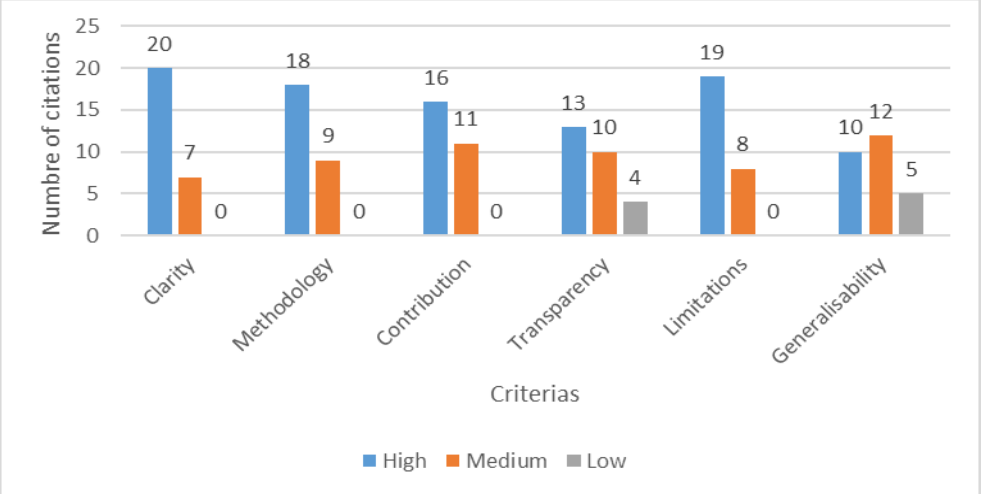

Figure 4: Summary of methodological quality assessment of included studies

3.6 Comparative Analytical Framework for Ontology-based and Ontology-driven BI Studies

Based on prior conceptualizations of ontology-based and ontology-driven BI, we developed a comparative analytical framework. (Table 3). It presents the structured comparative synthesis of ontology-based and ontology-driven BI approaches. Using a unified analytical framework, the two corpora are contrasted across architectural, functional, analytical, and evolutionary dimensions to support evidence-based examination of their differentiation, development trajectories, and interrelationships.

Table 3: Comparative analytical framework for ontology-based and ontology-driven BI studies

Analytical dimension	Ontology-based BI approaches	Ontology-driven BI approaches
Position of ontology in system architecture	Ontologies function as auxiliary semantic layers added to existing BI architectures. Core components (ETL, data warehouse, OLAP, dashboards) remain conceptually independent.	Ontologies act as central design artifacts structuring the overall BI architecture and informing system organization.
Primary role of ontologies	Support specific tasks such as semantic annotation, schema matching, data integration, and query expansion.	Guide data modeling, business concept formalization, indicator definition, and analytical logic.
Dependency of BI components on ontologies	Low to moderate: BI processes can operate without ontologies, which mainly enhance interoperability and usability.	High: BI components are ontologically grounded; system behavior and analytics depend on ontological models.
BI lifecycle coverage	Typically limited to isolated stages (e.g., data integration, querying, or metadata management).	Spans multiple BI stages, including data acquisition, modeling, analytics, interpretation, and system adaptation.
Type of analytics supported	Predominantly descriptive and exploratory analytics with semantic enrichment.	Knowledge-intensive, adaptive, and semantically driven analytics.
Use of reasoning mechanisms	Limited reasoning (e.g., mapping support, basic inference, consistency checking).	Advanced reasoning (e.g., rule execution, semantic validation, concept-level analytics, explainability support).
Nature of reported contributions	Functional improvements to existing BI systems (e.g., better integration, semantic querying, interoperability).	Architectural and conceptual reconfiguration of BI systems toward intelligent and ontology-centered designs.
Evaluation focus	Task-level validation (query performance, integration accuracy, prototype demonstrations).	System-level validation (architectural coherence, analytical capabilities, decision-support effectiveness).
Evolutionary positioning	Dominant in earlier studies; addresses localized semantic challenges.	More prevalent in recent studies; reflects a shift toward knowledge-centered BI paradigms.
Relationship between approaches	Serves as a foundation for ontology integration within conventional BI systems.	Often builds upon or extends ontology-based mechanisms into core architectural roles, with emerging hybrid configurations.

4. Findings and Discussion

The findings of this systematic literature review are interpreted in direct relation to the research questions and to the broader discourse on intelligent decision-making systems. Beyond describing how ontology-driven BI

components have been conceptualized, the synthesis highlights how ontologies are increasingly mobilized as knowledge infrastructures that embed semantic reasoning, contextual interpretation, and governance mechanisms into BI environments. The analysis reveals not only methodological diversity, but also an evolutionary shift from semantic enrichment toward knowledge-centered and decision-oriented architectures, where ontologies mediate between theoretical models of knowledge representation and operational BI systems deployed in real organizational contexts.

4.1 Conceptualization and Evolution of Ontology-driven BI

The reviewed literature evidences a clear conceptual evolution in ontology-driven BI. Early studies (Rodríguez-Muro & Calvanese, 2011; Mao & Li, 2011; El Akkaoui et al., 2013) primarily positioned ontologies as formal semantic models supporting Ontology-driven Data Access and semantic ETL, with the main objective of improving interoperability and query interpretation. These contributions reflect a theoretically grounded phase focused on knowledge representation and semantic consistency, consistent with early Semantic Web and KM perspectives. Subsequent work demonstrates a transition toward knowledge-mediated and decision-oriented BI architectures. Studies such as Bhattacharjee and Deb Nath (2024) and Vahidnia et al. (2024) embed ontologies into automation and spatial decision-support systems, where ontological reasoning supports concrete analytical tasks. More recent contributions (Antunes, 2024; Asogwa et al., 2024) conceptualize ontologies as intelligent layers connecting heterogeneous data to process logic and domain knowledge, enabling systems to move beyond descriptive reporting toward context-aware and semantically guided decision support.

This progression evidences an alignment with the evolving discourse on intelligent decision-making systems, which emphasizes knowledge-centered analytics, reasoning capabilities, and explainability. Importantly, the literature shows that these developments are not purely conceptual: ontology-driven BI is increasingly instantiated in applied systems addressing real decision contexts (e.g., healthcare analytics, urban planning, educational governance). However, despite this maturation, the absence of a unified theoretical definition of ontology-driven BI continues to fragment the field, limiting cumulative theory building and methodological standardization.

4.2 Methodological, Technological, and Tool-based Approaches

Methodologically, the literature is dominated by prototype-based and design-oriented studies (Vahidnia et al., 2024; Robson & Baek, 2023; Quamar et al., 2020), supported by formal modeling and systematic reviews (Asogwa et al., 2022; Dhaouadi et al., 2022). These studies consistently operationalize theoretical constructs from ontology engineering and KM—such as shared conceptualization, semantic alignment, and reasoning—into functional BI components using OWL, RDF, SPARQL, and ontology engineering tools.

Evidence across these studies demonstrates that ontologies are not treated merely as abstract models but are embedded into ETL workflows, analytical engines, and decision-support layers. For example, Bracons Cucó et al. (2024) operationalize semantic standardization in healthcare ETL pipelines, while Aishwarya et al. (2024) implement ontology-based reasoning to support biomedical inference tasks. These implementations illustrate how theoretical perspectives on semantic intelligence are translated into computational mechanisms that support real analytical and decision processes.

A significant methodological trend is the emergence of hybrid intelligent architectures combining ontologies with machine learning and automation techniques (Nicholson et al., 2023; Robson & Baek, 2023). These systems reflect a broader shift in intelligent decision-making research toward integrating symbolic knowledge and data-driven analytics. However, despite these advances, the review reveals a persistent lack of large-scale empirical validation, standardized benchmarks, and longitudinal deployment studies, which constrains the ability to assess the true organizational impact of ontology-driven BI.

4.3 Domains, Integration Frameworks, and Emerging Patterns

The application domains identified in this review provide concrete evidence of how ontology-driven BI bridges theory and practice. Healthcare dominates the literature (Asogwa et al., 2024; Robson & Baek, 2023), where ontologies are operationalized to integrate heterogeneous clinical data, support medical reasoning, and enhance decision relevance. These systems directly instantiate theoretical KM constructs—such as shared vocabularies, conceptual interoperability, and knowledge validation—within real decision-support infrastructures. Beyond healthcare, studies in urban analytics (Vahidnia et al., 2024), education (Antunes et al., 2022), sustainability (Ascencion Arevalo et al., 2023), and corporate governance (Castro et al., 2021) demonstrate the transferability of ontology-driven principles across knowledge-intensive environments. Across

these domains, ontologies serve as mediating structures between data repositories, analytical models, and organizational decision frameworks. Architecturally, three dominant integration patterns emerge:

4.3.1 Data warehouse and ETL integration

Ontologies are systematically embedded into ETL and DW processes to operationalize semantic alignment and conceptual consistency (Bracons Cucó et al., 2024; Zaman et al., 2020). These studies provide concrete evidence that theoretical models of shared conceptualization can be implemented as automated semantic pipelines, directly influencing data quality and analytical reliability.

4.3.2 OLAP and data mining analytics

At the analytical layer, ontologies support semantic querying, intelligent aggregation, and inference-based analytics (Aishwarya et al., 2024; Nicholson et al., 2023). These systems illustrate how ontological reasoning enables a transition from data-centric BI toward knowledge-intensive analytics, a defining characteristic of intelligent decision-making systems.

4.3.3 Decision support and governance

Ontologies increasingly structure decision rules, compliance mechanisms, and interpretability layers (Castro et al., 2021; Guo & Liu, 2019), reinforcing their role in explainable and accountable decision environments. Emerging conversational and collaborative BI systems (Quamar et al., 2020; Fahad et al., 2022) further demonstrate how ontologies operationalize human–system interaction and collective sense-making.

Collectively, these patterns evidence a systemic shift toward interactive, explainable, and knowledge-centered BI ecosystems, aligning ontology-driven BI with the core objectives of intelligent decision-making research.

4.4 Impacts, Performance, and Theoretical Implications

Although large-scale quantitative validation remains limited, multiple studies report tangible improvements in semantic accuracy, interoperability, and decision relevance (Vahidnia et al., 2024; Bracons Cucó et al., 2024), alongside enhanced governance and traceability (Castro et al., 2021). These findings provide empirical support for theoretical claims positioning ontologies as enablers of intelligent decision support.

From a theoretical perspective, the synthesis demonstrates that ontologies increasingly function as bridging mechanisms between data, knowledge, and decision logic, operationalizing KM principles within BI architectures. From a practical standpoint, the reviewed systems show how these principles materialize in applied decision contexts, particularly in complex, regulated, and data-intensive environments.

However, the evidence also reveals structural limitations: fragmented engineering practices, weak scalability assessments, and insufficient organizational deployment studies. Addressing these gaps is essential if ontology-driven BI is to move from experimental implementations to a mainstream intelligent decision-making paradigm. Future research must therefore prioritize standardized evaluation protocols, cross-domain frameworks, and industrial-scale validation to consolidate ontology-driven BI as a foundational approach for next-generation decision intelligence.

5. Study Contribution

This study makes a significant contribution to the knowledge management and Business Intelligence (BI) literature by delivering a systematic and integrative synthesis of ontology-driven BI research and by grounding its conclusions in explicit empirical and methodological patterns identified across the reviewed studies. By analyzing and classifying prior work according to core BI components—ETL, data warehousing, OLAP, data mining, and decision support—this review consolidates a fragmented body of research into a coherent analytical framework, clarifying how ontology-driven approaches have been operationalized across the BI lifecycle.

The findings demonstrate, based on the reviewed evidence, that ontologies are not merely used as auxiliary semantic layers, but are frequently positioned as central knowledge structures guiding data integration, schema design, reasoning mechanisms, and analytical processes. Across multiple studies, ontologies were empirically applied to concrete organizational problems, including semantic data integration, decision rule formalization, domain-aware analytics, and context-driven decision support, thereby illustrating how theoretical knowledge-representation models have been translated into implemented architectures, prototypes, and domain-specific BI solutions. This evidence-based mapping explicitly shows how ontology-driven BI research has bridged

conceptual foundations from knowledge engineering and semantic web research with real-world BI and decision-support applications.

The study advances theory by reframing ontology-driven BI as a knowledge management paradigm, in which ontologies function as organizing knowledge infrastructures that support semantic interoperability, knowledge formalization, and machine-assisted reasoning across BI processes. At the same time, the review provides empirical insight by identifying dominant methodological trends (e.g., prevalence of framework proposals and prototype implementations), application domains, and validation strategies, while also revealing persistent limitations related to scalability testing, cross-domain transferability, and large-scale organizational evaluation. By systematically evidencing where and how ontology-driven BI has been implemented, and where empirical support remains weak, this review generates actionable research directions. It highlights the need for hybrid architectures, stronger empirical validation, and domain-independent evaluation protocols to move ontology-driven BI from conceptual and experimental stages toward robust, deployable intelligent decision-making systems.

5.1 The Visual Representation of the Findings

To facilitate comprehension, and ensure a clear synthesis of the study's outcomes, a mind map was developed to visually organize and illustrate the key findings. This visualization, presented in Figure 5, to capture the central concepts that emerged from the analysis.

By structuring the results in this manner, the mind map serves not only as a cognitive aid for the reader but also as a tool for highlighting the complexity and coherence of the insights generated that might be less apparent in linear textual formats, thus supporting both analytical clarity and narrative accessibility.

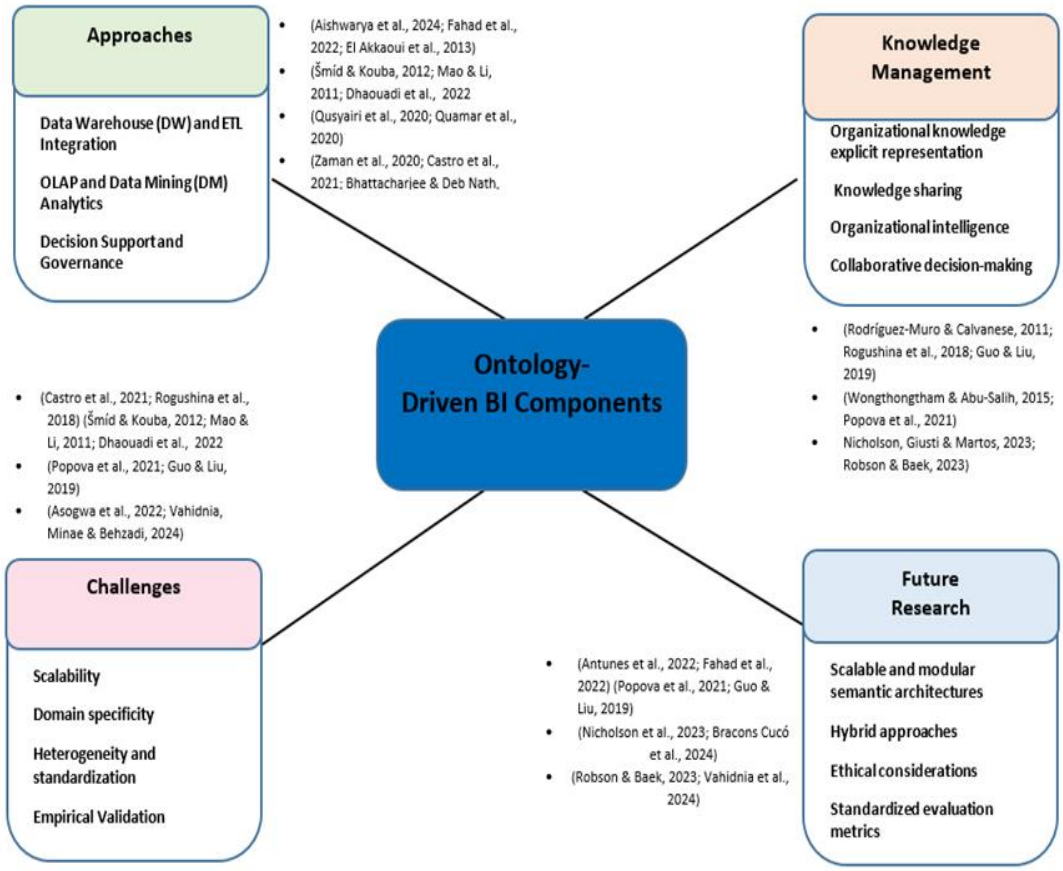

Figure 5: 4 Representation of key findings on BI components (designed by the authors)

6. Conclusions and Future Research Directions

This systematic literature review synthesized 27 peer-reviewed studies published between 2011 and 2024 to examine the evolution, design, application domains, and performance characteristics of ontology-driven Business Intelligence (BI) components. The findings reveal a clear evolution from early conceptual and ontology-based data integration efforts toward more mature ontology-driven BI architectures that embed ontologies across core BI components to enhance semantic interoperability, reasoning capabilities, and intelligent decision support. From a design perspective, the reviewed studies predominantly adopt layered or service-oriented architectures supported by Semantic Web standards, positioning ontologies as central knowledge structures that mediate between heterogeneous data sources, analytical processes, and decision contexts. The reviewed implementations span diverse domains, including healthcare, industrial systems, smart environments, and public services, providing empirical evidence of the practical relevance of ontology-driven BI in real organizational settings. However, despite consistent benefits in semantic integration, knowledge reuse, and decision support, current approaches remain constrained by scalability challenges, ontology engineering and maintenance complexity, and limited real-time processing capabilities. From a knowledge management perspective, these results demonstrate that ontology-driven BI extends beyond technical data integration to support the formalization, sharing, and operationalization of organizational knowledge. By aligning heterogeneous data under shared conceptual models, ontology-driven BI frameworks contribute to the development of organizational intelligence and knowledge-based decision processes. Future research should therefore focus on developing scalable and performance-aware ontology-driven BI architectures, investigating hybrid models that integrate ontological reasoning with advanced analytics and machine learning, and conducting longitudinal empirical studies to assess organizational value, usability, and adoption dynamics. In parallel, greater attention should be given to governance, ethical, and transparency issues to ensure the responsible deployment of semantically enriched BI systems within knowledge-intensive organizations.

AI Statement: During the preparation of this work, the authors state that AI tools were used solely in order to assist with paraphrasing and proofreading during the writing process. Then the authors reviewed and edited the content as needed to ensure accuracy, originality, and academic integrity.

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References

A.C.B. and Mahesh, K. (2023) 'Ontology-based data interestingness: A state-of-the-art review', *Natural Language Processing Journal*, 4, p. 100021. https://doi.org/10.1016/j.nlp.2023.100021

Adda, M. (2010) 'A Pattern Language for Knowledge Discovery in a Semantic Web context', *International Journal of Information Technology and Web Engineering*, 5(2), pp. 16–31. https://doi.org/10.1016/j.nlp.2023.100021

Ahmed, J. and Ahmed, M. (2018) 'Big data and semantic web, challenges and opportunities a survey', *International Journal of Engineering & Technology*, 7(4.5), p. 631.

Aishwarya, B. et al. (2024) 'Semantic Reasoning and Knowledge Discovery in Biomedical Informatics Using Domain-Specific Ontologies', *2024 International Conference on Trends in Quantum Computing and Emerging Business Technologies*, Pune, India, March 2024, pp. 1–6. https://doi.org/10.1109/TQCEBT59414.2024.10545087

Antunes, A. et al. (2023) 'Gamified Educational Learning Contents Ontology', *Atas da 23a Conferência da Associação Portuguesa de Sistemas de Informação*, Associação Portuguesa de Sistemas de Informação, APSI, 2023. https://doi.org/10.18803/capsi.v23.295-316.

Antunes, A.L., Cardoso, E. and Barateiro, J. (2022) 'Incorporation of Ontologies in Data Warehouse/Business Intelligence Systems - A Systematic Literature Review', *International Journal of Information Management Data Insights*, 2(2), p. 100131. https://doi.org/10.1016/j.jjimei.2022.100131

Antunes, A.L.F. (2024) 'Application of Semantic Web Techniques in Data Warehouse and Business Intelligence Systems', *Proceedings of the International Conference on Information Management and Data Science*, ProQuest. Available at: https://search.proquest.com

Arendarenko, E. and Kakkonen, T. (2012) 'Ontology-Based Information and Event Extraction for Business Intelligence', in Ramsay, A. and Agre, G. (eds.) *Artificial Intelligence: Methodology, Systems, and Applications*. Berlin, Heidelberg: Springer, vol. 7557, pp. 89–102. https://doi.org/10.1007/978-3-642-33176-3_8

Ascencion Arevalo, K.M., Neunsinger, C., Zimmermann, R., Blum, R. and Weakly, K. (2023) 'HOLY: An Ontology Covering the Hydrogen Market', *Proceedings of the International Semantic Web Conference (ISWC)*, Springer, vol. 14266, pp. 3–17. https://doi.org/10.1007/978-3-031-47243-5_1

Asogwa, E.C. et al. (2024) 'A Medical Intelligent Process Model Using Ontology Based Technique', *International Journal of Simulation: Systems, Science & Technology*, February 2024. https://doi.org/DOI 10.5013/IJSSST.a.25.01.03

Bhattacharjee, A. and Deb Nath, R.P. (2024) 'SETLonDEMAND: Towards an on Demand ETL Approach for Semantic Data Warehouses', *2024 6th International Conference on Electrical Engineering and Information & Communication Technology (ICEEICT)*, Dhaka, Bangladesh, May 2024, pp. 1315–1320. https://doi.org/10.1109/ICEEICT62016.2024.10534564

Bracons Cucó, G., Gil Rojas, J., Peñafiel Macías, P., Borrat Frigola, X., Lymperidou, A., Martínez-González, J., Labarga, A. and Frid, S. (2024) 'OntoBridge versus Traditional ETL: Enhancing Data Standardization into CDM Formats Using Ontologies within the DATOS-CAT Project', in Mantas, J. *et al.* (eds.) *Digital Health and Informatics Innovations for Sustainable Health Care Systems*. Amsterdam: IOS Press. https://doi.org/10.3233/SHTI240681

Brandt, M.M., Psarommatis, F., Simon, C., Waaler, A. and Zhou, B. (2023) 'Towards Standardised Product Data Exchange with Information Modelling Framework at Siemens Energy', *Proceedings of the SemIIM Workshop 2023*, CEUR Workshop Proceedings. https://ceur-ws.org

Budgen, D. and Brereton, P. (2006) 'Performing systematic literature reviews in software engineering', *Proceedings of the 28th International Conference on Software Engineering*, Shanghai, China, May 2006, pp. 1051–1052. https://doi.org/10.1145/1134285.1134500

Castro, A. et al. (2021) 'An Ontological-Based Model to Data Governance for Big Data', *IEEE Access*, 9, pp. 109943–109959. https://doi.org/10.1109/ACCESS.2021.3102486

Choi, J. et al. (2020) 'Social media analytics and business intelligence research: A systematic review', *Information Processing & Management*, 57(6), p. 102279. https://doi.org/10.1016/j.ipm.2020.102279

Dhaouadi, A. et al. (2022) 'Data Warehousing Process Modeling from Classical Approaches to New Trends: Main Features and Comparisons', *Data*, 7(8), p. 113. https://doi.org/10.3390/data7080113

De Oliveira, E. R. and Rodrigues, P. (2021). A review of literature on human behaviour and artificial intelligence: contributions towards knowledge management, *Electronic Journal of Knowledge Management*, v. 19, Issue 1, p. 88–98. https://academic-publishing.org/index.php/ejkm/article/view/2307

El Akkaoui, Z. et al. (2013) 'A BPMN-Based Design and Maintenance Framework for ETL Processes', *International Journal of Data Warehousing and Mining*, 9(3), pp. 46–72. http://doi.org/10.4018/jdwm.2013070103

Fahad, M., Darmont, J. and Favre, C. (2022) 'The Collaborative Business Intelligence Ontology (CBIOnt)', *arXiv*, 2 November 2022. https://doi.org/10.48550/arXiv.2211.00995

Ghelani, D. (2022) 'Complex Business Intelligence Queries in Natural Language', *Preprints*, 23 September 2022. https://doi.org/10.20944/preprints202209.0387.v1

Girase, A.V., Patnaik, G.K. and Patil, S.S. (2016) 'Developing knowledge driven ontology for decision making', *2016 International Conference on Signal Processing, Communication, Power and Embedded System*, IEEE. https://doi.org/10.1109/SCOPES.2016.7955653

Gomez-Uribe, C.A. and Hunt, N. (2016) 'The Netflix Recommender System: Algorithms, Business Value, and Innovation', *ACM Transactions on Management Information Systems*, 6(4), pp. 1–19. https://doi.org/10.1145/2843948

Guo, H. and Liu, K. (2019) 'Hierarchical Ontology Graph for Solving Semantic Issues in Decision Support Systems', *Proceedings of the 21st International Conference on Enterprise Information Systems*, Heraklion, Crete, Greece, pp. 483–487. https://doi.org/10.5220/0007697504830487

Kitchenham, B. (2004) 'Procedures for Performing Systematic Reviews', *Joint Technical Report*, Software Engineering Group, Department of Computer Science, Keele University, Keele, UK, Technical Report TR/SE-0401; National ICT Australia (NICTA), Technical Report 0400011T.1.

Kitchenham, B. et al. (2009). Systematic literature reviews in software engineering—A systematic literature review. *Information and Software Technology*, 51(1), 7–15. https://doi.org/10.1016/j.infsof.2008.09.009

Luque-Morales, R.A. et al. (2023) 'Ontology Development for Knowledge Representation of a Metrology Lab', *Engineering, Technology & Applied Science Research*, 13(6), pp. 12348–12353. https://doi.org/10.48084/etasr.6445

Mao, X. and Li, Q. (2011) 'Ontology-based web spatial decision support system', *2011 19th International Conference on Geoinformatics*. https://doi.org/10.1109/GeoInformatics.2011.5981121

Masmoudi, M. et al. (2024) 'Semantic Data Integration and Querying: A Survey and Challenges', *ACM Computing Surveys*, 56(8), pp. 1–35. https://doi.org/10.1145/3641286

Matar, N., Al-Jaber, A. and Matar, W. (2024) 'Unlocking Business Intelligence and Data Analytics Adoption Patterns: Insights from Jordanian Higher Education Institutions', *Engineering, Technology & Applied Science Research*, 14(5), pp. 16198–16206. https://doi.org/10.48084/etasr.6931

Moussas, K., Hafiane, J., and Achaba, A. (2024). Business intelligence and its pivotal role in organizational performance: An exhaustive literature review. *Journal of Autonomous Intelligence*, *7*(4), Article 1286. https://doi.org/10.32629/jai.v7i4.1286

Nebot, V. et al. (2009) 'Multidimensional Integrated Ontologies: A Framework for Designing Semantic Data Warehouses', in Spaccapietra, S., Zimányi, E. and Song, I.-Y. (eds.) *Journal on Data Semantics XIII*. Berlin, Heidelberg: Springer, vol. 5530, pp. 1–36. https://doi.org/10.1007/978-3-642-03098-7_1

Neumayr, B., Anderlik, S. and Schrefl, M. (2012) 'Towards ontology-based OLAP: datalog-based reasoning over multidimensional ontologies', *Proceedings of the Fifteenth International Workshop on Data Warehousing and OLAP*, Maui, Hawaii, USA, November 2012, pp. 41–48. https://doi.org/10.1145/2390045.2390053

Nicholson, N., Giusti, F. and Martos, C. (2023) 'Ontology-Based AI Design Patterns and Constraints in Cancer Registry Data Validation', *Cancers*, 15(24), p. 5812. https://doi.org/10.3390/cancers15245812

Niemi, T. et al. (2007) 'Ontologies with Semantic Web/Grid in Data Integration for OLAP', *International Journal on Semantic Web and Information Systems*, 3(4), pp. 25–49. https://doi.org/10.4018/jswis.2007100102

Orche, A.E. and Bahaj, M. (2020) 'Approach to Combine an Ontology-Based on Payment System with Neural Network for Transaction Fraud Detection', *Advances in Science, Technology and Engineering Systems Journal*, 5(2), pp. 551–560. https://doi.org/10.25046/aj050267

Osman, I., Ben Yahia, S. and Diallo, G. (2021) 'Ontology Integration: Approaches and Challenging Issues', *Information Fusion*, 71, pp. 38–63. https://doi.org/10.1016/j.inffus.2021.02.007

Phuoc, D.L. and Nguyen, T.B. (2006) 'OWL-Based Data Cube for Conceptual Multidimensional Data Model', *ICTACS 2006*, Ho Chi Minh City, Vietnam, December 2006, pp. 247–260. https://doi.org/10.1142/9789812772671_0018

Popova, M., Globa, L. and Novogrudska, R. **(**2021**)** 'Multilevel Ontologies for Big Data Analysis and Processing', *Proceedings of the Conference on Big Data Analysis and Processing*, Halle University Repository. https://repo.bibliothek.uni-halle.de

Quamar, A. et al. (2020) 'Conversational BI: an ontology-driven conversation system for business intelligence applications', *Proceedings of the VLDB Endowment*, 13(12), pp. 3369–3381. https://doi.org/10.14778/3415478.3415557

Qusyairi, M., Sudarma, M., & Dharma, A. (2020). Design and build data warehouse using ontology and rule base method in supporting sales and service information. *International Journal of Engineering and Emerging Technology*, *5*(2), 66–71. https://doi.org/10.24843/IJEET.2020.v05.i02.p011

Ren, S., Wang, T. and Lu, X. (2018) 'Dimensional modeling of medical data warehouse based on ontology', *2018 IEEE 3rd International Conference on Big Data Analysis (ICBDA)*, Shanghai, March 2018, pp. 144–149. https://doi.org/10.1109/ICBDA.2018.8367693

Robson, B. and Baek, O.K. (2023) 'An ontology for very large numbers of longitudinal health records to facilitate data mining and machine learning', *Informatics in Medicine Unlocked*, 38, p. 101204. https://doi.org/10.1016/j.imu.2023.101204

Rodríguez-Muro, M. and Calvanese, D. (2011) 'Dependencies: Making Ontology-Based Data Access Work in Practice', *Proceedings of the Alberto Mendelzon Workshop (AMW)*, Punta del Este, Uruguay. https://inf.unibz.it.

Rogushina, J., Gladun, A. and Pryima, S. (2018) 'Use of Ontologies for Metadata Records Analysis in Big Data', *Proceedings of the Workshop on Big Data and Semantic Technologies*, CEUR Workshop Proceedings. https://ceur-ws.org.

Savaglio, C. et al. (2019) 'Data Mining at the IoT Edge', *2019 28th International Conference on Computer Communication and Networks (ICCCN)*, Valencia, Spain, July 2019, pp. 1–6. https://doi.org/10.1109/ICCCN.2019.8846968

Schrefl, M. (2013) 'Ontology-Driven Business Intelligence for Comparative Data Analysis', *Proceedings of the International Workshop on Ontology-Driven Information Systems*, Université Libre de Bruxelles. https://cs.ulb.ac.be

Selma, K. et al. (2012) 'Ontology-based structured web data warehouses for sustainable interoperability: requirement modeling, design methodology and tool', *Computers in Industry*, 63(8), pp. 799–812. https://doi.org/10.1016/j.compind.2012.07.006

Sharma, S., Rana, V. and Kumar, V. (2021) 'Deep learning based semantic personalized recommendation system', *International Journal of Information Management Data Insights*, 1(2), p. 100028. https://doi.org/10.1016/j.jjimei.2021.100028

Šmíd, M. and Kouba, Z. (2012) 'OnGIS: Ontology driven geospatial search and integration', *Proceedings of the 13th International Conference on Computational Science and Its Applications*. https://doi.org/10.1016/j.jjimei.2021.100028

Song, F., Zacharewicz, G. and Chen, D. (2013) 'An ontology-driven framework towards building enterprise semantic information layer', *Advanced Engineering Informatics*, 27(1), pp. 38–50. https://doi.org/10.1016/j.aei.2012.11.003

Stănescu, G. & Oprea, S.-V. (2025). Recent trends and insights in semantic web and ontology-driven knowledge representation across disciplines using topic modeling. *Electronics*, *14*(7), 1313. MDPI. https://doi.org/10.3390/electronics14071313

Suša Vugec, V. et al. (2020) 'Business intelligence and organizational performance: The role of alignment with business process management', *Business Process Management Journal*, 26(6), pp. 1709–1730. https://doi.org/10.1108/BPMJ-12-2019-0515

Taelman, R. et al. (2018) 'Triple storage for random-access versioned querying of RDF archives', *Web Semantics: Science, Services and Agents on the World Wide Web*. https://doi.org/10.1016/j.websem.2018.08.001

Turban, E., Sharda, R. and Delen, D. (2011) *Decision Support and Business Intelligence Systems*, 9th edn. Boston: Prentice Hall.

Vahidnia, M.H., Minaei, M. and Behzadi, S. (2024) 'An ontology-based web decision support system to find entertainment points of interest in an urban area', *Geo-spatial Information Science*, 27(2), pp. 505–522. https://doi.org/10.1080/10095020.2024.2319841

Villanueva Chavez, J. and Li, X. (2011) 'Ontology based ETL process for creation of ontological data warehouse', *2011 8th International Conference on Electrical Engineering, Computing Science and Automatic Control*, Merida City, Mexico, October 2011, pp. 1–6. https://doi.org/10.1109/ICEEE.2011.6106597

Wang, Z. et al. (2022) 'From Personalized Medicine to Population Health: A Survey of mHealth Sensing Techniques', *IEEE Internet of Things Journal*, 9(17), pp. 15413–15434. https://doi.org/10.1109/JIOT.2022.3187563

Wimalasuriya, D.C. and Dou, D. (2010) 'Ontology-based information extraction: An introduction and a survey of current approaches', *Journal of Information Science*, 36(3), pp. 306–323. https://doi.org/10.1177/0165551510368830

Wongthongtham, P. and Abu-Salih, B. (2015) 'Ontology and trust based data warehouse in new generation of business intelligence: State-of-the-art, challenges, and opportunities', *2015 IEEE 13th International Conference on Industrial Informatics (INDIN)*, Cambridge, July 2015, pp. 476–483. https://doi.org/10.1109/INDIN.2015.7281780

Zaman, G. et al. (2020) 'Digital Library of Online PDF Sources: An ETL Approach', *International Journal of Computer Science and Network Security*, 20(11), pp. 172–181. https://doi.org/10.22937/IJCSNS.2020.20.11.21

Zhuoxun Zheng et al. (2022). *Query-based Industrial Analytics over Knowledge Graphs with Ontology Reshaping.* arXiv preprint. https://doi.org/10.48550/arXiv.2209.11089

Hussain, A.A., Al Turjman, F. and Sah, M. (2021) Semantic Web and Business Intelligence in Big Data and Cloud Computing Era. In: Ben Ahmed, A. *et al.* (eds.) *Innovations in Smart Cities Applications – Volume 4 (SCA 2020).* Lecture Notes in Networks and Systems, vol. 183. Springer, Cham, pp. 107–118. https://doi.org/10.1007/978-3-030-66840-2_107

Padeli, W., Pangil, F. and Kadir, K. A. (2025). Navigating knowledge in the hybrid era: Critical success factors for managing knowledge in commercial and industrial hybrid workplaces, *Electronic Journal of Knowledge Management***,** https://doi.org/10.34190/ejkm.23.2.3800 An

Leveraging Research for Knowledge Continuity: A Case in Infrastructure Management

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Abstract: Ensuring long-term knowledge continuity is a key challenge for organizations managing the long-cycle maintenance of complex infrastructure. This paper explores how agency-led research programs can support dynamic knowledge continuity within the Dutch Directorate-General for Public Works and Water Management (Rijkswaterstaat, RWS), particularly in relation to its storm surge barriers. The long-cycle maintenance of the storm surge barriers faces long redesign cycles which result in a challenging human capital development environment with regards to specialist knowledge domains. Current knowledge of complex barrier systems is of a distributed nature following several decades of intensive outsourcing. At present the agency is investing in research programs aimed to strengthen its knowledge in strategic areas. This article aims to add to the limited literature of leveraging research efforts for long term knowledge continuity in a distributed knowledge environment. The research was conducted using questionnaires and semi-structured interviews. Fourteen respondents comprise of active researchers, research supervisors, and research managers. Researchers acquire high levels of proficiency in critical engineering knowledge domains. This equates to the development of valuable human capital that flows from the program when researchers complete their projects. Researchers were found to be highly motivated to stay on and locally implement their findings or contribute to their domain of engineering knowledge. Results include nine ways in which the research programs contribute to long-term knowledge continuity, of which human capital development is the most important. The study further reveals that while research programs effectively cultivate deep technical expertise, their potential is underutilized due to limited follow-up employment opportunities and a lack of strategic alignment with staffing and insourcing. We argue that research-developed talent should be strategically integrated into local technical teams to strengthen RWS's internal capabilities, foster standardization, and ensure preparedness for long-cycle maintenance and redesign challenges. Our findings inform both theoretical perspectives on dynamic knowledge management and practical strategies for asset-intensive public organizations.

Keywords: Knowledge continuity, Critical infrastructure, Research programs, Strategic insourcing, Human capital, Talent development, Rotating traineeship, Long-cycle maintenance

1. Introduction

Achieving knowledge continuity across generations of engineers is essential to the asset management of critical infrastructure. Achieving this for unique, complex, and ageing infrastructure with high demands for reliability and availability has proven to be challenging. This has been previously investigated in the context of the Dutch storm surge barriers (Kharoubi *et al.*, 2024; Walraven, Vrolijk and Kothuis, 2022; Ponsioen *et al.,* 2023). The core of the knowledge management challenge is that the long-term management of assets is not a very suitable environment for developing lead-designer level technical knowledge because many critical tasks are too infrequent to facilitate reliable 'learning on the job' (Kamps *et al.*, 2024a). Absence of authentic learning opportunities can be a major challenge to development of specific knowledge, even if sufficient time and other learning resources are available (Beane, 2019). Challenges to knowledge continuity are regularly exacerbated by attrition through retirement happening in waves, as reported from research at a different public agency (Delany and O'Donnell, 2005). Waves of attrition and limits to knowledge development outside the highly dynamic phase of design and construction cannot be completely avoided. Therefore strengthening institutional pathways for

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developing technical talent with barrier-domain knowledge is needed for knowledge continuity at the agency (Kamps *et al.*, 2024a).

Infrastructure is affected by trends like population growth, technological development, climate change, energy transition and environmental protection (Nezami *et al.*, 2022). Avoiding obsolescence of infrastructure in a changing environment requires continual redesigns demanding deep engineering knowledge. Research as a knowledge-using, creating, and sharing activity can support rebuilding knowledge in time for long-cycle maintenance challenges. Research activity can be planned outside the timeframes of redesign and updating of technical systems when knowledge is most needed (Kamps *et al.*, 2024a). This article will investigate the research question "How can agency-led research programs be leveraged to achieve dynamic knowledge continuity in the management of critical complex infrastructure?". The research was situated at and centred around the knowledge continuity challenges of the Dutch storm surge barriers. The study used a trial round of semi-structured interviews, followed by the main round where quantitative survey questions were added. Due to the small sample size, all quantitative responses were also extensively discussed during the interviews.

This first section explores literature and practice with regards to the relationships between knowledge continuity, research programs, distributed knowledge and knowledge process outsourcing. The second section describes the method employed for the research, while the third section elicits its results. The fourth section discusses the findings from both a theoretical and practical perspective, while the fifth section concludes the research with theoretical and practical recommendations, as well as limitations and potential for follow-up research.

1.1 Static Goals in a Dynamic World

The Dutch Directorate General of Public Works and Water Management, Rijkswaterstaat (RWS), manages many critical and complex infrastructures. The six storm surge barriers are among its most complex and unique assets, and in 2018, a knowledge strategy was published specifically for these barriers. The knowledge strategy includes a provision for continuity of distributed knowledge, which states that engineering knowledge is sufficiently assured when held by two or more reliable partners (organizations with which RWS regularly works). If it is not, it must be held by two or more engineers employed by RWS. This straightforward knowledge continuity policy reveals an underlying assumption that 'sufficient' engineering knowledge is a constant or steady state that needs to be managed. The knowledge strategy provides the tools for determining knowledge risk for key domains of barrier knowledge.

Rijkswaterstaat has a long and rich history of managing knowledge risk. The earliest RWS document on managing knowledge risks dates back to 1983 (Mazure, 1983), several years before knowledge management emerged as a distinct scientific discipline. Mazure's report addresses the risk of losing hydraulic engineering knowledge at the end of the Delta program, which built the modern Dutch flood defences and provided employment for many engineers. Mazure's method is relatively simple and revolves around counting the number of 'heads' of hydraulic engineers across various departments of RWS. Knowledge risk management has since evolved, and current practice at RWS agrees well with the task-centred approach described by Boyles (2009) for the nuclear industry. A task-centred approach is also used for the professional standards adopted and published by the International Atomic Energy Agency (IAEA) (2017). In this approach, the organizational knowledge base is scanned for the risk of losing key knowledge carriers, while also assessing the impact on the ability to complete key tasks. When the method's goals are met, critical knowledge remains continuously available.

Prescribing in policy a continuous availability of engineering knowledge for all critical tasks does not take into account that some engineering tasks have very long cycles, as fifteen to thirty years between updates of systems is typical (Vader *et al.,* 2023). Currently, in line with the steady-state assumption, policy does not account for what employed engineers knowledgeable in critical domains should do with this knowledge during periods of discontinuity in use. Knowledge of infrequent tasks however tends to fluctuate in time, following the intensity of knowledge use (Walker, 2018). This paper, therefore, questions whether a steady-state knowledge continuity model is most suitable for infrequent tasks and instead proposes a policy of directed knowledge build-ups, leveraging agency-led research.

Conventional knowledge risk management minimizes the risk of losing key knowledge. If it is known in advance when knowledge will be needed however, this risk does not need to be considered for any point in time, but only for the time when the focal task is set to commence. Taking this perspective, some knowledge attrition can be viewed as acceptable, so long as it is rebuilt in time for the focal task. Conceptualizing knowledge continuity in a different way than avoiding all loss of knowledge offers clear advantages. Conventional management of

knowledge risks aligns the timing of mitigating efforts with the time of the expected loss of knowledge, i.e., the retirement of a highly valued expert. Assigning an apprentice to a soon-to-retire expert has been found in both the literature and internally at RWS to not always to be successful, as there may be no relevant tasks to enable the apprentice to absorb the tacit knowledge of the expert during the apprenticeship (Kamps *et al.*, 2024a; Leonard, Swap and Barton, (2015); Mazzucato and Collington, (2024)). Managing engineering knowledge for expected tasks aligns the timing of efforts to improve task readiness with challenging tasks to come. This does not replace the need for knowledge risk assessments and associated mitigation efforts; it does, however, provide a more useful basis for deploying non-core activities aimed at reactivating dormant knowledge, such as research and (digital) twinning (Kamps *et al.*, 2024a). Long-cycle engineering challenges are reasonably predictable in terms of time, as RWS has detailed plans containing all expected upgrades and system replacements for the next thirty years. The term 'dynamic knowledge continuity' is introduced here to describe a policy of seeking to continuate critical knowledge over time, but accept significant variability. During, or preferably even leading up to periods of high demand, a concentrated effort of human resource development will then be necessary to compensate for the periods of low demand and associated attrition.

1.2 Managing Local Assets with Distributed Knowledge

In the present time, RWS outsources most of its design and engineering work. Outsourcing such knowledge processes causes reliance on distributed rather than internal knowledge (Edvardsson and Durst, 2014). A specialized firm often has superior knowledge continuity and opportunities for learning in its field (Mudambi and Tallman, 2010). Internal knowledge retention also carries cost, and a firm's internal retention capacity is limited, which is why Lichtenthaler (2008) advocates for an integrated strategy comprising both internal and external knowledge. Mudambi and Tallman (2010) note that managing external knowledge processes and distributed knowledge requires having overlapping knowledge in-house, and the more in-house knowledge is available, the better it is for management of external processes. Hartman, Ogden and Hazen (2017) advocate avoiding knowledge attrition by partially insourcing tasks for which knowledge retention is considered necessary. This is also supported by Anderson and Parker (2002), who focus on component-integration and show a significant amount of insourcing is necessary to support the local learning that results in intimate component knowledge and integrated system knowledge.

An asset management organization that must ensure the reliability and availability of complex and unique infrastructure has knowledge continuity vulnerabilities similar to a firm acting as a systems-integrator. It must avoid vendor lock-in, and the resulting dependency and loss of negotiating power as well as prevent gradual loss of local knowledge. At RWS these are not just theoretical risks either, as some of the research programs investigated for this study were, among other reasons, started to reduce undesirable dependency and lock-in. If complex tasks are completely outsourced for some time, knowledge is also very challenging to bring back (Agndal and Nordin, 2009; Mazzucato and Collington, 2024).

Summarizing, an organization like RWS should retain critical engineering abilities necessary to effectively work with their partners and, learn and develop knowledge, but also seek to benefit from specialist provider's abilities to stay up-to-date on innovation. As a 'first among peers' of Dutch public asset managers such as provinces, municipalities and water boards, RWS is well-positioned to develop and lead knowledge development for the asset management of complex public assets. This would be in line with the recommendation by Mazzucato (2024) for public agencies to assume such a role.

1.3 Research Driving Human Capital Development for Knowledge Continuity

Well-chosen avenues of research give researchers time and reason to read through documentation that has been untouched for a long time and bring its content to life, providing valuable opportunities for learning about critical but sparsely-used domains of knowledge (Kamps *et al.,* 2024a). Knowledge management also teaches us that we all know and learn more than we can tell. The advances in a researcher's (tacit) knowledge will far surpass that which is captured in written research reports (Nonaka and Takeuchi, 1995; Grant, 2007). The developing technical talent through research builds valuable human capital. Conventional academic models of value creation through research emphasize primarily the products of research and their application, whereas value creation through human capital development receives less recognition as a key aim of research. Williams (2020) provides an overview of thirty-six measures of scientific impact, only one of which is about human capital development (number of PhDs awarded). Some authors do recognize human capital as a key output of research programs. Guimarães and Humann (1995) for example give a detailed account of a major research program initiated by the Brazilian government in the 1960s with the main aim of developing human capital. More notably Bozeman, Dietz, and Gaughan (2001) propose a value model that includes human capital aspects, but consider

the property difficult to measure. They also point to the 'social capital' development during research, which develops a potentially highly valuable network of individuals with related knowledge in the asset management of critical infrastructure. In asset management, continuity of personified, tacit and connected knowledge is independently valuable, because only by having knowledgeable technical staff at hand can the agency be ready for the challenges presented by the long-term maintenance of its critical infrastructure. RWS itself does mention human capital development as a research program goal, but does not provide any further provisions or elaboration on the topic.

While doing research, absorbing critical but long-dormant details of a complex asset's engineering helps researchers find answers to the questions they work on and increase their knowledge, but that in itself does little for knowledge continuity. Knowledge continuity is served mostly when the personified knowledge gained remains available for the organization, yet the research periods for Masters, EngD and PhD projects of six months to four years are not enough to significantly contribute to retention and continuity of tacit knowledge. This makes prolonged post-research involvement essential in the face of a century-long service life of key infrastructure. A human resource strategy that aligns with knowledge development and transfer goals is highly recommended by the literature, but often not achieved in the practice of state owned companies (Phaladi, 2023). This supports the case for further research in integration of research, knowledge management and human resource management in public agencies. This argument is also strengthened by the expectation of AI replacing entry-level white collar jobs first (Dillender and Forsythe, 2022), potentially reducing developmental paths by learning on the job in the near future. Using non-primary tasks like research assignments to develop new talent may soon gain even more importance.

2. Method

The first step in this research was developing a case for the contribution of research to knowledge continuity based on the literature and agency policy documents in relevant domains. RWS has attracted a diverse pool of researchers to work on their research needs at the storm surge barriers, supervised by academics from several universities. While preparing the study there was an opportunity to observe a key meeting discussing the future of the I-storm platform. The I-storm platform facilitates international knowledge-exchange between storm surge barrier managing agencies and various partner organization. It currently also facilitates multiple international research collaborations. To see some of the ongoing research at the agency in action two full-day sessions of focus group research conducted by another researcher were observed.

Next, a round of four semi-structured trial interviews was conducted. These interviews were held with one PhD researcher, one postdoctoral researcher, one research supervisor, and one senior research manager. These trial interviews were used to test the interview questions and get a better feel of the topic and the most pressing concerns relating to knowledge development at the agency. To get the best preparation for the main data collection, a thematic analysis (Braun and Clarke, 2021) was conducted on the interview transcripts. The narratives were coded using the initially included, largely literature-derived benefits as codebook. Groundedness and supportiveness of quotes were used to evaluate each benefit. This analysis revealed that the research programs do indeed develop engineering talent, but subsequent talent retention is suboptimal. This motivated deepening the research on talent retention, and to achieve this a more structured interview format including multiple-selection and scale questions was adopted.

Bozeman, Dietz and Gaughan (2001) point to the contributions research activity in organizations makes to human capital development. They concede, however, that measuring the value of this human capital contribution is challenging and must at least in part rely on interviews and questionnaires. They caution against relying solely on simple quantitative metrics such as salary development to assess the human capital value created. Following the recommendations of Bozeman, Dietz and Gaughan (2001), interviews were used to detail the contributions of agency research to knowledge and talent development. In addition, scale questions were used to provide measure for key outcomes.

For the main round of data collection, all the current researchers, research supervisors and research managers working for the Dutch storm surge barriers were invited. All managers and supervisors accepted the invitation. Among active researchers there were a few declines, mostly of researchers in the final stages of their project. Ultimately there were fourteen participants. The participant group consisted of six research managers and supervisors, three PhD candidates, one employed postdoctoral researcher, one Engineering Doctorate (EngD) researcher, two Masters of Science (MSc.) students and one Bachelor of Science (BSc.) student.

The research community of the Dutch storm surge barriers offers a valuable study opportunity of an intrinsic case (Creswell and Poth, 2018). Knowledge continuity challenges affect virtually all complex ageing assets within the RWS portfolio of assets, but the storm surge barriers are recognized as their most challenging case. They combine the most unique technical solutions with the highest demands for proving adherence to high reliability standards at all time (Kharoubi *et al.,* 2024; Mooyaart *et al.*, 2023). Because of the importance and visibility of the storm surge barriers, their knowledge requirements receive a relatively high degree of attention. It is therefore that the research programs of the storm surge barriers make a valuable intrinsic case for study as successes in assuring technical knowledge in this challenging case may provide lessons which can be applied to other less prestigious yet also complex public assets later.

Participants primarily contributed in-depth interviews ranging from just over an hour to two and half hours. A quantitative survey was added to the interviews to be able to visualize the spread of their opinions. This gives a reliable record of how they view their contribution to knowledge continuity of the storm surge barrier community, what more they would like to do and what impediments they experience. The questions can be found in Appendix A. Participants were asked to explain the reasoning behind their choices while completing the form, so that their responses could be reliably interpreted. The form started with a discussion of a simple flow-diagram of research process and benefits, followed by a self-assessment of the knowledge gained during the research period, using six scales. Also the supervising managers, employed by RWS, where asked to assess the knowledge level of their researchers with this form for comparison. This was followed by a multiple-selection question asking participants where they would like and expected to work after completion of their research, and one about the best follow-up to their research. More open questions were discussed at the end of the interviews.

Quantitative self-assessment of knowledge can yield unreliable results (Tracey *et al.*, 1997). To improve quality, results from the trial round were used to develop a semantic scale with five described levels. Participants used the five descriptions to compare their perceived individual knowledge to. This way, the five levels were used to provide 'anchors' on a twelve-point scale. This approach had some unintended effects. In the trial round, knowledge was described by participants in terms of 'able to talk on equal terms to the best experts available'. This approach appears to have been effective for individuals who view knowledge in such terms, but in the main round, it was discovered that people have different ways of assessing their knowledge compared to others. Some participants assess their knowledge mostly based on the length of time they have worked on a topic compared to others. Other participants assess their relative knowledgeability based on whether the agency itself employs experts in their field, and yet others indeed explain their self-ranking based on whether they can discuss their topic 'as equals' with experts in their domain. Discovering these different ways of viewing their own knowledge shows the value of having a discussion with each participant over their answers to the scale questions, and the interpretation of the results.

To validate research findings, the combined results were shared with all participants for review. The responses were analysed and have led to minor revisions. Additionally, results were also discussed with two knowledge managers from the Port of Rotterdam to receive an outside perspective from another asset management organization with critical infrastructure with long life cycles and consequently, long knowledge use gaps between major works.

The research was conducted within the Asset Management Research Group at RWS. The majority of interviews were conducted on-site. Interviews were divided over four RWS offices, located in the Dutch cities of Rijswijk, Eindhoven, Capelle, and Utrecht. Participants are, for the most part, clustered in four research topics: Formal verification (part of the international Stormsafe consortium), Synthesis-Based Engineering (also part of Stormsafe), Asset Management, and Digital Twins. The digital twins group is now mostly out of the research phase and functions as an expert group within RWS, which builds and advises on digital twins, and also advises on related research.

3. Results: Leveraging Research for Dynamic Knowledge Continuity

New research groups have been initiated for various reasons. Some were initiated because of repeated dissatisfaction with asset management project results. This applies to the groups concerned with developing better ways to re-develop and verify asset control software. Others were initiated because technological advancements were perceived to create new opportunities for asset management; the Digital Twins group is a notable example of this. Yet other research has started to develop knowledge to improve readiness for future challenges, such as changing storm seasons and associated maintenance windows. Existing local technical

knowledge, partially centred around existing research groups, is essential for determining whether there are technological opportunities to structurally improve asset management project outcomes through research.

3.1 Research Contributions to Knowledge Continuity

From the responses of participants, we identified nine benefits of performing research for the knowledge continuity at the agency (Table 1). These benefits cover as well tacit, explicit, social and embedded knowledge.

Research will contribute valuable explicit knowledge for future challenges (benefit 1). By choosing real asset management challenges as domains for research, the researchers involved will get to intimately know the challenges, technical systems, and procedures. Some researchers will be hired to stay on after completing their research. Knowledge of challenges and systems will give researchers a significant head start to be able to contribute to solving these challenges professionally (benefit 2). Not every researcher makes a great fit for long-term employment within the government. Traits participants associate with a successful career at RWS are valuing the 'greater good' of society over money, thinking long term, and being 'a connector' who enjoys working with professionals from contracted firms and other departments. The agency can still benefit from research-acquired skills even if researchers are not hired, if they remain involved with the topic while working for a different employer such as a knowledge institute, engineering firm, or IT company. There are several examples of senior external consultants who started their involvement with the storm surge barriers through a barrier-related research assignment.

Research benefits three to nine are important but secondary. Although discussed with enthusiasm, no participant thought these secondary benefits on their own, were likely to significantly impact knowledge continuity. They create value, but are predominantly seen as a collateral benefit. They are each described in Table 1. The next sections will explore the current state and challenges with regard to the talent pool emerging from the research programs.

Table 1: Benefits of research for knowledge continuity

Benefits		Discussion
1.	Solutions to barrier engineering long-cycle maintenance challenges	Some research outcomes were very successful and immediately implemented, others required further development, and one case showed a seemingly promising idea unfortunately did not work. All cases give direction to future improvement efforts on the barriers.
2.	Talent pool with highly specific domain knowledge	Researchers working on unique knowledge domains, such as the one-off-a-kind drive units of the Maeslant Barrier finish their research period with knowledge only very few other people possess. This knowledge is internally classified as at-risk, mostly from retirements of older knowledge carriers. Through the research program a new generation of engineers becomes available for the long-cycle maintenance of the barriers.
3.	Finding errors in existing systems	Software oriented research has found previously unnoticed weaknesses in existing software, even though that was not the research goal. Improvements in software and its documentation are valuable to knowledge continuity.
4.	Highlighting missing system information	One researcher found system information to be incomplete. This will now be addressed before the actual redesign is commissioned. Research filling the gaps in system information can prevent delays.
5.	Learning by others	Focus group research and interview research provide a learning opportunity for their participants. Several participants noted that giving interviews about their work and experience in specific topics was a reflective experience. Focus group research brings people in the organization together to discuss meaningful challenges.
6.	Codification of existing practice	A researcher in the organization domain reported that through the research, the actual practice in the agency was documented in much more detail than in policy documents. Thus, a degree of codification of tacit practice was achieved.
7.	Tool development	Research has created several valuable digital tools. Digital twins especially have a multitude of uses such as (control) scenario research, testing of software modifications, improving the systems' documentation and educational purposes.
8.	Connecting organizations	Sponsoring research connects RWS with several universities and knowledge institutes. This provides access to the latest developments about how best to deal with barrier system obsolescence challenges. Research groups also bring together people from different barrier managing organizations and countries. These connections and collaborations provide benefits beyond

Benefits		Discussion
		direct research results. They also benefit continuity as the network becomes more robust and valuable external experts can be more easily located.
9.	Adapting to discipline developments for long-cycle maintenance needs	Sponsoring research, either directly or through larger consortia, provides opportunity to assure that research directions align with the long-term needs of the storm surge barriers and or other critical assets. Steering the direction of research may yield much more long-term benefits than the direct research results. All the research currently sponsored is directly linked to known challenges in the long-cycle management of critical assets.

3.2 Knowledge Self-assessment

The analysis of the trial interviews revealed that human talent development was perceived as the most important knowledge continuity benefit of the research program. The extent to which the research period matured researchers into knowledge carriers valuable to the long-cycle maintenance of the storm surge barriers was measured with a questionnaire. Participants scored a knowledge assessment form, and afterwards discussed why they had given particular scores, providing insight into the given scores. Researchers scored the form for themselves, whereas research managers scored it for the researchers they had recently worked with.

Six categories of knowledge were investigated, ranging from specialist domain to integral knowledge of the barriers' engineering, and covering both knowledge of the barriers as they are now to knowing what revisions to make to improve their future-readiness. McElroy (2010) stresses the importance of incorporating both storing and sharing existing knowledge as well as organizational proficiency in developing knowledge needed for new challenges in any comprehensive knowledge management program. At the storm surge barriers, the most challenging cases of knowledge use are maintenance projects at the barrier which also encompass (partial) design revisions necessary to keep the barrier aligned with changing demands and conditions (Kamps *et al., 2024a*). Because of the importance of being able to not only understand current designs but also adapt them to changing conditions we asked participants to rate both (existing) domain knowledge and ability to revise it. Major projects require knowledge at the system-specialist level as well as at the systems-integrator level (Whyte and Davies, 2021). To see whether there might be major differences with regards to the development of specialist versus integrative knowledge we mapped this on a three point scale. Mapping both current domain vs revision ability and specialist to integrative knowledge lead to the six categories used. Below are the six categories as they were described on the form.

SD	Specialist domain barrier knowledge (research topic)
ID	Intermediate domain barrier knowledge (discipline associated with the research topic)
WD	Integral (wide) domain knowledge of the barrier as a whole, detailed interactions between barrier systems
SR	Specialist domain revision strategy
IR	Intermediate domain revision strategy
WR	Full barrier(wide) revision strategy

The participants were divided into four groups, as shown in Figure 1. The groups are labelled as:

- R-Phd: researchers doing their PhD and assessing their own knowledge level (n=5)
- M-PhD: managers (domain experts) from the RWS organisation, co-supervising the PhD researchers and assessing the knowledge level of their PhD's (n=5)
- R-M: master students working on their graduation research and assessing their own knowledge level (n=3)
- M-M: managers (domain experts) from the RWS-organization co-supervising the master thesis students, and assessing the knowledge level of their master thesis students (n=2)

These numbers do not exactly match the number of participants in the study. Some managers filled out for two rather than one recent student and two participants did not answer this question.

The scale that was filled out by participants, ran from 0 to 12, and had the following descriptions attached to the scale on how one would describe the knowledge level of oneself and other researchers in terms of knowledge development relative to incumbent engineers:

0. Just saw the barrier for the first time
3. Junior system specialist, 1-2 years at the barrier
6. Senior system specialist, 3-8 years at the barrier
9. Recognized system expert, 8+ years involved with the system, leading role in construction or major revision
12. Full knowledge, can do any task or answer any reasonable question

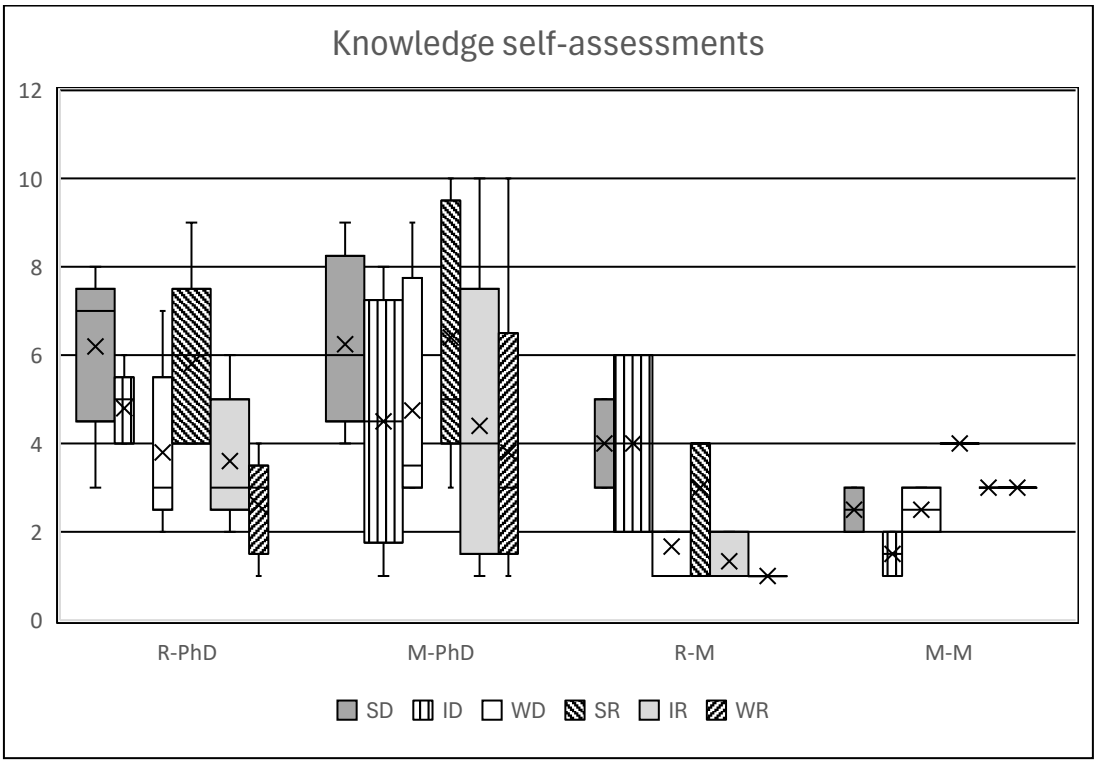


Figure 1: Box plots of knowledge (self)-assessment of researchers and research managers

Results in Figure 1 show that the mean values between researchers and supervising managers are similar; however, the scores given by managers show higher variation. The high variability in responses can generally be attributed to participants choosing different ways to score the scales. One manager and one researcher explained the high scores they gave by explaining that within their domain, there are currently no others at the agency with more knowledge about the topic. Another manager gave high scores because the researchers they supervised were observed talking on equal terms with senior experts about the most complicated details of the system they worked on. One manager who gave low scores explained that PhD research faces stiff demands in terms of scientific rigor and specialization, leaving little room to learn about the broader engineering aspects of the barrier during the research period. Some researchers preferred not to rate their ability any higher than the number of years of experience mentioned at the corresponding point of the scale. They would explain 'at the end of my PhD, I will be four years in, and then counted two points up from the 'Junior specialist, 1-2 years at the barrier'. Multiple managers gave high scores for the 'revision strategy decision making' scales because they explained the (PhD) researchers that they supervise know the latest technological developments better than almost any RWS professional. When researchers and managers gave low rankings for revision strategy decision making, they explained this in terms of a lack of organizational knowledge about what will actually be feasible and work within the RWS context.

Reflecting on the approach for this question and its results, we notice that while we intended to measure professionally applicable knowledge, the answers are actually a compound of two concepts. We believed that because the storm surge barrier engineers are a small community, it would be practical for participants and the interviewing researcher to agree on who would be good examples in their domain for the junior, senior and expert levels used in the scoring system and then accurately score the question. A careful read of participants recorded explanation of their given scores however shows that the way we presented the question caused both managers and participating SSB researchers to include aspects of organizational socialization (Bauer and

Erdogan, 2011) in their answers. Perceived limits to the achieved organizational socialization explains most of the lower scores given. Taking this into account, it can be concluded that researchers are considered to have reached high levels of specialist domain knowledge within the research period, comparable to and sometimes exceeding incumbent engineers. Several managers also expressed they value input from researchers on barrier design revisions. In order to fully reach researcher's potential and apply their knowledge to the benefit of the organization, they may need to be able to give their input in a setting of existing technical know-how and support with regards to organizational socialization.

3.3 Post-research Scenarios for Employment

Researchers were asked where they would provide the most value to the long-cycle maintenance of the storm surge barriers post-research (Best), where they would like to work (Preference), and where they expect to work after research completion (Expectation). Managers filled out for one or two researchers they recently worked with. This results in the five categories shown in Figure 2:

- R-B: what researchers think is best for the barriers (where researchers think they should work after completion of their research)
- R-P: what researchers prefer (where researchers want to work after completion of their research)
- R-E: where researcher expect to work after completion of their research
- M-B: what supervising managers think is best for the barriers (where should the researchers work after completion of their research)
- M-E: where managers expect their researchers to work after completion of the research

The 'preference' question for the supervising managers was omitted as their perception of the researchers' preference is not relevant for the research objective of this study.

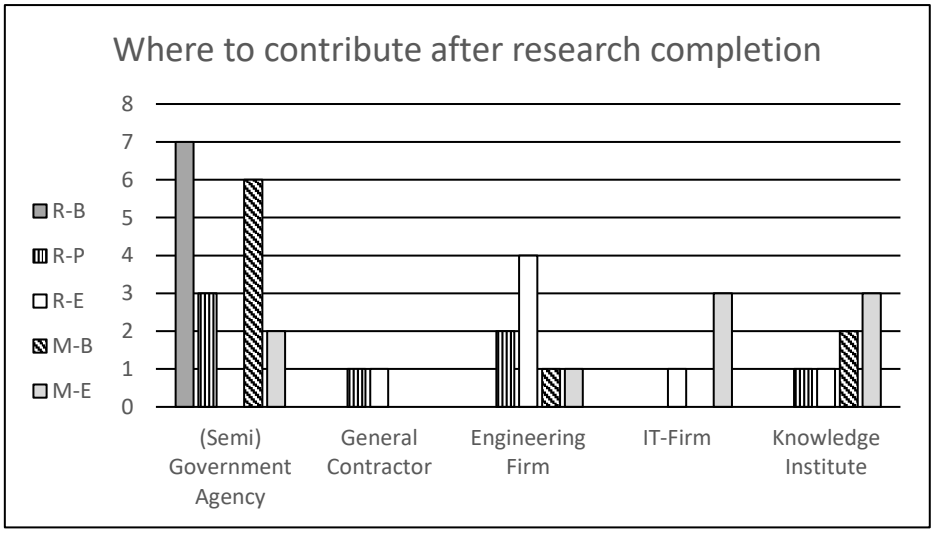


Figure 2: Post-research employment scenarios

All participating researchers scored being directly involved with locally implementing their research as the most valuable follow-up their research could have. The managers have a bit more nuanced view, and several explained the value of having consultants with knowledge of barrier systems at partner firms. Researchers who did not wish to work at the agency (made a different choice for R-P) provided the following reasons: the 'meeting culture', a lack of opportunities for technical work, and uncertainty about research-topic related employment opportunities. One former researcher who is now agency-employed enjoys being given a lot of responsibility and making high-impact decisions based on his expertise. Two managers gave separate accounts of researchers who started at the agency post-research but left soon because they were mostly handling unrelated urgent technical issues. Overall, the results indicate a strong desire to undertake more research-related technical work locally, which is also a recurring theme in the given narratives.

Being considered an innovative employer improves hiring success (Jones, 1996). The absence of substantial local implementation work appears to currently limit the attractiveness of the organization as an employer in domains that matter to the researchers at the agency. Researchers and managers explained that although conducting

research-related work while employed outside of RWS is attractive, it is currently very difficult to find outside employment where they are confident that they will be able to continue working on their topic of choice.

Participating researchers explain that during the start of their professional career, they have a strong preference for doing technical projects themselves over managing design assignments contracted elsewhere. It is worth considering the career paths of those researchers that do not choose to progress into managerial or advisory roles but for whom no opportunity for further technical employment is desirable or feasible. Capacity building in partner organizations, which was suggested by several managers, can for example be achieved by initiating technology-centred rotating traineeships as an alternative to the current management and organization centred offering. This way researchers can experience working in their domain of choice at partners and suppliers and potentially find prolonged involvement. Research into this possibility is currently under way.

3.4 Next Steps for Research Outcomes

Participants were asked to indicate what should happen with their research topic after they were done, and they could award either three, two, or one point for an option and Figure 3 shows the number of points awarded. The first three options are indicated with an 'I'. These are options for direct Implementation of research outcomes, either by a local team, by another organization, or by developing policies or standards based on the research outcomes. The last three options are indicated with an 'R'. These are options for further Research, either at the agency, other organizations in the distributed knowledge network or by academia. Results show a clear preference for local research and implementation, which is shared by both researchers and managers. This is consistent with the R-B and M-B scores given in the previous section.

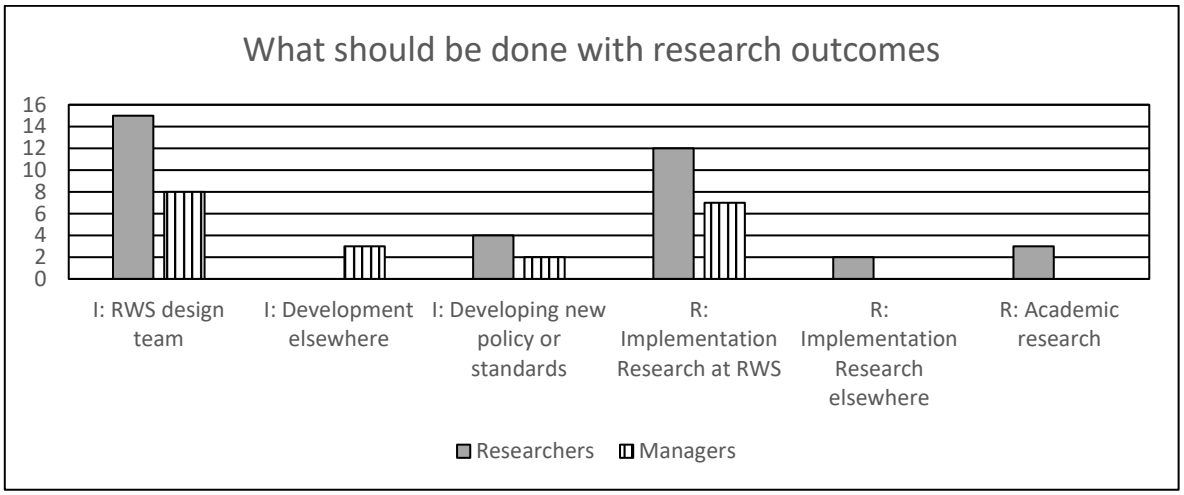


Figure 3: Preferences for further development of topic, points given

4. Discussion

4.1 Rebuilding Local Engineering Capacity for Long-term Continuity and Task Readiness

The most talented engineers want to be directly involved in building things, and often have a stronger attachment to their technical craft of choice than to their employer (Glen, 2003; James, 2002), which was also confirmed during the meetings with participants. Following the 2004 launch of the far-reaching outsourcing policy of 'market unless' (Brink, 2009; Rijkswaterstaat, 2004), RWS moved away from its technocratic roots and became oriented on network and asset management. As outsourcing maintenance and design work became the new standard, some engineering capabilities were lost, and RWS currently has limited in-house engineering and IT delivery capacity. Bringing back local expertise after it has been outsourced is a challenging and lengthy effort (Mazzucato and Collington, 2024). While limited opportunities to locally develop technical designs and solutions were a frequently heard observation among participants, all who have been with the agency for more than a few years report that the situation is improving. To further improve attractiveness to technical talent, RWS will need to invest in creating a more attractive work environment for them. To achieve this, the agency will need to insource technical development work, at least for a portion of the work in strategic domains, as described in Paragraph 1.2.

RWS currently has reliable suppliers of knowledge processes, such as engineering and IT, in several domains that it previously handled in-house. Historically, there have however been missed opportunities with regard to

uniformity or standardization of work delivered, such as software built for comparable purposes by different partners being dissimilar in setup. Without strong and technically competent internal guidance and leading by example, vendors can adhere to their own standards and preferences, resulting in variability of technical systems beyond what is desirable for knowledge continuity and long term asset sustainment. Improving uniformity in solutions is currently addressed through the agency innovation policy. The policy framework is called IUP, or Innovation, Uniformity, and Production, conceptualized as three subsequent steps in the innovation process. Given the importance of achieving technological uniformity across systems and components within the portfolio of assets (Kamps *et al.*, 2024b), there is a strong case for uniformity as the central theme in innovation policy. The innovation policy is relatively recent, and a renewed focus on uniformity can be expected to benefit future knowledge continuity and asset management, especially when coupled with a focus on standardizing system data (Nezami *et al*., 2022). Research programs typically precede or reside in the 'I' phase of the IUP protocol. In the present set of fifteen policy documents on the RWS network about IUP, there is no explicit mention of using innovation efforts to develop human capital. This signals the agency does not (yet) view its innovation program as an opportunity to attract or retain technical talent alongside the important push for uniformity of systems.

Once local expertise is rebuilt, this will be reflected in more favourable knowledge continuity base, resulting in a reduced need for investment in the knowledge domains that have improved through research and/or partial insourcing. Due to the temporary nature of peaks in knowledge demand driven by technological and environmental changes, future investments will likely be necessary in different domains or disciplines than those currently receiving investment. Participants estimate that work on updating and replacing the control systems across the entire RWS portfolio may take approximately 15 to 20 years, during which there will be sufficient work to support a dedicated asset control system development group locally. This will support both innovation goals (uniformity), knowledge management goals (continuity), research quality (supervision and direction), and research-work transition (clear starting point for new hires).

4.2 Dynamic Knowledge Continuity Graphed Over Time

We learn by doing, and knowledge which is not being used will eventually not be readily available in people's heads. This implies a potentially quantifiable relationship between supply and demand of knowledge. At the storm surge barriers domain-specific technical knowledge will be in high demand during the design phase. During regular maintenance and operation it will be much lower, but will rise again during system upgrades or redesigns that need to address technological or environmental developments. To construct a graph of knowledge demand over time, we selected the general shape of the Paulson curve (Paulson, 1976), because it is an empirical distribution of design effort over time. Redesign efforts are typically no less difficult than initial design, but the total amount of work is (ideally) less (Anquetil *et al*., 2007). The redesign knowledge demand peak is plotted for a quarter of the time of the initial design and is placed at a point in the future, visualizing a long-cycle redesign effort.

Assuming that knowledge supply will follow demand but some knowledge will be lost per unit of time, we can calculate an associated supply-curve. This has been done in Figure 4. The supply curve is derived from the demand curve by the following formula:

$$S_i = \Delta t \cdot D_i + (1 - A) D_{i-1}$$

Symbol	Meaning
S:	Knowledge supply
D:	Knowledge demand
Δt:	Timestep
A:	Rate of attrition

The rate of attrition A was set to 0.2, roughly corresponding with a five-year average career at the agency. This is pessimistic compared with overall career lengths, but a reasonable estimate for the more recently hired engineers. Plotting over time, the supply curves of Figure 4 are found. To the right of the graph, it can be observed that due to the shorter timeframe of the redesign, a larger gap between knowledge demand and supply is exhibited compared to the initial design. Having to make difficult redesign decisions with limited remaining knowledge can lead to suboptimal outcomes (Kamps *et al.*, 2024a). Having a research program in the same knowledge domain preceding the redesign period can help to rebuild critical knowledge just-in-time for a challenging effort. This reduces the demand-supply gap (dashed lines).

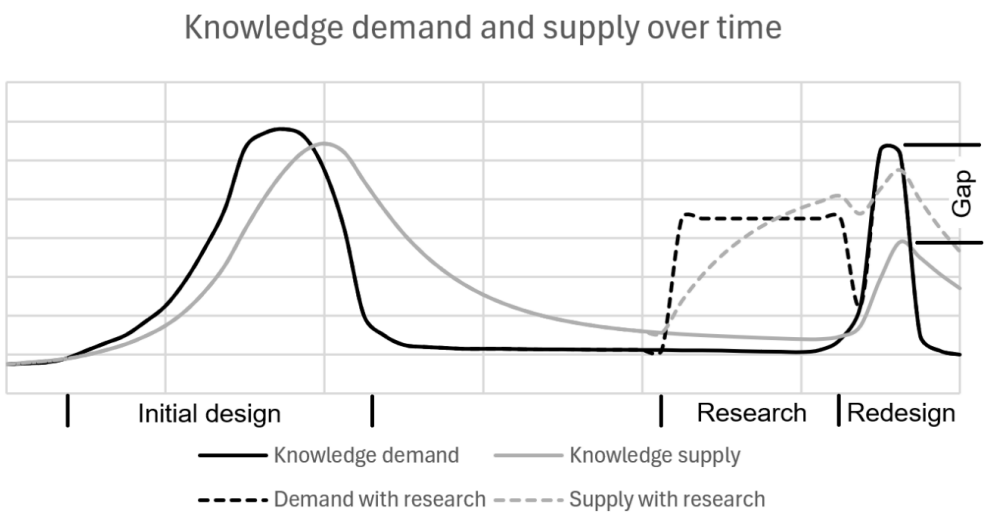


Figure 4: Knowledge demand and supply between initial design and redesign

For actual research programs to have the assumed effects, the research must be practice and implementation-oriented. This was stressed several times by senior research managers and supervisors participating in the study. It is also essential to achieve continuity of individuals associated with a task. Part of the knowledge development during the research phase will inevitably be tacit knowledge gained by the researchers. Even though research-developed knowledge is externalized in the report, as people will know much more than they wrote down or can tell (Nonaka and Takeuchi, 1995), most of the knowledge gained will be lost if only the report is passed on. By allowing researchers to continue through the uniformity and production phases of innovation, research benefits can be maximized. The total contribution of research can be increased even further by taking the potential benefits of research listed in Table 1 into active consideration during the planning phase.

4.3 Leveraging Research for Dynamic Knowledge Continuity: Decision Making

Since the 1990s RWS as a whole is oriented towards network management and is procurement oriented with regards to most engineering rather than considering itself a technical specialist (Vinke, 2013; Brink, 2009; Rijkswaterstaat, 2004). Most engineering knowledge being distributed with partner organizations leaves knowledge continuity of unique systems vulnerable (Kamps *et al.*, 2024a). To rebuild strategic expertise internally and develop a higher degree of internal knowledge for the storm surge barriers than is customary for the rest of the asset portfolio, a decision making framework is necessary. Figure 5 shows a decision-making process which involves considerations of knowledge, innovation, research and staffing, and reduces each decision to a yes/no junction. It was developed using the discussions of the flow-diagram image shown as conversation-starter in the main round and can be found in Appendix A. Here for example one manager explained that organizational needs are important drivers of research, but enthusiasm about new opportunities like digital twins and AI are important too for gaining the necessary momentum in getting new research approved. Another manager explained that RWS should not strive to do all research relevant to it internally, and collaborations and making contributions to research elsewhere can be much more cost-effective. A third manager explained that the bar for deciding to start an internal execution group is rather high and this is only decided on when there are no real alternatives but the task is still very important. These and other insights were collected in a visual format resulting in Figure 5, because they add an important dimension to the realizability of capturing human capital flowing out of the research program. Visualisation has been shown to improve understanding and decision-making in complex managerial contexts by making relationships explicit, and swim-lane diagrams in particular are recognised tools for clarifying responsibilities (Jeyaraj and Sauter, 2014). Although the diagram does not do justice to the full range of considerations involved, it was validated with participating research managers. They confirmed it captures the basic structure of how knowledge- and innovation management goals of continuity and uniformity can guide investment in research and expertise.

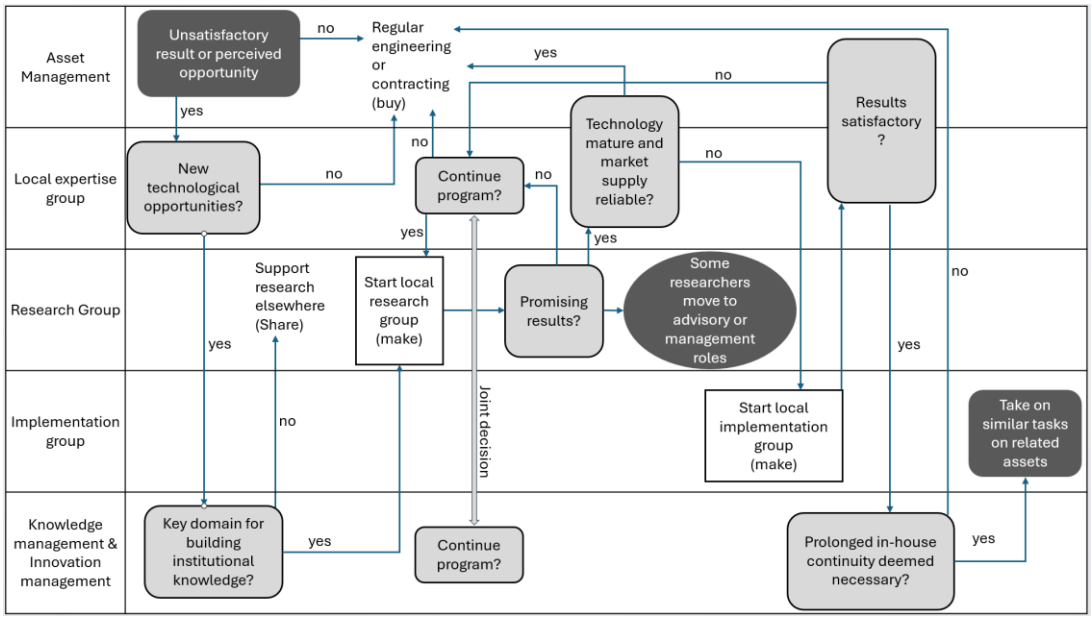


Figure 5: Swim Lane Diagram of applying research programs for knowledge continuity

5. Conclusion

5.1 Contributions to Theory

Knowledge continuity management was re-conceptualized from a steady-state organizational management function to one that triggers knowledge (re)development in time for the demands of asset management. Figure 4 shows that for redeveloping unique infrastructure, the gap between knowledge supply and demand during redesign decisions will tend to be more pronounced than for initial design. A well-developed research program can alter this dynamic and support the necessary knowledge buildup for redesign ahead of time.

It was shown that researchers develop valuable knowledge during their research period (Figure 1) and are highly motivated to locally implement their research results (Figures 2 and 3). Human capital was identified as the most important value created by the research function in an asset management agency, and several conditions for fully benefiting from developed human capital were identified. The effects on knowledge supply for future challenges were conceptually mapped in Figure 4.

Knowledge management and innovation management goals of continuity and uniformity can both be advanced by forming strategic expertise groups of former researchers and insource work for key knowledge domains. The strategic management decisions for starting research groups and local implementation were developed into a swim lane diagram (Figure 5). This demonstrates how research and innovation considerations at an asset management agency can be leveraged as a decision tool to integrate research management, innovation management and knowledge management.

5.2 Recommendations for Practice

The advent of substantial, well-connected and organized research groups positions RWS at the forefront of several key areas, where RWS should aspire to lead in knowledge development, implementation, and standardization. Continuing these programs will enable the agency to continue to develop its core competence as manager of complex and critical infrastructure networks. To reap the full benefits of these new successes, the agency also needs to strategically invest in local implementation capabilities associated with the most important avenues of research. These local expertise groups with practical implementation experience will provide a valuable starting point and support for young professionals who stay on after their research.

Opening and promoting post-research job opportunities that provide the most value to the agency should become a priority. Ideally, potential post-research professional opportunities should start to be developed as early as the planning stage of research, both within and outside the organization. One way to facilitate continued involvement with knowledge domains within which expertise was developed during the research period would be for the agency to provide a traineeship which rotates over RWS and partner organizations working with the

same technology. This is expected to be more attractive to technical talent than the current internal and organization-centred model.

5.3 Limitations and Recommendations for Future Work

This study was conducted as a case study within a small research community focused on Dutch storm surge barriers, which limits the generalisability of the findings. Future research could broaden the scope to include larger populations responsible for managing complex but more common long-lived infrastructure, such as locks, tunnels, movable bridges or military systems. Key findings in this population are rapid technical knowledge development and high motivation coupled with limited organizational socialization, and high attrition of human capital due to limited follow up opportunities after research. Studying related groups may reveal whether these opportunities and challenges with leveraging research programs to improve knowledge continuity observed reflect wider patterns in the management of long-lived complex assets. Further work is also needed to determine how career pathways can be supported in ways that most benefit the continuity of knowledge in the wider distributed-knowledge system when long-term employment within the relevant public agency is limited. In addition, future research could focus on quantifying and modelling the relationship between supply and demand of domain-specific knowledge and notable events in asset management through systematic data collection. These steps would enable more robust validation of the conceptual model and support the development of an evidence-based and integrated management of knowledge continuity, innovation, strategic staffing and research programming.

Ethical statement: All interviews were conducted on the basis of informed consent obtained prior to participation. Written consent was secured after discussing the scope of the study and potential identification risks with participants. Participation was voluntary, and participants could decline to answer any question or withdraw from the study at any time. All participant contributions were anonymized, and all participants were provided with the full manuscript for review.

Use of AI and AI-Assisted Technologies: Generative AI tools (OpenAI's ChatGPT and Microsoft Copilot) were used during manuscript preparation to support literature exploration, language refinement, and proofreading. All sources identified with the assistance of AI were read and evaluated by the lead author prior to inclusion, and all AI-generated suggestions were reviewed, edited, and applied at the authors' discretion. The authors take full responsibility for the content of the publication, including the interpretation of sources and the conclusions drawn.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

Agndal, H. and Nordin, F. (2009) 'Consequences of outsourcing for organizational capabilities', *Benchmarking: An International Journal*, 16(3), pp. 316–334. Available at: https://doi.org/10.1108/14635770910961353.

Anderson, E.G. and Parker, G.G. (2002) 'The effect of learning on the make/buy decision', *Production and Operations Management*, 11(3), pp. 313–339. Available at: https://doi.org/10.1111/j.1937-5956.2002.tb00189.x.

Anquetil, N., de Oliveira, K.M., de Sousa, K.D. and Batista Dias, M.G. (2007), 'Software maintenance seen as a knowledge management issue', *Information and Software Technology*, 49(5), pp. 515–529. Available at: https://doi.org/10.1016/j.infsof.2006.07.007.

Bauer, T.N. and Erdogan, B. (2011) 'Organizational socialization: The effective onboarding of new employees,' in *APA handbook of industrial and organizational psychology, Vol 3: Maintaining, expanding, and contracting the organization*. Washington, DC, US: American Psychological Association (APA handbooks in psychology®), pp. 51–64. Available at: https://doi.org/10.1037/12171-002.

Beane, M. (2019), 'Shadow learning: building robotic surgical skill when Approved means fail', Administrative Science Quarterly, Vol. 64 No. 1, pp. 87-123, Available at: https://doi.org/10.1177/0001839217751692

Boyles, J.E.,Kirschnick, F., Kosilov, A., Yanev, Y. and Mazour, T. (2009) 'Risk management of knowledge loss in nuclear industry organisations' *International Journal of Nuclear Knowledge Management,* 3(2), pp.125-136 Available at: https://www.inderscienceonline.com/doi/10.1504/IJNKM.2009.02656.

Bozeman, B., Dietz, J.S. and Gaughan, M. (2001) 'Scientific and technical human capital: an alternative model for research evaluation', *International Journal of Technology Management*, 22(7/8), p. 716. Available at: https://doi.org/10.1504/IJTM.2001.002988.

Braun, V. and Clarke, V. (2021), '*Thematic Analysis: A Practical Guide*'. SAGE Publications.

Brink, M. A. v. d. (2009), '*Rijkswaterstaat on the horns of a dilemma'*. Eburon, Netherlands

Creswell, J.W. and Poth, C.N. (2018) *'Qualitative Inquiry and Research Design: Choosing Among Five Approaches', SAGE Publications Ltd*.

Delany, A. and O'Donnell, D. (2005), 'Perceptions of continuity management in an Irish semi-state organisation', Electronic Journal of Knowledge Management, Vol. 2 No. 1, pp. 1-12.

Dillender, M. and Forsythe, E. (2022) 'Computerization of White Collar Jobs.' National Bureau of Economic Research (Working Paper Series). Available at: https://doi.org/10.3386/w29866.

Edvardsson, I.R. and Durst, S. (2014) 'Outsourcing of knowledge processes: a literature review', *Journal of Knowledge Management*, 18(4), pp. 795–811. Available at: https://doi.org/10.1108/JKM-01-2014-0033.

Glen, P. (2003) '*Leading Geeks: How to Manage and Lead the People Who Deliver Technology',* Wiley (J-B Warren Bennis Series).

Guimarães, J.A. and Humann, M.C. (1995) 'Training of human resources in science and technology in Brazil: The importance of a vigorous post-graduate program and its impact on the development of the country', *Scientometrics*, 34(1), pp. 101–119. Available at: https://doi.org/10.1007/BF02019176.

Grant, K.A. (2007), 'Tacit knowledge revisited – we can still learn from Polanyi', Electronic Journal of Knowledge Management, Vol. 5 No. 2, pp. 173-180.

Halse, C (2011) 'Becoming a supervisor: the impact of doctoral supervision on supervisors' learning', *Studies in Higher Education*, 36:5, 557-570, Available at: https://doi.org/10.1080/03075079.2011.594593.

Hartman, P.L., Ogden, J.A. and Hazen, B.T. (2017) 'Bring it back? An examination of the insourcing decision'. *International Journal of Physical Distribution & Logistics Management*, 47(2/3), pp.198–221. Available at: https://doi.org/10.1108/IJPDLM-09-2015-0220.

Hawkins, A. (2022) 'Archives, linked data and the digital humanities: increasing access to digitised and born-digital archives via the semantic web,' *Archival Science*, 22(3), pp. 319–344. Available at: https://doi.org/10.1007/s10502-021-09381-0.

INTERNATIONAL ATOMIC ENERGY AGENCY (2017), 'Knowledge Loss Risk Management in Nuclear Organizations', *IAEA Nuclear Energy Series*, No. NG-T-6.11, IAEA, Vienna

James, W.M. (2002) 'The Human Side: Best HR Practices for Today's Innovation Management', *Research-Technology Management*, 45(1), pp. 57–60. Available at: https://doi.org/10.1080/08956308.2002.11671483.

Jeyaraj, A. and Sauter, V.L. (2014) 'Validation of Business Process Models using Swimlane Diagrams'. *Journal of Information Technology Management,* Available at: https://jitm.ubalt.edu/XXV-4/article3.pdf

Jones, O. (1996) 'Human Resources, Scientists, and Internal Reputation: The Role of Climate and Job Satisfaction', *Human Relations*, 49(3), pp. 269–294. Available at: https://doi.org/10.1177/001872679604900301.

Kamps, M., van den Boomen, M., van den Bogaard ,J. and Hertogh, M. (2024a) 'Intergenerational transfer of engineering expertise: knowledge continuity management in storm surge barrier engineering', *Built Environment Project and Asset Management*, 14(6), pp. 874–891. Available at: https://doi.org/10.1108/BEPAM-10-2023-0179.

Kamps, M., van den Bogaard, J., van den Boomen, M. and Hertogh, M. (2024b), 'Knowledge Continuity Aspects in Designs and Contracts of Dutch Storm Surge Barriers', *European Conference on Knowledge Management*, 25(1), pp. 342–350. Available at: https://doi.org/10.34190/eckm.25.1.2342.

Kharoubi, Y., van den Boomen, M., van den Bogaard, J. and Hertogh, M. (2024) 'Asset management for storm surge barriers: how and why?', *Structure and Infrastructure Engineering*, pp. 1–15. https://doi.org/10.1080/15732479.2024.2391034.

Leonard, D. A., Swap, W. C., Barton, G. B. (2015), '*Critical Knowledge Transfer: Tools for Managing your Company's Deep Smarts*', Harvard Business Review Press

Lichtenthaler, U. (2008) 'Relative capacity: Retaining knowledge outside a firm's boundaries', *Journal of Engineering and Technology Management*, 25(3), pp. 200–212. Available at: https://doi.org/10.1016/j.jengtecman.2008.07.001.

Mazzucato, M. (2024) 'Collective value creation: a new approach to stakeholder value', *International Review of Applied Economics*, 38:1-2, 43-57, https://doi.org/10.1080/02692171.2022.2144149.

Mazzucato, M. and Collington, R. (2024), '*The Big Con: How the Consulting Industry Weakens Our Businesses, Infantilizes Our Governments and Warps Our Economies'*. Penguin Books, London.

Mazure, P.C. (1983) 'Advies en onderzoek waterkeringen en overige waterbouwkunde binnen de RWS naar aanleiding van de afloop van de Deltawerken', *M 83.018* . Available at: https://repository.tudelft.nl/islandora/object/uuid%3A5ce7ce04-c33c-4380-9c97-76f9bdfc3273.

Mooyaart, L.F., Bakker, A.M.R, van den Bogaard, J.A., Rijcken, T. and Jonkman, S.N. (2023) 'Economic optimization of coastal flood defence systems including storm surge barrier closure reliability,' *Journal of Flood Risk Management*, 16(3), p. e12904. Available at: https://doi.org/10.1111/jfr3.12904.

Mudambi, S.M. and Tallman, S. (2010) 'Make, Buy or Ally? Theoretical Perspectives on Knowledge Process Outsourcing through Alliances', *Journal of Management Studies*, 47(8), pp. 1434–1456. Available at: https://doi.org/10.1111/j.1467-6486.2010.00944.x.

Nezami, M.R. *et al.* (2022) 'Collaboration and Data Sharing in Inter-Organizational Infrastructure Construction Projects', *Sustainability*, 14(24), p. 16835. Available at: https://doi.org/10.3390/su142416835.

Nonaka, I. and Takeuchi, H. (1995), '*The Knowledge-creating Company: How Japanese Companies Create the Dynamics of Innovation'*, Oxford University Press, New York, NY, USA.

McElroy, M.W. (2010) *The New Knowledge Management*. London: Routledge. Available at: https://doi.org/10.4324/9780080512655.

Paulson, B.C. (1976) 'Designing to Reduce Construction Costs', *Journal of the Construction Division*, 102(4), pp. 587–592. Available at: https://doi.org/10.1061/jcceaz.0000639.

Phaladi, M.P. (2023) 'Developing knowledge protective capacity through retention practices in South African state-owned companies,' *South African Journal of Information Management*, 25(1), pp. 1–10. Available at: https://doi.org/10.4102/sajim.v25i1.1727.

Ponsioen, L.A, Jonkman, SN (ed.), Bakker, AMR (ed.) and Nederend, JM (ed.) 2023, '*Investigation and development of a Digital Twin for the Maeslant barrier: Exploring the application of digital twins in the maintenance and operation of storm surge barriers*.' Delft University of Technology. Available at: https://pure.tudelft.nl/ws/portalfiles/portal/180826280/EngD_Thesis_Luc_Ponsioen_def.pdf.

Reagans, R. and McEvily, B. 'Network Structure and Knowledge Transfer: The Effects of Cohesion and Range.' *Administrative Science Quarterly*, vol. 48, no. 2, 2003, pp. 240–67. *JSTOR*, https://doi.org/10.2307/3556658.

Rijkswaterstaat (2004), "Ondernemingsplan: Een nieuw perspectief voor Rijkswaterstaat: doorpakken, wel degelijk", Directoraat-Generaal Rijkswaterstaat, Den Haag, available at: https://open.rijkswaterstaat.nl/publish/pages/20831/ondernemingsplan_een_nieuw_perspectief_voor_rijkswaterstaat_doorpakken.pdf

Sjögårde, P. and Ahlgren, P. (2024) 'Seed-based information retrieval in networks of research publications: Evaluation of direct citations, bibliographic coupling, co-citations and PubMed related article score.' arXiv. Available at: https://doi.org/10.48550/arXiv.2403.09295.

Tracey, J., Arroll, B., Barham, P. and Richmond, D. (1997) 'The validity of general practitioners' self assessment of knowledge: cross sectional study', *BMJ*, 315(7120), pp. 1426–1428. Available at: https://doi.org/10.1136/bmj.315.7120.1426.

Vader, H., Bakker, A.M.R., Jonkman, S.N., van den Boomen, M., van Baaren, E. and Diermanse, F.L.M. (2023) 'A framework for assessing the remaining life of storm surge barriers'. *Structure and Infrastructure Engineering*, 20(12), pp.2022–2034. Available at: https://doi.org/10.1080/15732479.2023.2177874.

Vinke, D. (2013) 'RIJKSWATERSTAAT From Skilful Technical Specialist Towards Strategic Professional Procurer.' TU Delft. Available at: https://repository.tudelft.nl/record/uuid:4adbc7c8-b41d-4193-8b73-2ba3759d9022.

Walker, A. (2018) 'The "Walker dip"', *Journal of The Royal Naval Medical Service*, 104, pp. 173–176. Available at: https://doi.org/10.1136/jrnms-104-173.

Walraven, M., Vrolijk, K. and Kothuis, B.B. (2022), 'Chapter 20 – design, maintain and operate movable storm surge barriers for flood risk reduction', in Brody, S., Lee, Y. and Kothuis, B.B. (Eds), Coastal Flood Risk Reduction, Elsevier, pp. 271-286, https://doi.org/10.1016/B978-0-323-85251-7.00020-2.

Whyte, J. and Davies, A. (2021) 'Reframing Systems Integration: A Process Perspective on Projects' *Project Management Journal*, 52(3), pp. 237–249. Available at: https://doi.org/10.1177/8756972821992246.

Williams, K. (2020) 'Playing the fields: Theorizing research impact and its assessment', *Research Evaluation*, 29(2), pp. 191–202. Available at: https://doi.org/10.1093/reseval/rvaa001.

Appendix A: Research Benefit Questionnaire

Table A1: Added benefits questionnaire

Topic	Questions
Introduction	**What research are you currently doing, supervising or managing?**
Activation of critical domain knowledge	Does your research involve working with any vulnerable knowledge (knowledge associated with a sustainment-critical domain that few people have a deep understanding of)
	Does your research involve studying documents, code or artifacts from critical infrastructure that you believe may have been untouched or rarely used for 10 years or more? Please explain?
	Did you interview people or were taught by people about their achievements designing or modifying critical infrastructure or its support systems from 10 or more years ago? Please explain?
Connecting organizations	What organizations are involved?
	Whom are the key people involved around the research (no names necessary, role, job description, knowledge discipline and organization. E.g. supervisors, participants)
	Has the research led to meaningful conversation, or do you even know of a follow up meeting between participants outside the research?
The researcher as future expert	Do you think you will be involved with this task yourself?
	What factors are important in determining this?
	Is it also as you would like to have it? Do you feel in control here?
	Do you agree with the statement 'I could make the contribution I want to make'
	Do you think anyone else associated with the research has a moderate or higher probability to be involved with such task themselves? If so, what is their role?

Topic	Questions
Introduction	**What research are you currently doing, supervising or managing?**
Learning by others	Do any of your research activities offer meaningful learning experiences? Example focus group sessions with experts whose time is very limited, system tests, expert feedback on proposed domain-specific solutions? To what extent do such sessions also facilitate learners / juniors? Do you see any specific group of people well suited to benefit from such learning experience?
Tool development	Does your research generate data or tools separate from the primary report?
	Who has access to these after the research, and how are they stored?
	Will these reach their full benefit for sustainment of critical infrastructure? If not, what could be improved to increase that?
Codification of existing practice	Does your research generate descriptions of previously tacit practices?
	Who has access to these after the research and how are they stored?
	Will these reach their full benefit for sustainment of critical infrastructure? If not, what could be improved to increase that?
Improved integration of codified sources	Do you or are you supposed to quote only or primarily public sources in your research
	Do you or could you also use proprietary domain documentation, artifacts or code as sources?
	Are these quoted or listed with the same diligence as public (scientific) sources
	If they are, where or how is this documented?
	Do you see any potential to improve the impact of your work to connectedness and navigability of proprietary explicit domain documentation?
Discipline wide impact and leadership	How are the goals in this line of research agreed upon? Is any party clearly 'in the lead' with regards to the goals of the line of research?
	What party do you perceive as 'leading the field' or the discipline?
	Does the field move in a direction favourable to support of long term sustainment of critical infrastructure?
	Do you think publicly funded research makes or could make a meaningful contribution to the development of your field to facilitate long term sustainment and life cycle of critical infrastructure?
Application to upcoming sustainment challenges	Are you aware of your research being intended or designed to contribute to a specific future task or set of tasks?
	If not, can you imagine it contributing to any major sustainment effort (maintenance + updates, upgrades and redesigns)
	Was there any possibility / potential to better associate with an upcoming sustainment challenge of the storm surge barriers? Was this in any way considered as far as you are aware?
Closing questions	The nine categories of the potential added value that research can have on knowledge continuity for critical infrastructure. As a person involved in infrastructure sustainment related research, what is your first impression of the added value investigation?
	Is there something you would like to see included?

Table A2: Comments, sources and groundedness with each topic

Benefit in Initial questionnaire	Comments and sources	Groundedness
Activation of dormant critical domain knowledge	This idea is mentioned in Kamps *et al.* (2024a). This happens often but is a contributing activity rather than a benefit. See also the paragraph about 'reconsidering what constitutes research benefits' further in this appendix.	g12, 10s
Connecting organizations	Interpersonal connections between individuals improve knowledge sharing between organizations (Reagans and McEvily). The supportive quote in the preliminary interviews however is about several former RWS researchers later doing valued work as external consultants.	g8, 1s

Benefit in Initial questionnaire	Comments and sources	Grounded ness
The researcher as future expert	Bozeman, Dietz and Gaughan (2001) explore human capital development as a key research benefit. This is the most widely recognized benefit with participants, and also the one participants expect the most from. This is why the subsequent main round included additional questions to investigate the topic further.	g20, 12s
Learning by others	We expected there may be significant learning effects by professionals contributing to the research, for example the supervisors. Learning effects in supervisors have been studied, for example by Halse (2011), but this focusses mostly on supervision skills rather than improvements in their content knowledge, which we were most interested in. While there are several quotes supporting learning by others, none of the supervisors reported major improvements in their own content knowledge.	g14, 7s
Tool development	Research resulting in a working digital twin of the Maeslant barrier had just been completed (Ponsioen *et al.,* 2023). This got us interested in tool development by the research program. Most examples found are digital twins built for different purposes. Internal research on control system twins started much earlier than operation-visualising and information-ordering twins, and they are now in professional use.	g4, 3s
Improved integration of codified sources	Large digital archives can present significant challenges to effective use (Hawkins, 2022). Documents interconnected by citations are more navigable as they enable seed-based search practices such as snowballing (Sjögårde and Ahlgren, 2024). This sparked interest in potential improvements in navigability of the archived by the increased research activity working with and citing RWS documents. The only quote supporting better navigability however is from digital twin research, where many documents can be linked to the digital twin which increases structure and connectedness of documentation. It is probably too early to notice any improvement through citation activity. This benefit was dropped as there was insufficient supporting evidence.	g9, 1s
Discipline wide impact and leadership	Mazzucato and Collington (2024) explicitly advocate for public agencies taking a leading role in developing the knowledge domains most essential to them. The benefits of advancing knowledge domains to best support the idiosyncratic needs of the storm surge barriers are well recognized, in particular in the domains of decoupling control software and hardware for the security and automation of the barriers	g17, 12s
Application to upcoming sustainment challenges	This was included because some research topics deal specifically with challenges posed by climate change. It is already well embedded in RWS research planning practice. The main concern raised is that in current practice, results often come in at a later date than when they are needed for asset management practice.	g10, 4s
Codification of existing practice	From preliminary interviews. A participating researcher in asset management explained that existing written policies, handbooks and guidelines did not fully cover the way asset management practitioners handle their tasks. Research resulted in improved professional descriptions of procedures.	
Finding errors in existing systems	From preliminary interviews. A participant from the control systems domain explained research aimed at modernizing control systems found errors in parts of the existing code. Much of the control code is for dealing with (combinations of) partial system failures that have never happened. Research for control system modernization has elicited previously unnoticed errors in these difficult to assess parts of the control code.	

Reconsidering what constitutes a research benefit

One of the most well-grounded initially included benefits, mentioned in Kamps *et al.* (2024a) is activation of dormant critical domain knowledge. Thematic analysis however revealed that the initial list included both beneficial outcomes, and activities leading up to them. While activation of dormant knowledge is intuitive, as evidenced by research managers explicitly asking for it when it no longer appeared during the main interview series. It is however an activity that leads to benefits, not a benefit in and of itself. The actual benefit is already included in 'Learning experiences by participants' and 'the researcher as future expert. The beneficial outcome is knowledge gained by participants, for example due to reflection on their work caused by in-depth interviews questioning it, or gained by the researchers and brought into the organization if and when they transition from

a research- to a professional role. In the same way adapting to upcoming challenges is a key goal of the research program, but the solutions it finds is the benefit.

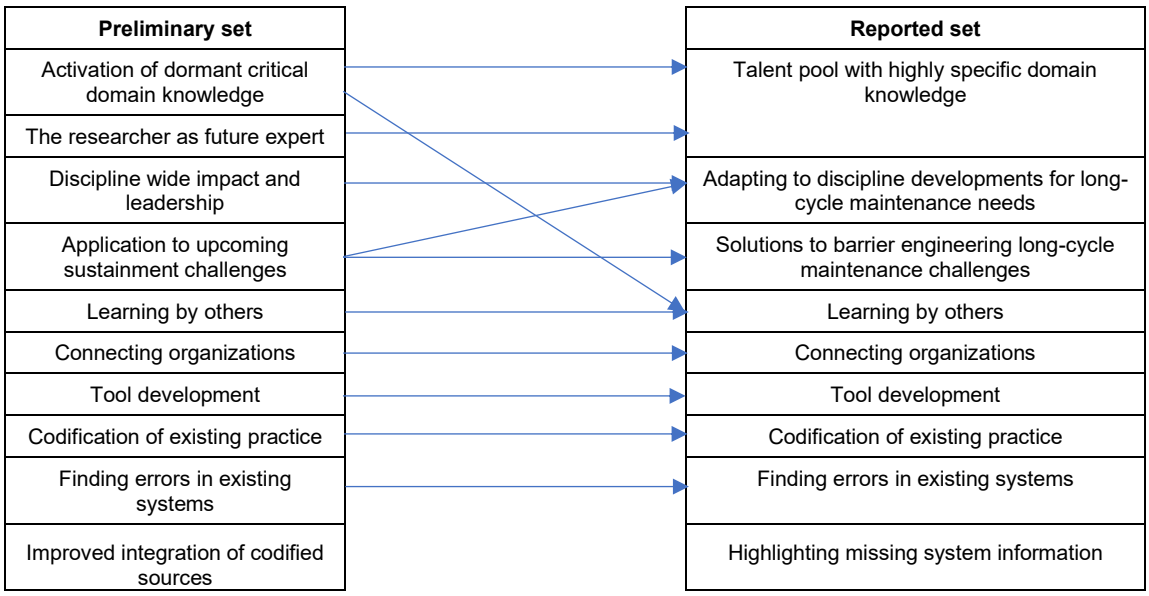
Other changes in the list

The main round of interviews resulted in surprisingly few new examples or insights not found in the preliminary round. The only really new benefit found was from the single participating Bachelor student. His research revealed serious limitations in the (technical) knowledge readily available to him for his research. This resulted in an effort to (professionally) gather and redevelop this knowledge to be able to further his topic. Because there were few new examples or benefits of the agency research programs, the thematic analysis was not repeated.

Mapping

The research benefits from the initial questionnaire are mapped onto the final set in Table 1 in the article. The order in the lists have been rearranged for uncluttered arrangement of the arrows.

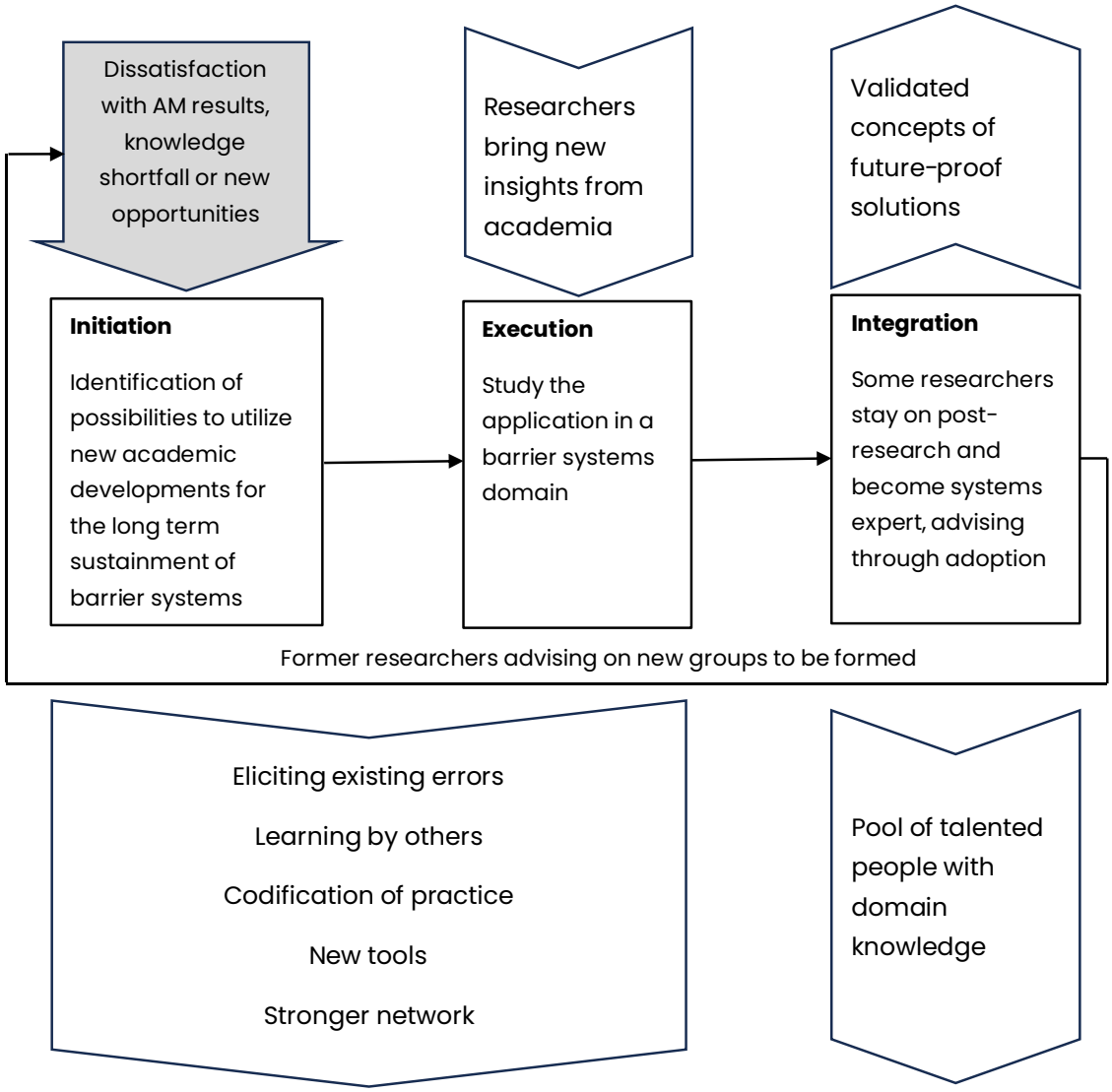
Table A3: Mapping of the research benefits in the questionnaires to the reported set



Main round added questions

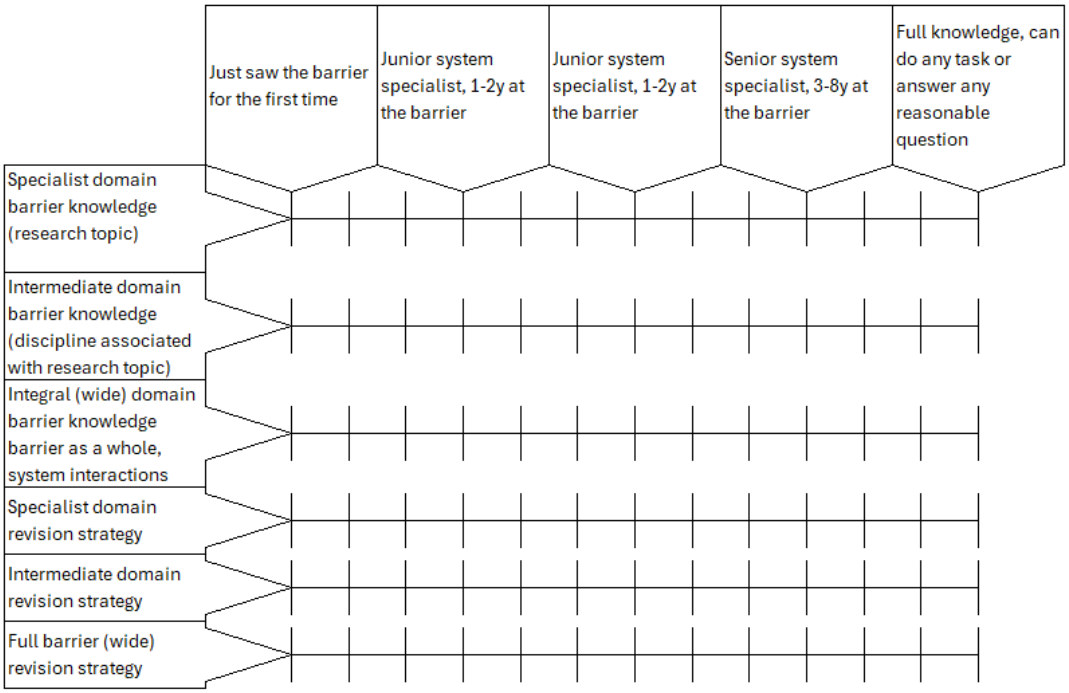
Q1: Flow-diagram of agency-research and its benefits

Participants were asked to comment on the flow diagram and the benefits to the agency during and after research (diagram adapted for size)



Q2: Research as future expert, current knowledge self-assessment

Participants were asked to estimate their knowledge in the given domains and indicate this on the form.



Q3: Researcher as future expert, post research employment

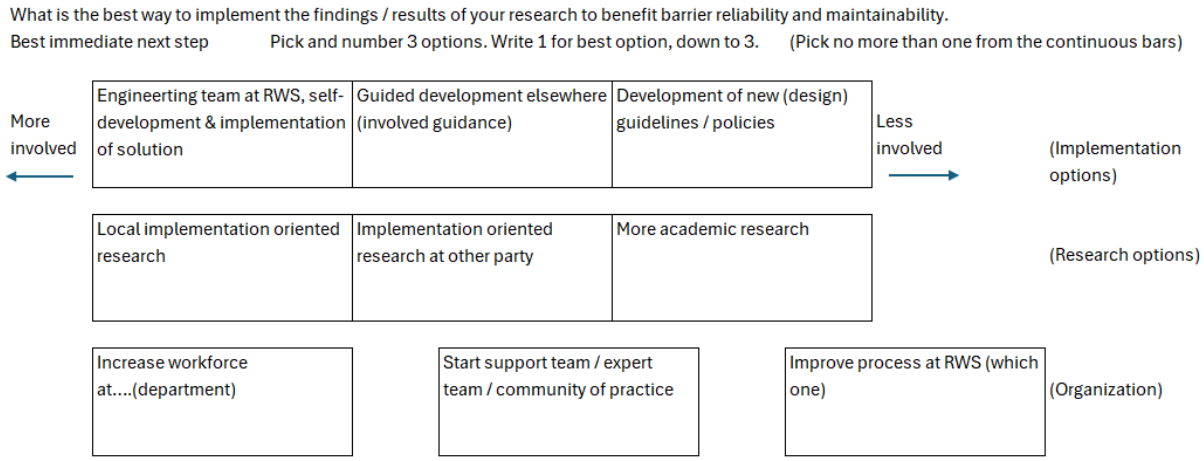
The bar below shows five post-research employment situations. Please write in the bar an E, a P and a B.

- Put the E where you expect to work
- Put the P where you would prefer to work
- Put the B where you think would be best for the barrier

(Semi) government agency	General contractor	Engineering firm	IT-firm	Knowledge institute

Q4: Implementation of research findings for knowledge continuity

Note: The 'organization' options were dropped from the graph in the report for readability and the number of points given to these options were low.



GenAI–Sustainability Nexus: Mediating Roles of Knowledge Management and Social Responsibility in HEIs

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Abstract: Generative Artificial Intelligence (GenAI) is rapidly reshaping knowledge processes in higher education, yet its contribution to Sustainable Performance (SP) remains unclear. This study investigates how GenAI use affects the sustainable performance of higher education institutions (HEIs), where SP is conceptualised as a multidimensional outcome encompassing financial, environmental and social performance. Drawing on the Resource-Based View, the Knowledge-Based View and Stakeholder Theory, the study proposes that GenAI creates value indirectly through two organisational capabilities: Knowledge Management Capability (KMC) and Institutional Social Responsibility (ISR). Survey data were collected from 387 instructors in Kazakhstani colleges who actively use GenAI tools in their work, and analysed using partial least squares structural equation modelling with higher-order constructs. The results show that GenAI does not directly enhance SP, but is positively associated with KMC, which in turn has a strong positive effect on SP. ISR is also positively related to SP, yet GenAI has no significant direct effect on ISR. Mediation analysis reveals that KMC mediates the GenAI–SP relationship, and that GenAI contributes to SP through a significant serial pathway GenAI → KMC → ISR → SP, while ISR alone does not mediate the GenAI–SP link. The findings extend existing theory by demonstrating that GenAI acquires strategic value only when embedded in robust knowledge-management and responsibility structures. Practically, the study highlights the need for HEIs in transition economies such as Kazakhstan to move from tool-centred GenAI adoption towards capability-driven strategies that strengthen KMC and formalise ISR in order to achieve financial, environmental and social gains.

Keywords: Generative artificial intelligence, Sustainable performance, Knowledge management capability, Institutional social responsibility, Higher education, Kazakhstan, PLS-SEM

1. Introduction

The rapid spread of Generative Artificial Intelligence (GenAI) is transforming content production, knowledge processes and digital interactions in education (Nikolopoulou, 2025), while also being increasingly recognised as a driver of sustainable and socially responsible development (Humble and Mozelius, 2024).

Although GenAI is widely expected to support sustainable development across the financial, environmental and social dimensions of sustainable performance (SP) (Shen and Badulescu, 2025), its actual contribution to SP in universities remains theoretically assumed rather than empirically demonstrated (Torrent-Sellens, Enache-Zegheru and Ficapal-Cusí, 2025; Al-Emran, Abu-Hijleh and Alsewari, 2024). This uncertainty is reinforced by growing expectations for universities to embed sustainability into their core strategies (Iqbal and Piwowar-Sulej, 2022) and by the increasing urgency of sustainability transitions within higher education (HE) (Azizi, 2023).

HEIs represent a particularly important context for examining GenAI, as they actively integrate GenAI into curricula, pedagogical strategies, and institutional practices, recognising its transformative potential to enhance educational outcomes, foster critical thinking, and prepare students for future careers. Integrating GenAI into HE is considered crucial for developing future generations of AI-literate professionals and enabling institutions to respond effectively to technological and societal transformations (Jin et al., 2025).

This institutional role is evident in Kazakhstan. For example, Satbayev University (2025) rose by 110 positions in the QS Sustainability Rankings 2025, ranking 771st globally with strong performance in governance (81.1/100) and environmental education (74.4/100), reflecting the growing institutionalization of ESG principles within Kazakhstani HEIs. At the same time, Nazarbayev University (2023) has committed to integrating GenAI into its teaching and governance processes through capacity development and institutional guidelines, illustrating how universities build organisational capabilities for the effective and sustainable use of GenAI.

Despite these developments, the mechanisms through which GenAI contributes to SP in HEIs remain insufficiently understood. Existing research remains fragmented, as most studies focus on GenAI adoption or

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user attitudes (Al-Emran et al., 2025; Al-Qaysi et al., 2025) rather than the organisational mechanisms that connect GenAI to SP. Even in advanced HE systems, university social responsibility remains weakly institutionalised (Detyna and Detyna, 2025), and no empirical research has examined these mechanisms in emerging contexts such as Kazakhstan.

To clarify how GenAI may contribute to sustainability, this study draws on the Resource-Based View (RBV) (Barney, 1991), the Knowledge-Based View (KBV) (Grant, 1996), and Stakeholder Theory (Freeman, 1984). Together, they suggest that GenAI generates value not directly, but through organisational capabilities—particularly KMC and ISR.

Kazakhstan provides a compelling context for examining these mechanisms. While national strategies emphasise digitalisation and sustainability, recent evidence shows uneven digital maturity, underdeveloped knowledge-management (KM) practices, declining SDG-related research engagement, and fragmented responsibility structures across HEIs (Gafu et al., 2025; Jamanbalayeva et al., 2025). These constraints underscore the need to examine how internal capabilities, particularly KMC and ISR, enable HEIs to translate GenAI adoption into SP.

Accordingly, this study examines how GenAI influences the SP of HEIs through the mediating roles of KMC and ISR. By integrating these dimensions into a single explanatory model and testing it in the underexplored context of Kazakhstan, the study advances understanding of how AI-enabled capabilities are translated into sustainability outcomes and provides evidence relevant for both theory development and institutional practice.

2. Literature Review and Hypotheses Development

Building on the study's context and research problem, this section synthesizes prior work on GenAI, KMC, ISR, and SP, drawing on RBV, KBV, and Stakeholder Theory to establish the theoretical grounding of the model. It further considers the implications of this literature for HEIs in Kazakhstan and uses this synthesis to formulate the study's hypotheses.

2.1 Generative Artificial Intelligence and Sustainable Performance

In Kazakhstani HEIs, GenAI may support financial sustainability by improving efficiency amid rising digitalisation costs (Gafu et al., 2025). Evidence from HE suggests that AI-supported digitalisation can streamline administrative processes and improve energy efficiency, generating long-term cost savings (Humble and Mozelius, 2024; Nikolopoulou, 2025). However, GenAI also requires significant infrastructure, which remains uneven across Kazakhstani HEIs (Jamanbalayeva et al., 2025). Increased electricity use and integration costs may offset short-term savings, linking the financial implications of GenAI adoption to its environmental impact (Humble and Mozelius, 2024).

This environmental dimension is especially relevant in Kazakhstan, where green transition policies emphasise technological innovation and resource efficiency (Rakhymzhan et al., 2024). In this context, GenAI may support greener organisational processes through energy optimisation, waste reduction, and resource-efficient innovation (Khan, Mehmood and Kwan, 2024). However, the relationship between GenAI adoption and environmental performance in HEIs remains underexplored.

In HE, GenAI may also support social sustainability by improving accessibility and inclusion (Nikolopoulou, 2025; Al-Emran, Abu-Hijleh and Alsewari, 2024). However, these benefits depend on ethical governance, as AI systems may reproduce biases in training data and exacerbate social disparities, potentially affecting students' well-being and sense of belonging (Francis, Jones, and Smith, 2025).

In Kazakhstan, digital development increasingly highlights the need to balance technological progress with social inclusion (Jamanbalayeva et al., 2025). Yet the practical contribution of GenAI to social sustainability within HEIs remains insufficiently examined at the institutional level, making its broader societal impact difficult to assess.

From an RBV perspective, GenAI can be regarded as a strategic resource that may support multidimensional SP in universities (Barney, 1991; Khan, Mehmood and Kwan, 2024; Shen and Badulescu, 2025). Accordingly, we propose:

H1: GenAI use is positively associated with SP.

2.2 Generative Artificial Intelligence, Knowledge Management Capability, and Sustainable Performance

GenAI demonstrates substantial potential to enhance organisations' KMC—a multidimensional capability reflecting how organisations acquire, share, and apply knowledge to strengthen strategic performance (Gold, Malhotra and Segars, 2001), consistent with the broader conceptualisation of KM proposed by Alavi and Leidner

(2001). From a KBV perspective, knowledge is a strategic resource, and GenAI can support the full knowledge cycle by helping organisations discover, synthesise, share, and apply knowledge across units (Grant, 1996; Jarrahi et al., 2023; Kudryavtsev, Khan and Kauttonen, 2024).

These interrelated processes position KMC as the mechanism through which GenAI-enabled knowledge flows translate into multidimensional SP. Through knowledge acquisition, organisations enhance innovation, decision-making, and environmental practices while strengthening social impact by integrating external expertise (Choi, Chang and Youn et al., 2021; Sahoo et al., 2022). Knowledge sharing further supports eco-innovation, environmental outcomes, and social performance by fostering collaboration and sustainability-oriented initiatives (Ahmad et al., 2023; López-Torres et al., 2026). Finally, knowledge application converts accumulated expertise into process innovations, competitive advantages, and sustainable practices that reinforce financial, environmental, and social outcomes (Kavalić et al., 2021; Martínez-Falcó et al., 2024).

However, recent HE studies typically position KM factors as antecedents of GenAI use, with GenAI use serving as an intervening mechanism linking KM factors to educational or social sustainability (Al-Qaysi et al., 2025; Al-Emran et al., 2025). In contrast, evidence from other sectors shows that KM processes themselves can mediate the link between digital capabilities and SP (Al-Husain et al., 2025).

Extending this perspective, the Kazakhstani HE sector represents a relevant yet underexplored context, where HEIs are actively pursuing digital transformation and sustainability goals while operating within systems of uneven digital maturity and evolving knowledge-management practices (Mendaliyeva et al., 2026).

Accordingly, the following hypotheses are proposed:

H2. GenAI use is positively associated with KMC.

H3. KMC is positively associated with SP.

H4. KMC positively mediates the relationship between GenAI use and SP.

2.3 Generative Artificial Intelligence, Institutional Social Responsibility, and Sustainable Performance

The relationship between GenAI and ISR has recently attracted scholarly attention as organisations seek to align technological innovation with ethical and socially responsible practices (Lim et al., 2025; Della Giovampaola et al., 2025). ISR refers to an institution's commitment to manage its activities transparently and responsibly while addressing stakeholder expectations and contributing to sustainable development (Lozano, 2018).

Grounded in Stakeholder Theory (Freeman, 1984), GenAI can support ISR by strengthening transparency, accountability, and stakeholder engagement within organisational processes. For instance, responsible institutional conduct is reinforced through stronger ethical governance and transparent data practices enabled by GenAI (Lim et al., 2025). Responsible research and innovation are further supported through the development of policies, standards, and infrastructures that guide AI use within HEIs (Smith et al., 2026). In addition, GenAI expands community outreach and social impact through AI-for-Social-Good initiatives and cross-sector partnerships (Della Giovampaola et al., 2025). These practices strengthen stakeholder trust and institutional legitimacy and contribute to broader sustainability outcomes (Latif et al., 2024; Janssen, 2025; Shen and Badulescu, 2025).

ISR can serve as the mechanism through which GenAI-driven innovation is translated into more ethical, transparent, and stakeholder-oriented institutional practices (Detyna and Detyna, 2025; Ouragini and Ben Hassine Louzir, 2024). However, despite its growing relevance in HE, ISR implementation still faces methodological and institutional challenges, particularly in assessing its impact and integrating AI-driven initiatives into responsibility frameworks (Detyna and Detyna, 2025).

In line with global discussions, the Kazakhstani HE sector provides an emerging yet underexplored context for examining the role of ISR in linking GenAI adoption with SP. In Kazakhstan, empirical research on ISR remains limited. Recent studies have primarily focused on individual-level perceptions of ISR and volunteering among university students rather than institutional mechanisms (Utemissova, Abdigapbarova, and Rezuanova, 2025). Moreover, although Kazakhstan's higher-education system has made progress toward internationalization, the existing legal and policy frameworks still lack clear mechanisms for integrating social responsibility principles into institutional governance and performance evaluation (Berdibaev et al., 2024). These limitations constrain the systemic implementation of ISR and its potential to support SP within Kazakhstani HEIs.

Based on this reasoning, we hypothesize:

H5. GenAI use is positively associated with ISR.

H6. ISR is positively associated with SP.

H7. ISR positively mediates the relationship between GenAI use and SP.

2.4 Linking Knowledge Management Capability and Institutional Social Responsibility

KMC has been increasingly recognised as a strategic enabler of social responsibility, since effective knowledge exploration and exploitation foster an organisation's social, environmental, and economic commitments (González-Ramos, Guadamillas and Donate, 2023). Drawing on the KBV (Grant, 1996), knowledge acts as a strategic resource that enables universities to transform intellectual capital into socially valuable practices. Likewise, following the Stakeholder Theory (Freeman, 1984), effective acquisition, sharing, and application of knowledge allow institutions to align their activities with the expectations of both internal and external stakeholders, thereby fostering ISR.

Rather than operating as isolated processes, KMC dimensions collectively shape how responsibility is embedded within institutional practices. The generation of new insights and the integration of external expertise contribute to ethical transparency and responsible research development (Beltrán-Lizárraga et al., 2024; Sobaih et al., 2025). The diffusion of knowledge across organisational units fosters openness, interdisciplinary collaboration, and the dissemination of socially relevant expertise that strengthens community engagement (Liu et al., 2024; Okere and Daramola, 2023). Ultimately, the practical application of accumulated knowledge translates ethical principles and research outputs into transparent governance structures and community-oriented initiatives (Ode and Ayavoo, 2020; Beltrán-Lizárraga et al., 2024).

Overall, developing KMC enables organisations to embed ethical, research-oriented and community-focused values into their strategic processes, thereby institutionalising socially responsible behaviour (Beltrán-Lizárraga et al., 2024; Sobaih et al., 2025). Integrating the KBV and Stakeholder perspectives (Grant, 1996; Freeman, 1984), this linkage represents a mechanism through which internal knowledge resources are transformed into external social value. In Kazakhstan, where national policies emphasise both digital transformation and societal impact (Ministry of Digital Development, 2017; Ministry of Education, 2024), this connection between KMC and ISR becomes particularly relevant. Accordingly,

H8. KMC is positively associated with ISR.

As GenAI improves KMC (Kudryavtsev, Khan and Kauttonen, 2024), it subsequently supports ISR by enhancing ethical governance, research integrity and community engagement (Beltrán-Lizárraga et al., 2024). Together, these knowledge-driven mechanisms create a sequential pathway through which AI-enabled innovation contributes to socially responsible and SP outcomes, consistent with the KBV (Grant, 1996). Thus,

H9. KMC and ISR serially mediate the relationship between GenAI use and SP.

Based on the hypotheses developed, a research model was constructed (Figure 1).

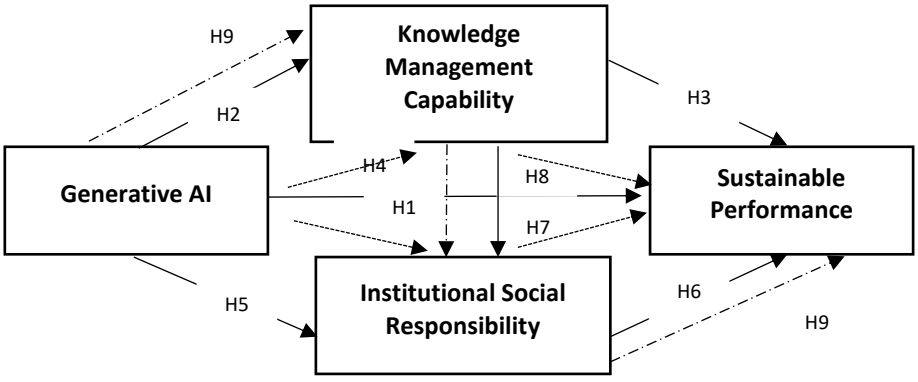

Figure 1: Research model

3. Research Methodology

This exploratory research aims to elucidate the impact of GenAI on the SP of HEI employees, with a specific focus on respondents who actively engage with GenAI tools as integral components of their daily routines. To achieve

its primary goal and test the proposed hypotheses, this research employs a quantitative deductive method, which is considered the most efficient way to analyze the relationships between variables (Al-Qaysi et al., 2025).

3.1 Research Context

Kazakhstan was chosen as the context for this study. This choice is justified by several reasons. The country demonstrates a strong state commitment to digital transformation through initiatives such as 'Digital Kazakhstan' and national development plans that emphasize the integration of AI into key sectors, including education (Hamada et al., 2021; Ahmad et al., 2025). Although the AI market in the country is still developing, there is a recognized need to improve digital literacy and prepare a skilled workforce (Arapbayev, 2024; Zholdigaly, Zhumabayeva and Abdykerimova, 2024). This makes Kazakhstan a relevant 'transition economy' for studying how the adoption of GenAI impacts institutional performance and allows for obtaining timely, context-specific insights for policymakers and educators overseeing the country's technological integration.

3.2 Data Collection

The study was conducted in the Kostanay region, which hosts 34 colleges (27 public and seven private) according to the regional educational registry. Of these, 25 institutions participated in our survey, representing approximately 74% of the region's colleges. The data collection took place between January and February 2025. The survey was conducted among instructors from various academic disciplines, and the link to the online survey, created using Google Forms, was distributed via college administrations.

Participation in the survey was voluntary, with no monetary incentives offered, and participants were assured of the confidentiality and anonymity of their responses. Only teaching staff (full-time or part-time instructors with educational responsibilities) were eligible to participate, and respondents confirmed their employment status within the participating institutions. The questionnaire was initially developed in English and translated into Kazakh and Russian using a back-translation procedure to ensure conceptual equivalence. Respondents completed the survey in the language they found most comfortable. Attention-check items (e.g., entering a specific number) were included to ensure data quality.

A total of 483 responses were collected. After removing incomplete, duplicate, or low-quality submissions based on attention-check performance, 387 valid questionnaires were retained for data analysis. Since the exact number of distributed invitations could not be tracked, a formal survey response rate cannot be precisely calculated; therefore, 80.1% reflects the share of valid responses among those received, not a conventional response rate. The final sample size (n = 387) exceeds the minimum threshold required for PLS-SEM based on the 10× rule (Hair et al., 2019; Hair et al., 2021), confirming adequate statistical power. The demographic characteristics are presented in Table 1.

Table 1: Demographic Characteristics

Demographic Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Women	296	76.5%
	Men	91	23.5%
Age Group	20-29 years	43	11.1%
	30-39 years	85	22.0%
	40-49 years	98	25.3%
	50-59 years	112	28.9%
	60+ years	49	12.7%
Education Level	Higher Education	316	81.7%
	Master's Degree	62	16.0%
	Specialized Secondary Education	9	2.3%
Total		387	100.0%

3.3 Measures

To measure the research constructs, scales were adapted from existing literature. Participants were asked to express their level of agreement with the statements on a five-point Likert scale, ranging from (1) “Strongly

Disagree" to (5) "Strongly Agree". The sources of the measurement instruments and their items are presented in Table 2, while the complete list of items is provided in Appendix A.

SmartPLS 4 was used for data analysis following the recommended two-step procedure: measurement model assessment followed by structural model evaluation (Hair et al., 2019).

Table 2: Source of measurement and items

Construct	Dimension	Items	Source
Generative AI Use		**3**	**Al-Emran, M., et al., 2025**
Sustainable Performance	Environmental Performance	3	Dey, M., et al., 2022
	Financial Performance	3	
	Social Performance	2	
Knowledge Management Capability	Knowledge Acquisition	4	The Dimensions of KMC
	Knowledge Sharing	4	Aboelmaged, M. G.,2014
	Knowledge Application	4	Items / Questions of KMC
			Masa'deh, R., et al., 2017
Institutional Social Responsibility	Ethical Responsibilities	7	Latif, K. F., et al., 2021
	Research and Development Responsibilities	4	
	Philanthropic Responsibilities	5	

Source(s): Authors' work

4. Results

Data analysis was conducted using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method with SmartPLS 4 software. Following the recommended two-stage approach, the measurement model was assessed first, followed by the structural model (Hair et al., 2019).

4.1 Measurement Model Assessment

The adequacy of the measurement model was confirmed by evaluating its internal consistency reliability, convergent validity, and discriminant validity. Internal consistency was established, as all Cronbach's Alpha (CA) and Composite Reliability (CR) values exceeded the 0.60 threshold (Table 3) (Hair et al., 2019). Initially, four items (KSH1, KAP1, ER3, and PR1) were removed due to weak factor loadings. Convergent validity was affirmed, with all item loadings and Average Variance Extracted (AVE) values for each construct being above 0.50 (Table 3). Finally, discriminant validity was supported through two criteria: the Fornell-Larcker criterion, where the square root of each construct's AVE was greater than its correlation with other constructs (Table 4), and the Heterotrait-Monotrait (HTMT) ratio, with all values falling below the conservative 0.9 threshold (Table 5) (Henseler et al., 2015). Collectively, these results confirm the measurement model's robustness, allowing for the subsequent structural model evaluation.

Table 3: Factor Loadings, Reliability and Convergent Validity

Items	Items	Loadings		α	CR	AVE
Generative AI use	AI1	0.914	AI	0.824	0.886	0.737
	AI2	0.842				
	AI3	0.816				
Knowledge Management Capability	KAC1	0.857	KAC	0.904	0.905	0.777
	KAC2	0.903				
	KAC3	0.896				
	KAC4	0.869				
	KSH2	0.872	KSH	0.871	0.871	0.795

Items	Items	Loadings		α	CR	AVE
	KSH3	0.902				
	KSH4	0.900				
	KAP2	0.819	KAP	0.879	0.900	0.807
	KAP3	0.940				
	KAP4	0.930				
Institution Social Responsibility	ER1	0.697	ER	0.847	0.851	0.567
	ER2	0.761				
	ER4	0.770				
	ER5	0.783				
	ER6	0.698				
	ER7	0.801				
	RDR1	0.741	RDR	0.867	0.878	0.717
	RDR2	0.873				
	RDR3	0.876				
	RDR4	0.887				
	PR2	0.623	PR	0.671	0.688	0.502
	PR3	0.726				
	PR4	0.794				
	PR5	0.682				
Sustainable Performance	EP1	0.814	EP	0.806	0.809	0.721
	EP2	0.880				
	EP3	0.851				
	FP1	0.843	FP	0.782	0.783	0.697
	FP2	0.848				
	FP3	0.813				
	ScP1	0.928	ScP	0.851	0.853	0.870
	ScP2	0.937				
Note(s): α: Cronbach alpha, CR: Composite reliability and AVE: Average variance extracted						

Source(s): Authors' work

Table 4: Discriminant Validity (Fornell and Larcker criterion)

	AI	KAC	KSH	KAP	ER	RDR	PR	EP	FP	ScP
AI	0.858									
KAC	0.109	0.882								
KSH	0.146	0.788	0.891							
KAP	0.193	0.778	0.782	0.898						
ER	0.147	0.637	0.681	0.646	0.776					
RDR	0.152	0.681	0.666	0.701	0.753	0.847				
PR	0.185	0.541	0.576	0.553	0.568	0.582	0.709			

	AI	KAC	KSH	KAP	ER	RDR	PR	EP	FP	ScP
EP	0.107	0.499	0.474	0.531	0.489	0.537	0.483	0.849		
FP	0.211	0.594	0.589	0.615	0.535	0.581	0.504	0.563	0.835	
ScP	0.104	0.693	0.686	0.654	0.689	0.659	0.475	0.495	0.606	0.933

Table 5: Discriminant validity (HTMT)

	AI	KAC	KSH	KAP	ER	RDR	PR	EP	FP	ScP
AI										
KAC	0.118									
KSH	0.162	0.888								
KAP	0.218	0.864	0.886							
ER	0.163	0.723	0.791	0.737						
RDR	0.167	0.768	0.765	0.792	0.899					
PR	0.238	0.677	0.741	0.694	0.732	0.751				
EP	0.132	0.583	0.566	0.630	0.582	0.638	0.640			
FP	0.256	0.706	0.713	0.733	0.653	0.704	0.686	0.707		
ScP	0.109	0.789	0.796	0.748	0.808	0.762	0.608	0.596	0.744	

4.2 Assessment of Higher-Order Constructs

The research model includes three formative higher-order constructs (HOCs): ISR, KMC, and SP. A standard two-step procedure was used to validate these HOCs. First, the Variance Inflation Factor (VIF) for each set of lower-order constructs (LOCs) was analyzed to check for multicollinearity. As shown in Table 7, all VIF values are below the recommended threshold of 5, indicating no multicollinearity issues (Hair et al., 2019).

Second, the relevance and statistical significance of the indicators were assessed by analyzing their outer weights and loadings. The results in Table 6 demonstrate that all outer weights are significant ($p < 0.001$) and all outer loadings are above the 0.70 threshold. Since all validation criteria are met, the HOCs (ISR, KMC, and SP) are confirmed as valid for the subsequent analysis (Sarstedt et al., 2019).

Table 6: Higher-order constructs

HOC	LOC	VIF	Outer weights	T	p value	Outer loadings	T	p value
KMC	KAC	3.204	0.324	4.170	0.000	0.917	40.749	0.000
	KSH	3.262	0.358	4.361	0.000	0.926	49.868	0.000
	KAP	3.134	0.399	6.137	0.000	0.931	59.542	0.000
ISR	ER	2.655	0.394	5.420	0.000	0.912	39.103	0.000
	RDR	2.721	0.486	6.245	0.000	0.936	47.433	0.000
	PR	1.594	0.247	4.255	0.000	0.754	18.479	0.000
SP	EP	1.552	0.234	4.010	0.000	0.718	13.584	0.000
	FP	1.850	0.307	4.836	0.000	0.818	25.072	0.000
	ScP	1.671	0.626	11.795	0.000	0.928	43.828	0.000

Note(s): LOC: Lower-order constructs, VIF: Variance inflation factor, t = t-statistics and p=probability

Source(s): Authors' work

4.3 Structural Model Assessment

After confirming the measurement model's validity, the structural model was evaluated. First, collinearity among predictors was checked using the Variance Inflation Factor (VIF); all values were below the threshold of 5. Next, the model's explanatory and predictive power was assessed. As shown in Table 7, the R^2 values for ISR

(0.622) and SP (0.674) indicate substantial explanatory power, while the value for KMC (0.028) indicates weak explanatory power (Hair et al., 2019). The predictive relevance of the model was confirmed, as all Q^2 values were greater than zero (Hair et al., 2019).

Table 7: Explanatory and Predictive Power of the Model

Endogenous Construct	R^2	Q^2
KMC	0.028	0.021
ISR	0.622	0.025
SP	0.674	0.016

A bootstrapping procedure (10,000 samples) was used to test the hypotheses. In addition to path coefficients (β) and their significance (p-values), the effect size (f^2) was assessed for each direct path. According to Cohen (1988), f^2 values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively.

Figure 2 illustrates the revised structural model with standardized path coefficients and R^2 values for endogenous constructs.

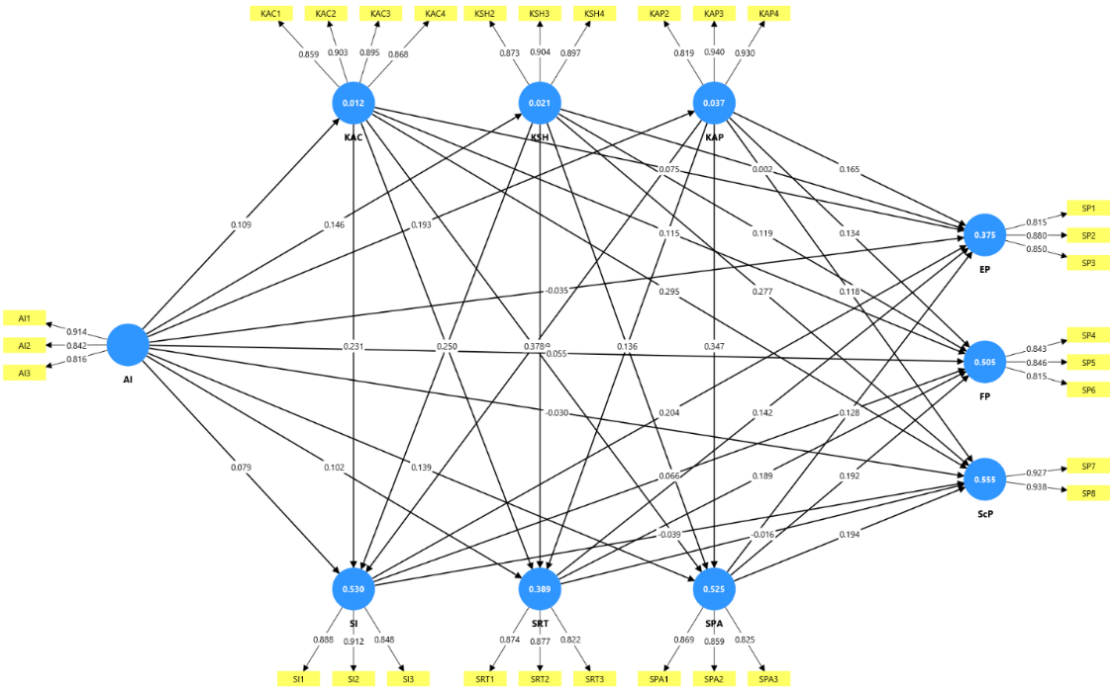

Figure 2: Structural model at the lower-order construct level

To provide a clearer overview of the latent-level relationships, Figure 3 illustrates a simplified structural model based on latent-variable scores. This visualization highlights the core causal links among GenAI, KMC, ISR, and SP.

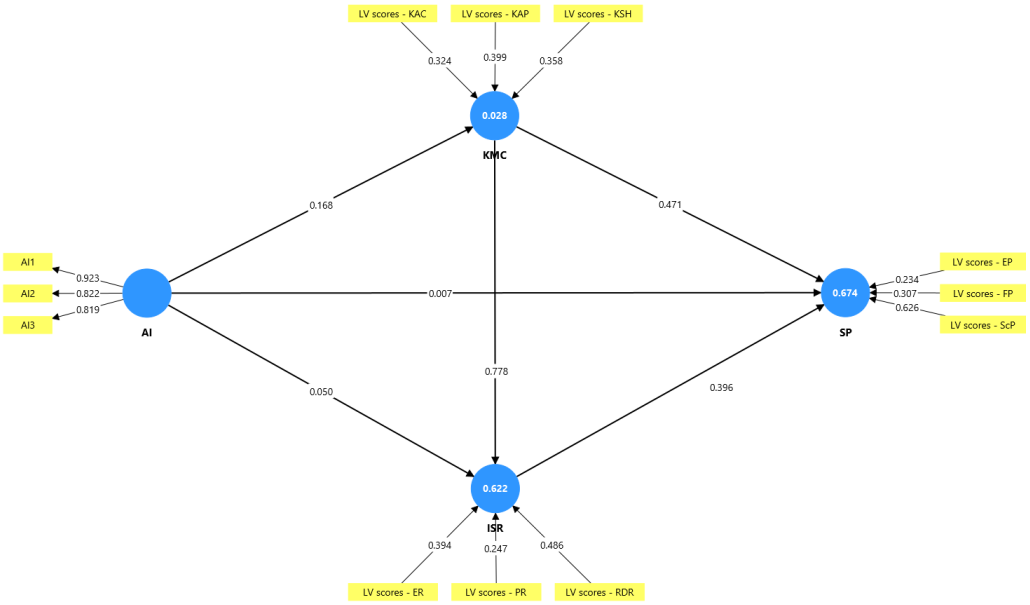

Figure 3: Structural model at the higher-order construct level

The structural model results are presented in Table 8.

Table 8:Results of Direct Hypothesis Testing

Hypothesis	Path Type	Path	β	T-Statistics	P-Values	f^2 Effect Size	Decision
H1	Direct	AI → SP	0.007	0.218	0.828	0.000	Not Supported
H2	Direct	AI → KMC	0.168	3.494	0.000	0.029	Supported
H3	Direct	KMC → SP	0.471	6.747	0.000	0.259	Supported
H5	Direct	AI → ISR	0.050	1.488	0.137	0.007	Not Supported
H6	Direct	ISR → SP	0.396	6.452	0.000	0.182	Supported
H8	Direct	KMC → ISR	0.778	20.029	0.000	1.556	Supported

The hypothesis testing indicates the following direct effects:

H1 (AI → SP): Not supported (β = 0.007, t = 0.218, p = 0.828).

H2 (AI → KMC): Supported (β = 0.168, t = 3.494, p < 0.001).

H3 (KMC → SP): Supported (β = 0.471, t = 6.747, p < 0.001).

H5 (AI → ISR): Not supported (β = 0.050, t = 1.488, p = 0.137).

H6 (ISR → SP): Supported (β = 0.396, t = 6.452, p < 0.001).

4.4 Mediation Analysis

Table 9 summarizes the indirect effects for H4, H7, and H9. The mediation analysis yielded the following results:

Table 9: Mediation Analysis Results

Hypothesis	Path Type	Path	β	T-Statistics	P-Values	Decision
H4	Indirect	AI → KMC → SP	0.079	3.116	0.002	Supported
H7	Indirect	AI → ISR → SP	0.020	1.389	0.165	Not Supported
H9	Indirect	AI → KMC → ISR → SP	0.052	2.801	0.005	Supported

H4 (AI → KMC → SP): Supported (β = 0.079, t = 3.116, p = 0.002)

H7 (AI → ISR → SP): Not supported (β = 0.020, t = 1.389, p = 0.165)

H9 (AI → KMC → ISR → SP): Supported (β = 0.052, t = 2.801, p = 0.005)

5. Discussion

5.1 Discussion of Findings

The findings provide a nuanced understanding of how GenAI use relates to SP in HEIs, particularly within the transition context of Kazakhstan. Although prior studies highlight GenAI's sustainability potential (Humble and Mozelius, 2024; Khan, Mehmood and Kwan, 2024), the lack of support for **H1** indicates that technological adoption alone does not directly enhance overall sustainable performance.

Rather than contradicting the RBV, this result illustrates its conditional logic. RBV suggests that performance gains emerge when valuable resources are supported by complementary capabilities that render them valuable, rare, inimitable, and non-substitutable (Barney, 1991). While GenAI may constitute a valuable technological asset, its strategic impact depends on institutional readiness, infrastructure, and human capital. In Kazakhstani HEIs, uneven digital maturity, limited AI integration, and insufficient faculty preparedness constrain the ability to convert GenAI use into sustained performance gains (Jamanbalayeva et al., 2025; Gafu et al., 2025). Without complementary governance and capability development, GenAI does not fulfil VRIN conditions, explaining the absence of a direct GenAI–SP relationship.

The supported relationships underlying **H2, H3, and H4** reposition KMC as the central conversion mechanism. The positive GenAI→KMC link (H2) aligns with the KBV, which conceptualises knowledge as a primary strategic resource (Grant, 1996). In practice, GenAI supports multilingual content management and academic information processing in Kazakhstani colleges (Sagimbayeva, 2024), strengthening knowledge acquisition, sharing, and application.

The strong KMC→SP relationship (H3) demonstrates that sustainability outcomes are driven less by technological presence than by enhanced knowledge processes. Effective knowledge utilisation improves innovation, operational efficiency, and resource optimisation, particularly in resource-constrained systems (Javed et al., 2025). The significant mediation effect (**H4**) confirms that GenAI contributes to SP indirectly by reinforcing knowledge-based capabilities that translate information into strategic and sustainability outcomes (Di Vaio et al., 2021). Thus, digital innovation precedes performance benefits through capability development rather than direct technological impact.

The results concerning institutional social responsibility (ISR) provide additional refinement. While ISR significantly enhances SP (**H6**), the non-significant GenAI→ISR relationship (**H5**) and the absence of mediation via ISR alone (**H7**) indicate that responsibility structures do not automatically emerge from technological adoption. GenAI is frequently implemented to improve productivity and efficiency (Janssen, 2025; Hosseini, Gao, and Vivas-Valencia, 2025), whereas ISR requires formal governance mechanisms and stakeholder-oriented accountability (Kong, 2024; Shen and Badulescu, 2025). In Kazakhstani HEIs, GenAI remains largely operational, focused on instructional and administrative support rather than strategic responsibility integration.

The significant ISR–SP link confirms Stakeholder Theory (Freeman, 1984), demonstrating that stakeholder-oriented governance strengthens institutional trust and long-term performance (Latif et al., 2024; Moussa, 2022). However, the absence of a direct GenAI→ISR pathway suggests that technological innovation does not inherently generate socially responsible governance without deliberate institutionalisation.

The confirmation of **H8 and H9** establishes a serial capability pathway (GenAI → KMC → ISR → SP). The strong KMC→ISR relationship (**H8**) indicates that effective knowledge processes facilitate responsibility integration (Beltrán-Lizárraga et al., 2024; Krawczyk, 2022). The supported serial mediation (H9) demonstrates that GenAI enhances sustainable performance through layered organisational mechanisms: strengthening knowledge capability first, enabling responsibility institutionalisation second, and improving sustainability outcomes third.

Taken together, the findings suggest that in transition HE systems such as Kazakhstan, the adoption of GenAI follows a capability maturation trajectory. Technological experimentation precedes consolidation of knowledge processes and subsequent embedding of responsibility structures. SP improvements materialise only when these organisational capabilities operate in combination, positioning KMC and ISR as complementary drivers that convert AI-enabled innovation into tangible sustainability outcomes (Kaldybay et al., 2024; Rakhmetullina et al., 2024).

5.2 Theoretical Contributions

This study advances the emerging literature on GenAI and SP in HE by explaining the organisational mechanisms through which GenAI contributes to SP. While prior research largely focuses on GenAI adoption, user perceptions, or educational outcomes (Al-Emran et al., 2025; Al-Qaysi et al., 2025; Nikolopoulou, 2025), limited evidence explains how GenAI translates into sustainability outcomes at the institutional level. By showing that GenAI does not directly influence SP but operates through organisational capabilities, this study clarifies the mechanisms linking AI adoption with sustainability outcomes in HEIs.

Second, the findings extend the KBV by identifying KMC as the key mechanism through which GenAI creates organisational value. While previous studies typically position knowledge-related factors as antecedents of AI adoption, the results demonstrate the reverse pathway, showing that GenAI strengthens KMC, which subsequently improves SP.

Finally, the study contributes to research on ISR in HE. By identifying a sequential pathway (GenAI → KMC → ISR → SP), the study integrates RBV, KBV, and Stakeholder Theory and demonstrates how digital technologies generate SP through layered organisational capabilities.

5.3 Practical Implications

The results show that GenAI delivers sustainability benefits only when supported by strong organisational capabilities. HEIs should prioritise capability-driven GenAI adoption by strengthening KM processes, digital skills and cross-unit collaboration. ISR likewise requires clearer governance, transparency procedures and responsible AI policies to ensure that GenAI enhances ethical conduct, research integrity and community engagement.

These implications are particularly significant for Kazakhstan, where uneven digital maturity, limited KM infrastructures and weak responsibility structures constrain the impact of technological innovation. Strengthening KMC and formalising ISR can help Kazakhstani universities convert GenAI use into broader sustainability benefits. For policymakers, investing in KM systems, AI ethics governance and incentives for socially oriented university practices will better align the sector with global sustainability and digital-transformation priorities.

5.4 Limitations and Future Research Directions

This study is limited by its cross-sectional design and non-probability sampling, which may affect causal interpretation and generalisability. Future research should employ stratified or multi-stage random sampling across diverse HEIs to ensure representation of academic disciplines, faculty ranks and institutional types. Conducting an a priori power analysis would help determine an adequate sample size, while two-wave or longitudinal data collection could reduce common method bias and capture temporal dynamics. Expanding geographical coverage and documenting sampling procedures, non-response patterns and regional differences in digital infrastructure would further strengthen methodological rigor. Comparative and cross-country studies could also illuminate how GenAI-enabled capabilities and responsibility structures evolve across different HE systems.

6. Conclusion

This study examined how GenAI contributes to the SP of HEIs through the mediating roles of KMC and ISR. The findings show that GenAI does not directly enhance SP, but instead operates through strengthened knowledge processes and, sequentially, through social responsibility structures. This confirms that technological adoption only generates value when embedded in robust organisational capabilities, extending the RBV and KBV perspectives in the HE context.

KMC emerged as a consistent and powerful enabler of both ISR and SP, highlighting its centrality for HEIs seeking to translate GenAI adoption into SP. The supported serial mediation further demonstrates that GenAI acquires strategic value only when HEIs combine effective knowledge processes with responsible governance and stakeholder-oriented practices. These findings are especially relevant for emerging systems such as Kazakhstan, where uneven digital maturity, fragmented responsibility structures and weak KM infrastructures remain key barriers to sustainability-oriented transformation.

Overall, this research provides new empirical evidence on how AI-enabled capabilities shape sustainability in HE and offers actionable insights for policymakers and university leaders seeking to align GenAI adoption with long-term development goals.

Ethical Statement: The Declaration of Helsinki was followed in conducting the study, and the protocol was approved by the Ethics Committee of Akhmet Baitursynuly Kostanay Regional University (Approval No. 25-B/2024 on December 20, 2024).

Use of AI-Assisted Language Tools: The authors used grammar-checking software during editing to improve language clarity and readability. All conceptual development, theoretical framework construction, research design, data analysis, interpretation of findings, and critical synthesis originated from the authors' scholarly expertise through direct human authorship. Language-editing tools were used solely for grammatical refinement, not for generating conceptual content or analytical insights.

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References

Aboelmaged, M.G., 2014. Linking operations performance to knowledge management capability: the mediating role of innovation performance. *Production Planning & Control*, 25(1), pp.44–58.

Ahmad, A.S.O., Abusham, E., Kuanyshbaikyzy, K.A. and Twaissi, S., 2025. Kazakhstan in the global economy: rank, growth, and digital adaptation from AI and data science lens. *Artificial Intelligence & Robotics Development Journal*, 5(3), pp.374–382.

Ahmad, F., Hossain, M.B., Mustafa, K., Ejaz, F., Khawaja, K.F. and Dunay, A., 2023. Green HRM practices and knowledge sharing improve environmental performance by raising employee commitment to the environment. *Sustainability*, 15(6), p.5040.

Al-Emran, M., Abu-Hijleh, B. and Alsewari, A.A., 2024. Exploring the effect of generative AI on social sustainability through integrating AI attributes, TPB, and T-EESST: a deep learning-based hybrid SEM-ANN approach. *IEEE Transactions on Engineering Management*, 71, pp.14512–14524.

Al-Emran, M., Al-Qaysi, N., Al-Sharafi, M.A., Khoshkam, M., Foroughi, B. and Ghobakhloo, M., 2025. Role of perceived threats and knowledge management in shaping generative AI use in education and its impact on social sustainability. *The International Journal of Management Education*, 23(1), p.101105.

Al-Husain, R.A., Jasim, T.A., Mathew, V., Al-Romeedy, B.S., Khairy, H.A., Mahmoud, H.A. and Alsetoohy, O., 2025. Optimizing sustainability performance through digital dynamic capabilities, green knowledge management, and green technology innovation. *Scientific Reports*, 15(1), p.24217.

Al-Qaysi, N., Al-Emran, M., Al-Sharafi, M.A., Yaseen, Z.M., Mahmoud, M.A. and Ahmad, A., 2025. Generative AI and educational sustainability: examining the role of knowledge management factors and AI attributes using a deep learning-based hybrid SEM-ANN approach. *Computer Standards & Interfaces*, 93, p.103964.

Alavi, M. and Leidner, D.E., 2001. Knowledge management and knowledge management systems: conceptual foundations and research issues. *MIS Quarterly*, 25(1), pp.107–136.

Arapbayev, N.L., 2024. Embracing AI in the Kazakhstan school curriculum. *Vestnik Nauki*, 3(11), pp.881–893.

Azizi, L., 2023. Which leadership processes encourage sustainable transitions within universities? *International Journal of Sustainability in Higher Education*, 24(1), pp.46–68.

Barney, J., 1991. Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), pp.99–120.

Beltrán-Lizárraga, M.G., Perpuli-Ceseña, A.C., Dagnino-Olivas, A.C. and Escalante-Ramírez, P., 2024. Critical review of university social responsibility management models: approaches, challenges, and opportunities. *Journal of Critical Pedagogy*, 8(19), pp.1–16.

Berdibaev, N., Tlepina, S.V., Berdibaev, Y., Tleulesova, B. and Rzagulova, S., 2024. Legal basis for the creation and functioning of international universities in the Republic of Kazakhstan. *Jurídicas CUC*, 20(1), pp.239–252.

Choi, Y., Chang, S. and Youn, S.-J., 2021. The effect of knowledge absorptive capacity on social ventures' performance. *Cogent Business & Management*, 8(1), p.1929032.

Cohen, J., 1988. *Statistical power analysis for the behavioral sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates.

Della Giovampaola, C., Gomez, L., Halopé, H., Tudor, M.C. and Ugazio, G., 2025. Closing reflections and future directions. In: *The Routledge handbook of artificial intelligence and philanthropy*. London: Routledge, pp.554-558.

Detyna, B. and Detyna, J., 2025. Social responsibility of universities – from declaration to implementation. *Scientific Papers of Silesian University of Technology. Organization and Management Series*, 226, pp.1–11.

Dey, M., Bhattacharjee, S., Mahmood, M., Uddin, M.A. and Biswas, S.R., 2022. Ethical leadership for better sustainable performance: role of employee values, behavior and ethical climate. *Journal of Cleaner Production*, 337, p.130527.

Di Vaio, A., Palladino, R., Hassan, R. and Escobar, O., 2021. Artificial intelligence and business models in the sustainable development goals perspective: A systematic literature review. Journal of Business Research, 121, pp.283–314.

Francis, N.J., Jones, S. and Smith, D.P., 2025. Generative AI in higher education: balancing innovation and integrity. *British Journal of Biomedical Science*, 81, p.14048.

Freeman, R.E., 1984. *Strategic management: a stakeholder approach*. Boston: Pitman.

Gafu, G., Hernández-Torrano, D., Terlikbayeva, N. and Zhanseitova, A., 2025. Mapping the landscape of SDG research in Kazakhstan: a machine learning–based approach. *Journal of the Knowledge Economy*, 16(5), pp.15879–15904.

Gold, A.H., Malhotra, A. and Segars, A.H., 2001. Knowledge management: an organizational capabilities perspective. *Journal of Management Information Systems*, 18(1), pp.185–214.

González-Ramos, M.I., Guadamillas, F. and Donate, M.J., 2023. The relationship between knowledge management strategies and corporate social responsibility: Effects on innovation capabilities. Technological Forecasting and Social Change, 188, p.122287.

Grant, R.M., 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(S2), pp.109–122.

Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M., 2021. *A primer on partial least squares structural equation modeling (PLS-SEM)*. 3rd ed. Thousand Oaks, CA: Sage.

Hair, J.F., Risher, J.J., Sarstedt, M. and Ringle, C.M., 2019. When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), pp.2–24.

Hamada, M., Temirkhanova, D., Serikbay, D., Salybekov, S. and Omarbek, S., 2021. Artificial intelligence to improve the business efficiency and effectiveness for enterprises in Kazakhstan. *SAR Journal*, 4(1), pp.34–41.

Henseler, J., Ringle, C.M. and Sarstedt, M., 2015. A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), pp.115–135.

Hosseini, M., Gao, P. and Vivas-Valencia, C., 2025. A social-environmental impact perspective of generative artificial intelligence. *Environmental Science and Ecotechnology*, 23, p.100520.

Humble, N. and Mozelius, P., 2024. Generative artificial intelligence and the impact on sustainability. In: *Proceedings of the 4th International Conference on AI Research (ICAIR 2024)*. Reading: Academic Conferences and Publishing International, pp.175–182.

Iqbal, Q. and Piwowar-Sulej, K., 2022. Sustainable leadership in higher education institutions: social innovation as a mechanism. *International Journal of Sustainability in Higher Education*, 23(8), pp.1–20.

Jamanbalayeva, S., Burova, E., Sagikyzy, A., Zhanabayeva, D. and Adamidi, A., 2025. The paradigm of the digital society: synthesis of technocratic and socio-humanitarian approaches. *Cogent Social Sciences*, 11(1), p.2513460.

Janssen, M., 2025. Responsible governance of generative AI: conceptualizing GenAI as complex adaptive systems. *Policy and Society*, 44(1), pp.38–51.

Jarrahi, M.H., Askay, D., Eshraghi, A. and Smith, P., 2023. Artificial intelligence and knowledge management: a partnership between human and AI. *Business Horizons*, 66(1), pp.87–99.

Javed, A., Latif, K.F., Sahibzada, U.F. and Aslam, N., 2025. Knowledge management towards sustainable competitive advantage in higher education: an analysis of productive and counter-productive behaviors. *Journal of Organizational Effectiveness: People and Performance*, 12(3), pp.712–735.

Jin, Y., Yan, L., Echeverria, V., Gašević, D. and Martinez-Maldonado, R., 2025. Generative AI in higher education: a global perspective of institutional adoption policies and guidelines. *Computers and Education: Artificial Intelligence*, 8, p.100348.

Kaldybay, K., Kumarbekuly, S., Aitenov, Z., Koishina, A., Kelgembayeva, B. and Kassymbek, A., 2024. Comparative analysis of the social responsibility of universities in the UK and Kazakhstan. *Journal of Ecohumanism*, 3(8), pp.2013–2021.

Kavalić, M., Nikolić, M., Stanisavljev, S., Đorđević, D., Pečujlija, M. and Terek Stojanović, E., 2021. Knowledge management and financial performance in transitional economies: the case of Serbian enterprises. *Journal of Business Economics and Management*, 22(6), pp.1436–1455.

Khan, A.N., Mehmood, K. and Kwan, H.K., 2024. Green knowledge management: a key driver of green technology innovation and sustainable performance in construction organizations. *Journal of Innovation & Knowledge*, 9(1), p.100455.

Krawczyk, P., 2022. Knowledge management and corporate social responsibility interactions in theory and practice. In: *Proceedings of the 23rd European Conference on Knowledge Management (ECKM 2022).* Reading: Academic Conferences International Limited, pp.654–661.

Kudryavtsev, D., Khan, U. and Kauttonen, J., 2024. Transforming knowledge management using generative AI: from theory to practice. In: *Proceedings of the 16th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K 2024).* Setúbal: SciTePress – Science and Technology Publications, pp.362–370.

Latif, K.F., Bunce, L. and Ahmad, M.S., 2021. How can universities improve student loyalty? The roles of university social responsibility, service quality, and "customer" satisfaction and trust. *International Journal of Educational Management*, 35(4), pp.815–829.

Latif, K.F., Tariq, R., Muneeb, D., Sahibzada, U.F. and Ahmad, S., 2024. University social responsibility and performance: the role of service quality, reputation, student satisfaction and trust. *Journal of Marketing for Higher Education*, 34(2), pp.967–991.

Lim, J.S., Lee, C., Shin, D., Kim, J. and Zhang, J., 2025. Perceived stakeholder engagement in corporate data responsibility (CDR) communication and its relationship with trust in generative AI systems: the mediating role of algorithmic and institutional responsibility. *Journal of Public Relations Research*, 37(5), pp.447–469.

Liu, W., Liu, Y., Zhu, X., Nespoli, P., Profita, F., Huang, L. and Xu, Y., 2024. Digital entrepreneurship: towards a knowledge management perspective. *Journal of Knowledge Management*, 28(2), pp.341–354.

López-Torres, G.C., García-Pérez-de-Lema, D., Santos-Jaén, J.M. and Torres, F.J.Á., 2026. The impact of knowledge sharing quality on environmental practices to improve the financial performance of SMEs: the mediating role of advanced management technologies. *Business Strategy and the Environment*, 35(1), pp.1349–1367.

Lozano, R., 2018. Proposing a definition and a framework of university social responsibility. *International Journal of Sustainability in Higher Education*, 19(3), pp.553–570.

Martínez-Falcó, J., Marco-Lajara, B., Zaragoza-Sáez, P. and Sánchez-García, E., 2024. The effect of knowledge management on sustainable performance: evidence from the Spanish wine industry. *Knowledge Management Research & Practice*, 22(3), pp.298–313.

Masa'deh, R., Shannak, R., Maqableh, M. and Tarhini, A., 2017. The impact of knowledge management on job performance in higher education: the case of the University of Jordan. *Journal of Enterprise Information Management*, 30(2), pp.244–262.

Mendaliyeva, Sh., Baigireyeva, Zh., Turekulova, D., Imanaliyeva, A. and Yesturliyeva, A., 2026. Improving the change management system in the organizations: the case of Kazakhstan. *Montenegrin Journal of Economics*, 22(1), pp.201–218.

Ministry of Digital Development of the Republic of Kazakhstan, 2017. *State programme "Digital Kazakhstan"*. Government of the Republic of Kazakhstan. Available at: https://cis-legislation.com/document.fwx?rgn=102961 [Accessed 26 November 2025].

Ministry of Education of the Republic of Kazakhstan, 2024. *Education development plan 2024–2030*. Available at: https://www.gov.kz/memleket/entities/edu/documents/details/597283 [Accessed 26 November 2025].

Moussa, W.H.M., 2022. The impact of implementing university social responsibility in Lebanese universities. *Management*, 12(1), pp.1–13.

Nazarbayev University, 2023. *Nazarbayev University's response to generative artificial intelligence in learning and teaching*. Available at: https://regulations.nu.edu.kz/bitstream/123456789/1030/1/NU%20Response%20to%20Integrating%20Generative%20AI%20into%20Learning%20%26%20Teaching.pdf [Accessed 12 March 2026].

Nikolopoulou, K., 2025. Generative artificial intelligence and digital educational technology. *Digital Educational Technology*, 5(1), ep2506.

Ode, E. and Ayavoo, R., 2020. The mediating role of knowledge application in the relationship between knowledge management practices and firm innovation. *Journal of Innovation & Knowledge*, 5(3), pp.210–218.

Okere, O.O. and Daramola, C.F., 2023. Corporate social responsibilities by academic libraries: a global review. *Journal of Library Services and Technologies*, 5(3), pp.76–89.

Ouragini, I. and Ben Hassine Louzir, A., 2024. University social responsibility and sustainable development: illustration of adapted practices by two Tunisian universities. *Social Responsibility Journal*, 20(6), pp.1177–1192.

Rakhmetullina, S., Konurbayeva, Z., Surova, D. and Sizov, M., 2024. Third mission of the university: vision, structure, experience. *Vestnik of D. Serikbayev East Kazakhstan Technical University*, 48(4), pp.67–80.

Rakhymzhan, G., Dabyltayeva, N.E., Sakhanova, G., Ruziyeva, E.A. and Bekmukhametova, A.B., 2024. Navigating Kazakhstan's sustainable economic future: a study of tech innovation, infrastructure and resource management. *Economies*, 12(5), p.104.

Sahoo, S.K., Mudligiriyappa, N., Algethami, A.A., Manoharan, P., Hamdi, M. and Raahemifar, K., 2022. Intelligent trust-based utility and reusability model: enhanced security using unmanned aerial vehicles on sensor nodes. *Applied Sciences*, 12(3), p.1317.

Sagimbayeva, A.E., Zhaxylykov, A.E., Shekerbekova, Sh.T. and Zhamkeeva, A.B., 2024. The role of generative artificial intelligence technology in controlling the knowledge of university students in programming. *Bulletin of Abai KazNPU. Series of Physical and Mathematical Sciences*, 87(3), pp.320–330.

Sarstedt, M., Hair, J.F., Cheah, J.H., Becker, J.M. and Ringle, C.M., 2019. How to specify, estimate, and validate higher-order constructs in PLS-SEM. *Australasian Marketing Journal*, 27(3), pp.197–211.

Satbayev University, 2025. *Satbayev University rises by 110 positions in ESG ranking of international universities*. Available at: https://satbayev.university/en/news/satbayev-university-rises-by-110-positions-in-esg-ranking-of-international-universities [Accessed 12 March 2026].

Shen, T. and Badulescu, A., 2025. Generative AI and sustainable performance in manufacturing firms: roles of innovations and AI regulation. *Sustainability*, 17(19), p.8661.

Smith, S.M., Tate, M., Freeman, K., Walsh, A., Ballsun-Stanton, B. and Lane, M., 2026. A university framework for the responsible use of generative AI in research. *Journal of Higher Education Policy and Management*, 48(1), pp.17–36.

Sobaih, A.E.E., Gharbi, H., Ben Abdallah, M.A. and Hassan, O.H.M., 2025. Unveiling the role of knowledge management effectiveness in university performance through administrative departments' innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 11(1), p.100473.

Torrent-Sellens, J., Enache-Zegheru, M. and Ficapal-Cusí, P., 2025. Promoting the European sustainable firm: how economic, social and green innovation and AI-based technologies create pathways of social and environmental sustainability. *Business Strategy and the Environment*, 34(7), pp.9093–9119.

Utemissova, Z., Abdigapbarova, U. and Rezuanova, G., 2025. Examining the social responsibility, social entrepreneurship, and volunteering levels of university students. *Journal of Social Studies Education Research*, 16(3), pp.69–99.

Zholdigaly, B., Zhumabayeva, L.O. and Abdykerimova, E.A., 2024. Artificial intelligence in the education sector of Kazakhstan: opportunities and prospects. *Yessenov Science Journal*, 48(3), pp.77–82.

Appendix A

Generative AI Use	I frequently use Generative AI tools for my academic endeavours. I spend a lot of time working with Generative AI tools. I exert considerable effort toward understanding and using GenAI.
Knowledge Management Capability	The institution…
Knowledge Acquisition	…collects useful knowledge identified from various sources. …provides opportunities to ask for specific knowledge when needed. …shares information about existing knowledge within the organization. …allows colleagues to inquire about skills when they need to learn something.
Knowledge Sharing	…ensures that knowledge is readily accessible to educators who need it. …distributes timely reports with relevant information to educators. …provides libraries, resource centers, and other platforms to display and distribute knowledge. …organizes lectures, conferences, and training sessions to facilitate knowledge sharing.
Knowledge Application	…offers various methods for educators to further develop their knowledge. …has mechanisms to safeguard knowledge both inside and outside the organization. …applies knowledge to meet critical needs and efficiently connects knowledge sources for problem-solving. …utilizes various methods to analyze and evaluate knowledge, generating new insights for future use.
Institution Social Responsibility	The institution…
Ethical Responsibilities	…has a comprehensive code of conduct. …tries to perform in a manner consistent with expectations of societal and ethical norms. …has reduced consumption of scarce resources like Electricity/Water. …encourages its students/staff initiatives towards good environmental performance. …encourages its members to follow professional standards. …is committed to prevention of pollution on all major environmental aspects. …behaves with honesty, transparency and fairness in all its activities and relationships with others.
Research and Development Responsibilities	…arranges for links with industry to develop skills in students. …encourages and empowers students to undertake research that creates social and economic impact. …integrates values such as respecting individual and social rights when carrying out research. …encourages scientific research on social problems and knowledge generation.
Philanthropic Responsibilities	…consistently offers scholarships to those in need. …offers free education to support staff. …understands and offers more time for students to pay their fees if they are in financial difficulty. …offers financial support to employees/students for extra-curricular activities. …participates in voluntary charitable activities within their local community.
Sustainable Performance	The Institution has a/an…
Environmental Performance	… initiative to reduce, reuse, and recycle. …initiative to reduce the negative environmental impact of its activities. …policy to improve its energy efficiency.

Financial Performance	…competitive advantages in its growth and performance. …competitive advantage in cost saving and operational efficiency. …competitive advantage in the value it provides.
Social Performance	…policy to strive to be a responsible and ethical institution. …policy to uphold business ethics and integrity.

Knowledge Sharing in R&D Teams: How do Reward, Cohesion, and Organizational Support Shape the Willingness to Share?

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Abstract: Knowledge sharing is a critical yet discretionary behaviour underpinning innovation and performance in research and development (R&D) teams. Despite its importance, limited empirical attention has been given to the factors shaping knowledge sharing willingness (KSW), particularly within R&D teams in developing economies. Anchored in Social Exchange Theory (SET), this study examines how teams' reward, organizational support, and group cohesion influence KSW, and whether trust moderates these relationships. Using a cross- sectional survey design, data were collected from 75 R&D team members across three mobile telecommunication companies in Ghana. Correlation and hierarchical regression analysis were employed to test the proposed relationships. The results reveal that team reward, organisational support, and group cohesion are significant positive predictors of KSW. Furthermore, trust significantly moderates the relationships between these antecedents and KSW, strengthening their effects under high-trust conditions. These findings emphasize the relational and exchange-based nature of knowledge sharing in R&D contexts, where perceived reciprocity and reduced relational risk enhance individuals' willingness to share knowledge. This study extends the knowledge sharing literature beyond dominant Western contexts and highlights KSW as a distinct micro-behavioural construct. The study offers practical insights for R&D managers seeking to design reward systems, supportive structures, and a trust-based team environment that fosters sustained knowledge sharing.

Keywords: Knowledge sharing willingness, Reward, Organizational support, Group cohesion, Enterprise R&D team

1. Introduction

In an era of digital disruption and the booming sharing economy, knowledge has become a core driver of sustainable organizational development across industries (Xiao et al., 2021; Yeboah, 2023). Firms increasingly rely on the creation and transfer of knowledge to enhance innovation capabilities, strengthen R&D performance, and optimize strategic resources (Xiao et al., 2021; Tang et al., 2020; Meixia, Yunxia & Mardani, 2023). Knowledge sharing, particularly, is widely recognized as a fundamental mechanism for supporting creativity, facilitating problem-solving, and gaining a competitive advantage in knowledge-intensive environments (Coun, Peters & Blomme., 2019; Philipson & Kjellstrom, 2020; Anwar et al., 2019). Knowledge sharing between staff, teams, and organizations helps to develop and utilize resources in an efficient and timely manner (Xiao et al., 2021). This makes effective knowledge sharing crucial, especially for R&D teams whose expertise is dispersed, and innovation requires rapid, interactive information exchange and effective communication (Zhu, 2016; Feifei & Miles, 2023).

Past studies on knowledge sharing have mostly focused on the features of sharing parties, sharing knowledge factors, shared leadership, and the levels at which knowledge sharing occurred (Xiao et al., 2021). Knowledge sharing on R&D teams has concentrated on the behavior and process of knowledge sharing, team characteristics, motivation, and organizational culture. However, knowledge sharing willingness is not a static but a dynamic process (Xiao et al., 2021). That is, in the R&D teams, the willingness to share knowledge requires the interplay between individual efforts, a conducive trust environment, and organizational support. Also, existing research primarily examines knowledge sharing at the organizational or team level, resulting in a significant gap in understanding the micro-behavioral factors influencing knowledge sharing within R&D teams (Du et al., 2019). While there are studies on knowledge sharing (Xiao et al., 2021; Tang, 2020; Ipe, 2016), the sharing willingness as a dependent element has received attention in Ghana. In addition, there is an over-concentration on knowledge sharing in organizations rather than niche units like R&D teams, as emphasized in Yeboah's (2023) systematic review on knowledge sharing in organizations. In addition, most knowledge sharing literatures are

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focused on the Western part of the world, creating a gap in the Ghanaian telecommunication context. This has led to investigating KSW among R&D teams in the telecommunication sector of Ghana. These telecommunication firms operate in a competitive, innovation-dependent environment with well-established R&D units, providing a suitable context for studying knowledge-sharing dynamics. This paper is essential and different from many empirical studies because it tests three sharing willingness enablers (reward, organizational support, group cohesion) on KSW. The study introduces trust, a key factor in the knowledge-sharing context, with the power to reduce exchange risk and uncertainty. Focusing on R&D teams in developing countries, this study provides evidence for understanding this underdeveloped area of knowledge sharing willingness behavior within the telecommunication ecosystems. The remaining section includes the literature review, methodology, results of the study, and conclusion.

2. Literature Review

2.1 Knowledge Sharing (KS)

The most often researched knowledge management process is knowledge exchange (Feifei & Miles, 2023). People usually transfer knowledge in one of two ways: formally, through training, workshops, and digital platforms, or informally, through storytelling, apprenticeships, and socializing (Edwards, 2022). Using data, information, and knowledge among diverse business partners is referred to as knowledge sharing (Zahedi, Shahin & Babar, 2016). Coordination of joint resources is facilitated by effective knowledge exchange, which also creates or increases value among key stakeholders (Shih et al., 2012). In order to increase the value of knowledge between the information owner and the knowledge receiver through various channels inside or between strategic alliances, knowledge sharing is a method of knowledge exchange and discussion. Knowledge sharing is thus defined as "the process by which individuals cooperatively and iteratively improve a notion, an idea, or a suggestion in the light of experience" (Chua, 2003). Knowledge sharing can be categorized into “tacit” and “explicit” knowledge, as generally viewed by some authors as a process stage within knowledge transfer. Hence, it exclusively addresses the one-way transfer of data from the sharer to the receiver. In order to maintain team members' mutually beneficial partnerships, a concept called "knowledge sharing" is used to encompass a wide range of knowledge-giving actions (Shao-nan et al., 2023). Knowledge sharing was described as the desire to share knowledge through common storage to achieve economic reuse of knowledge. Knowledge sharing is the process through which the source of the knowledge is encoded, made available, and then acquired, decoded, and eventually internalized by the knowledge recipient (Nima & Yeganeh, 2016).

2.2 Willingness to Share Knowledge

To develop a long-lasting competitive edge, businesses must be able to innovate (Ortigueira-S'anchez, Welsh & Stein, 2022). To achieve technological innovation, the subject of innovation must choose the best information sources from a variety of sources based on their own knowledge requirements. Even when the target has been accurately selected, the issue of the knowledge owner's willingness to share knowledge still exists. Knowledge is typically thought of as the exclusive property of an entity or person. It is exceedingly challenging to achieve knowledge sharing if an owner is unwilling to do so without charge (Chen & Huan, 2022). According to Husted and Michailova (2002), information sharing within an organization may endanger employees' exclusive positions within the company and diminish personal competition to the point that employees are reluctant to offer knowledge freely. The broad consensus among scholars is that incentives are what spur knowledge sharing. According to Liu and Xu (2019), the recipient's capacity for knowledge creation is favorably connected with the suppliers' willingness and capacity for sharing in the innovation collaboration entity. A good incentive system effectively motivates subjects to share knowledge, according to Zhou et al (2014), who argue that knowledge sharing does not happen automatically and that rewards have a major positive impact on knowledge sharing willingness. The innovation subject's readiness to share information will considerably grow when it receives enough rewards or when it requires the same amount of knowledge (Liao, 2008).

2.3 Research and Development (R & D) Teams

Several institutional structures have changed from individual-based systems to team-based arrangements to respond to the fast-shifting global competitive scene (Meixia, Yunxia & Mardani, 2023). This occurrence has prompted academics to investigate the daring features of a team-based work environment. According to Gerard (1995), a team is a fundamental unit that carries out an organization's strategic aim. Because of the diversity of its members' backgrounds, well-structured teams may help their organization meet a variety of environmental issues (McGrath, Arrow, & Berdahl, 2000). An R&D team is made up of experts in many fields of study. Team members are more likely to comprehend a variety of R&D activities when they acquire synergistic knowledge by

combining shared knowledge from others (Xiao et al., 2021). Team members might alter their talents or approaches to better their working style by discussing and synthesizing the various or complementary abilities and viewpoints from other team members through knowledge sharing. R&D is a knowledge-intensive process, and all team members are increasingly expected to have specialized knowledge to develop new technologies or products (Meixia, Yunxia & Mardani, 2023). Using the information that R&D members have gained from the sharing process, the best feasible solution to a problem can be found (Connelly, 2014). Team members can learn from one another to further abstract from and compare difficulties and use this information to apply experience-based abilities to new problems (Zhou et al., 2014). So, when information is known by numerous members, knowledge sharing may enhance group performance.

2.4 Influencing Factors of Knowledge Sharing Willingness within R&D Teams

2.4.1 Team rewards and knowledge sharing willingness

Reward systems have long been recognized as a central organizational mechanism for influencing employee attitudes and discretionary behaviors (Malik & Butt, 2017), including knowledge sharing willingness. Within R&D teams, where innovation outcomes depend heavily on collaborative expertise and the integration of dispersed knowledge, rewards can shape whether employees perceive knowledge sharing as beneficial or costly. Drawing from Social Exchange Theory (SET), employees are more willing to engage in behaviours that generate reciprocal benefits and recognition from the organization (Blau, 1964). Rewards include financial incentives, bonuses, promotions, and formal recognition as well as psychological satisfaction, reputation enhancement, learning opportunities, and feelings of contribution (Hu, Xi & Zhang, 2021). Connelly (2014) argued that employees become more willing to share specialized knowledge when they perceive adequate returns from the organization. Employees who perceive that sharing knowledge enhances their reputation and intellectual standing are more likely to engage in continuous collaborative exchanges. Thus, when organizations design equitable reward systems that acknowledge collaborative contributions, employees are more likely to perceive knowledge sharing as a valued and reciprocated activity. Team rewards reduce these perceived costs by aligning individual benefits with collective performance outcomes. Empirical studies indicate that financial incentives, recognition systems, and career advancement opportunities positively influence employees' willingness to share expertise and innovative ideas (Zhou et al., 2014; Chau, 2003). Therefore, employees who perceive fair and meaningful rewards are more likely to exhibit stronger KSW. This study proposes that:

H1: Team rewards positively influence knowledge sharing willingness among R&D team members.

2.4.2 Group cohesion and knowledge sharing willingness

Group cohesion refers to the extent of interpersonal attraction, unity, commitment, and emotional bonding among team members (Manus, 2016). In R&D teams, cohesion fosters collaborative relationships that facilitate communication, mutual understanding, and collective problem-solving. Since knowledge sharing is fundamentally social and relational, cohesive teams provide favorable conditions for the exchange of both explicit and tacit knowledge. Group cohesion strengthens interpersonal attachment, collaboration, and collective identity among team members. SET suggests that cohesive relationships foster reciprocal obligations and cooperative norms that encourage employees to contribute knowledge for collective benefit. In R&D teams, cohesive interactions facilitate open communication, collaborative problem-solving, and integration of specialized expertise. Xiao et al. (2021) argued that diverse R&D teams generate stronger innovation outcomes when members maintain collaborative and cohesive relationships that encourage knowledge integration. Research demonstrates that cohesive teams exhibit higher communication frequency, stronger trust relationships, and greater collaborative learning behaviors (Meixia, Yunxia & Mardani, 2023). Thus, stronger group cohesion is expected to enhance employees' willingness to share knowledge.

H2: Group cohesion positively influences knowledge sharing willingness among R&D team members.

2.4.3 Organizational support and knowledge sharing willingness

Perceived organizational support refers to employees' beliefs that the organization values their contributions and genuinely cares about their well-being (Eisenberger et al., 1986). Within knowledge-intensive environments, organizational support plays a critical role in shaping employees' willingness to share expertise, experiences, and innovative ideas. From an SET perspective, supportive organizational environments create reciprocal obligations that encourage employees to contribute behaviors beneficial to organizational goals, including KSW. Avila (2022) found that supportive organizational climates significantly enhance collaborative behavior and employees' willingness to exchange knowledge. Similarly, Bonuedie and Fombad (2026) argued that leadership support and

organizational encouragement foster stronger interpersonal interactions and collective learning behaviors. In innovation-oriented organizations, employees who perceive strong support are more likely to identify with organizational objectives and voluntarily contribute valuable expertise (Chang et al., 2021). Perceived organizational support signals that the organization values employees' contributions and supports their professional well-being. Under SET, employees reciprocate supportive treatment through positive discretionary behaviors such as knowledge sharing. Supportive organizational environments provide psychological safety, collaborative infrastructure, and managerial encouragement that reduce barriers to knowledge exchange. Studies have shown that employees who perceive high organizational support are more likely to engage in collaborative learning and knowledge-sharing activities (Chen & Hung, 2010). Therefore, organizational support is expected to positively influence KSW.

H3: Organizational support positively influences knowledge sharing willingness among R&D team members.

2.4.4 Moderating role of trust

Trust is widely regarded as one of the most critical relational mechanisms influencing KSW. Trust refers to the confidence that others will act fairly, reliably, and without opportunistic intentions (Shao-nan et al., 2023). In knowledge-sharing contexts, trust reduces fears associated with vulnerability, exploitation, and misuse of shared expertise. Since knowledge is a valuable strategic asset, employees often evaluate the risks and benefits of sharing before engaging in collaborative exchanges (Voogd et al., 2022). Employees who trust colleagues and organizational systems are more likely to interpret rewards, organizational support, and cohesive relationships positively. In contrast, low-trust environments may weaken the effectiveness of these mechanisms because employees remain skeptical about reciprocity and fairness. Prior studies indicate that trust strengthens collaborative behaviors and facilitates tacit knowledge exchange in innovation teams (Staples & Webster, 2008; Feifei & Miles, 2023). Trust is expected to strengthen the relationship between team rewards, organizational support, group cohesion, and KSW.

H4: Trust positively moderates the relationship between team rewards, organizational support, group cohesion, and knowledge sharing willingness among R&D team members.

2.5 Theoretical Framework

This study is primarily anchored in Social Exchange Theory, which posits that individuals engage in discretionary behaviors, such as knowledge sharing, when they perceive fair, beneficial, and trustworthy exchange relationships within their work environment. Social Exchange Theory (SET) best explains knowledge-sharing willingness in R&D teams because such behavior is voluntary, relational, and contingent upon perceived reciprocity, trust, and organizational support (Liao, 2008). Blau (1964) SET empowers employees to share knowledge when they believe benefits outweigh costs, while rewards and organizational support reciprocate contributions. The literature review pointed out many factors likely to influence the knowledge-sharing willingness in R&D teams. For instance, Cabrera and Cabrera (2002) suggested that implementing a strong reward structure and enhancing staff members' self-efficacy are effective ways to encourage knowledge-sharing practices. According to Staples and Webster's (2008) research, there is a strong positive association between trust and knowledge sharing for teams with various organizational models (local, mixed, and distributed). According to Xiao et al. (2021), members of R&D teams with a variety of knowledge, abilities, professional experience, and work experience can inspire innovative solutions, effectively boosting the depth and breadth of knowledge sharing. The study believes trust strengthens exchange relationships, which explains its moderating role. Trust is also considered a key relational factor. When team members trust each other, concerns about misuse of information or unequal contributions decrease, thus promoting greater openness. Trust can also enhance or weaken the effects of other predictors by influencing the interpretation of rewards, cohesion, and organizational support. In Figure 1, the study conceptualizes that trust, organizational support, group cohesion, and team reward will influence knowledge sharing willingness.

Hypothesis

H1: Reward to the R&D team has positive effects on knowledge sharing willingness (KSW)

H2: Group cohesion among R&D team members has positive effects on knowledge sharing willingness

H3: Organizational support to the R&D team has positive effects on knowledge sharing willingness.

H4: Trust moderates the relationship between reward, group cohesion, organizational support, and knowledge sharing willingness.

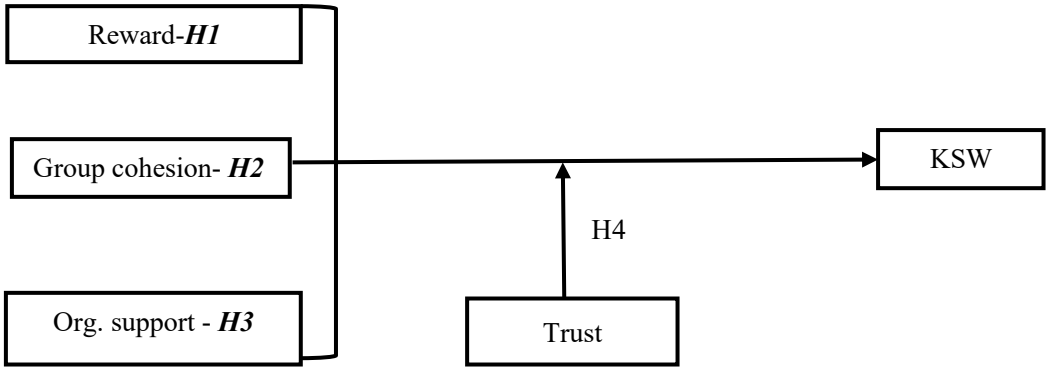

Figure 1: Research model

3. Methodology

3.1 Research Context: Ghana's Mobile Telecommunications Industry

Ghana's mobile telecommunications sector is a robust and highly active market, defined by high mobile penetration rates exceeding 130%. The industry is dominated by MTN Ghana, which commands roughly 60-70% of voice and data market shares, followed by Telecel Ghana (formerly Vodafone) and AT (AirtelTigo). The industry represents one of the fastest growing and most technologically dynamic sectors within the country's economy (West Africa Telecommunications Regulators Assembly, 2026). The sector has undergone substantial transformation over the past decade due to increasing mobile penetration, digitalization initiatives, internet expansion, and the growth of mobile financial services. Major telecommunications firms in Ghana compete aggressively through service innovation, network quality improvement, digital product development, and customer-centered technological solutions. Consequently, the industry has become highly knowledge-intensive, requiring continuous organizational learning, technological adaptation, and collaborative innovation. The competitive structure of the telecommunications industry places significant emphasis on Research and Development (R&D) activities. Telecom firms rely heavily on R&D teams to develop new digital products, optimize network systems, improve cybersecurity infrastructure, and enhance customer experiences through data-driven innovations. These activities require the integration of expertise from multiple disciplines, including software engineering, telecommunications engineering, information systems, data analytics, and digital finance. As a result, R&D teams operate within highly interdependent environments where collaboration and knowledge exchange are critical for achieving innovation objectives.

3.2 Research Design

This study adopted a cross-sectional survey design to examine the factors influencing R&D team members' willingness to share knowledge. As noted by Tharenou, Donohue and Cooper (2007), a cross-sectional design enables data collection from multiple individuals or groups at a single point in time, facilitating comparison across categories. This approach is cost-effective, time-efficient, and suitable for identifying relationships between independent and dependent variables. The design was considered appropriate because it captures R&D members' perceptions and behaviors at a specific period, ensuring the time validity of responses.

3.3 Participants

Given that not all enterprises maintain formal R&D departments, the study focused on mobile telecommunication companies in Ghana, an industry characterized by intense competition and continuous technological innovation. The sector's R&D teams play a pivotal role in driving advancements in artificial intelligence, Internet of Things (IoT), FinTech, and related technologies. The study employed a purposive sampling technique to select seventy-five (75) R&D team members. Unlike random sampling, which may include participants without sufficient familiarity with the knowledge sharing among team members, purposive sampling ensures that responses are obtained from individuals who are directly involved in R&D team projects. The researcher first obtained organizational consent before approaching team leaders, who facilitated access to participants. Owing to confidentiality concerns inherent in R&D activities, some demographic details were withheld at participants' request.

3.4 Data Collection Instrument

Data were collected using a structured, closed-ended questionnaire designed to capture measurable constructs related to knowledge sharing behavior. Questionnaires are widely used in management research due to their cost-effectiveness, reliability, and ability to measure latent constructs such as attitudes, perceptions, and behavioral intentions (Bryman, 2014). Except for demographic questions, all items were measured on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The questionnaire, administered in English, consisted of two main sections: demographics and the major variables understudy. Before full deployment, the questionnaire underwent expert review and pilot testing to ensure clarity, accuracy, and content validity. After revisions, the final survey was distributed electronically using Google Forms, a method suited for geographically dispersed respondents. Links to the questionnaire were shared with R&D team leaders, who disseminated them to members via internal communication platforms such as WhatsApp. To ensure data reliability and confidentiality, responses were collected anonymously; each participant could submit only once, and all items required completion before submission. Data collection was conducted between 11th and 20th November 2025. The online data collection recorded 75 valid responses, all of which were included in subsequent analyses.

3.5 Measurement Instrument

The study employed a structured questionnaire based on a five-point Likert scale ranging from 1 = "Strongly Disagree" to 5 = "Strongly Agree" to measure the study constructs. The measurement items were adapted from previously validated scales in the literature to ensure validity and reliability. Knowledge sharing willingness and group cohesion were measured using scales adapted from Silva, Mosquera and Soares (2022) and Killingsworth et al. (2016). The constructs assessed respondents' willingness to share knowledge and the level of interpersonal connectedness among R&D team members. Organizational support was measured using a four-item scale adapted from the Perceived Organizational Support Scale developed by Eisenberger et al. (1986). Team reward was measured using a three-item scale adapted from Meixia, Yunxia & Mardani (2023), focusing on recognition, rewards, and incentives associated with knowledge-sharing behaviors and team performance. Trust was measured using a four-item scale adapted from Kanawattanachai and Yoo (2002). The complete questionnaire items are presented in Appendix A.

3.6 Analytical Approach

Data were analyzed using Microsoft Excel and SPSS software. Excel was used for preliminary screening, graphical visualization, and data coding, while SPSS facilitated statistical analysis. The study employed descriptive statistics, correlation analysis, and hierarchical regression to examine relationships among variables and test hypotheses. To assess moderating effects, hierarchical regression analysis was performed by introducing interaction terms and comparing model variations across high and low levels of the moderating variable. Results were presented following APA guidelines, supported by tables, charts, and interpretive explanations.

4. Results of the Study

4.1 Background Information of Respondents

Table 1 revealed that 77.3% of the participants were males, and 22.7% were females. Also, among the team members, 46.7% were within the ages of 36 to 45, none was below 25 years, and 4% were more than 55 years. Moreover, 61.3% of the participants had a bachelor's degree, and 26.7% had masters' qualification.

Table 1: Respondents' demographic characteristics

Description	Frequency	Percent (%)
Gender		
Male	58	77.3
Female	17	22.7
Total	75	100.0
Age (in years)		
Below 25	0	0.0
26-35	12	16.0
36-45	35	46.7

Description	Frequency	Percent (%)
46-55	25	33.3
Over 55	3	4.0
Total	75	100.0
Education		
Diploma	7	9.3
Bachelor's degree	46	61.3
Master's degree	20	26.7
Doctoral degree	2	2.7
Total	75	100.0
Years in organization		
Below 5 years	25	33.3
6-10 years	35	46.7
11-15 years	12	16.0
16-20 years	3	4.0
Total	75	100.0

4.2 Assessment of Reliability and Validity

All constructs demonstrated acceptable internal consistency based on Cronbach's alpha values. As shown in Table 2, Knowledge Sharing Willingness (α = 0.709) and Trust (α = 0.725) met the minimum reliability threshold. Group Cohesion recorded a strong coefficient (α = 0.824), indicating highly consistent item responses. Organizational Support (α = 0.758) and Team Reward (α = 0.799) also showed satisfactory reliability. With all variables exceeding the recommended 0.70 benchmark, the measurement scales are considered reliable and appropriate for further analyses, including correlation and regression modelling.

Table 2: Reliability statistics of the variables

Variable	No. of items	Mean	Reliability
Knowledge sharing willingness	4	2.502	.70.9
Trust	4	3.45	.725
Group cohesion	4	3.21	.824
Organizational support	4	2.98	.758
Team reward	4	3.07	.799

In Table 3, exploratory factor analysis (EFA) was conducted to examine the dimensionality and adequacy of the study constructs. The Kaiser-Meyer-Olkin (KMO) values ranged from 0.535 to 0.794, indicating acceptable to good sampling adequacy, and the chi-square goodness-of-fit tests supported the suitability of the model for factor analysis. Knowledge sharing willingness demonstrated strong factor validity (KMO = 0.794), with high loadings (.635- .914) and 70.38% variance explained. Group cohesion also showed satisfactory validity (KMO = 0.666), with loadings between .582 and .908 and 67.76% explained variance. Organizational support exhibited adequate measurement properties (KMO = 0.735), explaining 58.22% of the variance, with one dominant indicator (OZ4). Team reward recorded a lower AVE (47.85%) and marginal KMO (0.535), suggesting weaker item convergence. Trust accounted for 64.10% of the variance (KMO = 0.638), though one item (T4) showed a very low loading, indicating potential measurement limitations. EFA results largely support the factorial validity of the constructs, with caution warranted for items with weak loadings.

Table 3: Exploratory factor analysis of constructs

Constructs	Factor loading	Extraction	% of Variance (AVE)	KMO
Knowledge sharing willingness				
KS1	.840	.706		KMO = 0.794
KS2	.909	.827	70.377	Goodness-of-fit test X^2 =
KS3	.914	.835		
KS4	.865	.749		25.796
KS5	.635	.403		
Group cohesion				
GC1	.908	.825		KMO = 0.666
GC2	.860	.739	67.76	Goodness-of-fit test X^2 =
GC3	.582	.339		26.121
GC4	.899	.808		
Organizational support				
OZ1	.687	.472		KMO = 0.735
OZ2	.691	.477	58.224	Goodness-of-fit test X^2 =
OZ3	.707	.500		8.847
OZ4	.939	.881		
Team reward				KMO = 0.535
TR1	.835	.769	47.852	Goodness-of-fit test X^2 =
TR2	.749	.738		7.56
TR3	.403	.313		
Trust				
T1	.519	.269		KMO = 0.638
T2	.859	.738	64.104	Goodness-of-fit test X^2 =
T3	.560	.313		2.764
T4	.210	.044		

4.3 Correlation

The correlation results in Table 4 demonstrated inter-item correlation among the study variables. The study found that Knowledge Sharing Willingness was significantly and positively related to trust (R= 0.699, $p < 0.01$), Group cohesion (R= 0.930, $p < 0.01$), Organizational support (R= 0.954, $p < 0.01$), and Team reward (R= 0.744, $p < 0.01$). This means that the assumption holds for the proposition that reward, group cohesion, and organizational support will positively influence KSW among the R&D team. Although such high correlations may raise concerns regarding construct overlap and potential multicollinearity, several factors support the robustness of the findings. First, the reliability analysis (Table 2) demonstrated acceptable internal consistency for all constructs ($\alpha > 0.70$). Second, the exploratory factor (Table 3) analysis provided evidence of factorial validity, with most items loading adequately on their respective constructs and explaining substantial proportions of variance. Furthermore, the hierarchical regression results presented in Table 5 suggest that the explanatory variables are not perfectly redundant. The sequential inclusion of each explanatory variable resulted in incremental increases in explained variance (ΔR^2). From a theoretical perspective, strong correlations are expected within R&D team settings where organisational support, group cohesion, trust, and reward systems operate simultaneously and reinforce one another.

Table 4: Inter correlation matrix.

Variables	1	2	3	4
Knowledge sharing willingness	1			
Trust	.699**	1		
Group cohesion	.930**	.791**	1	
Organizational support	.954**	.673**	.857**	1
Team reward	.744**	.279*	.518**	.611**

***. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed).*

4.4 Direct and Indirect Effect Analysis

Table 5 presents the results of hierarchical regression analysis predicting knowledge sharing willingness. In Step 1, the control variables were entered, and education had a significant positive effect on knowledge sharing willingness, whereas gender was not significant. This initial model accounted for 24.0% of the variance, indicating a meaningful baseline contribution of demographic factors. In Step 2, the main effects of team reward (β 0.616, $p < 0.01$), group cohesion (β 0.44, $p < 0.05$), and organizational support (β 0.049, $p < 0.05$) were introduced. All three variables were positively and significantly related to knowledge sharing willingness. This resulted in a substantial increase in the explained variance (ΔR^2 .185). This finding suggests that team reward, group cohesion, and organizational support play a central role in fostering employees' willingness to share knowledge. As seen in Table 5, step 3 added trust as a moderating variable through the interaction terms. The interaction between team reward and trust was significant (ΔR^2 .086). This shows that rewards for knowledge-sharing willingness are strengthened in high-trust contexts. In Step 4, the interaction between group cohesion and trust was also significant. Step 5 showed a significant interaction between organizational support and trust, contributing an additional 5.6% to the explained variance. Moreover, Figure 2 exhibits the moderation analysis of trust and group cohesion, as well as trust and organizational support in Step 4 and Step 5, respectively. The outcome indicated that trust and group cohesion combined to influence KSW (Step 4: β 0.199, $p < 0.05$). The result indicated that when trust is high, knowledge sharing willingness is higher. In contrast, knowledge sharing willingness is weak when there is low team trust.

Table 5: Hierarchical regression model

Variables		Knowledge sharing, willingness & trust.			
	Step 1	*Step2*	*Step 3*	*Step 4*	*Step 5*
Control variables					
Education	1.424*	1.084	1.161*	1.192*	1.121*
Gender	.467	.345	.309	.292	.285
Main factors					
Team Reward		.616**	.510**	.490**	.491**
Group Cohesion		.049*	.079*	.091*	.173**
Organizational Support		.444*	.721*	.688*	.279*
Interaction term					
Reward*trust			.179**	.490**	.294**
Group cohesion *trust				.199*	.278**
Org. support*trust					.478**
R	.490	.652	.715	.719	.722
R^2	.240*	.425*	.511*	.561	.620
F	44.19*	55.68*	58.87*	47.83*	52.87*
ΔR^2	.240	.185	.086	.005	.056

N = 75, *p < 0.05, **p < 0.01, dependent variable = knowledge sharing willingness

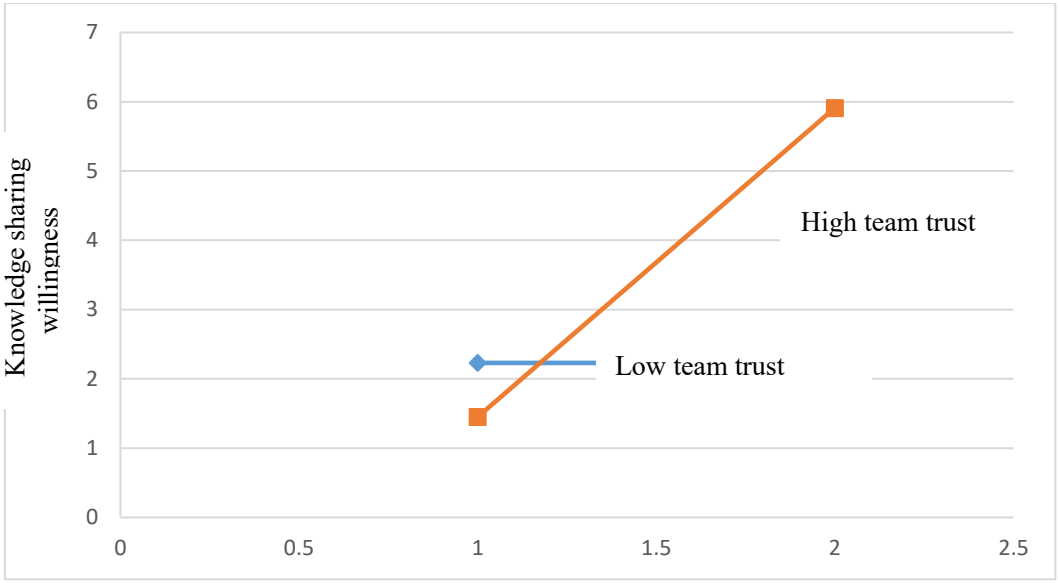

Figure 2: Low and high team trust

5. Discussion and Conclusion

5.1 Discussion of Results

This study examined the factors that influence knowledge sharing willingness within R & D teams in Ghana's mobile telecommunications industry using Social Exchange Theory (SET) as the analytical lens. The findings provide strong empirical and theoretical support for the proposition that knowledge sharing in R&D environments is fundamentally a socially embedded exchange behavior shaped by organizational, team, and relational conditions (Blau, 1964; Liao, 2008).

The positive effect of team rewards on KSW confirms SET's central argument that employees engage in discretionary behaviors when they perceive fair and beneficial reciprocity in the employment relationship (Blau, 1964). In R&D environments, knowledge is a strategic resource often associated with personal expertise and competitive advantage. As such, employees tend to protect rather than freely share it unless clear reciprocal benefits exist. For example, Cabrera and Cabrera (2002) argue that reward systems aligned with knowledge-sharing behaviors reduce perceived costs of contribution and increase employees' willingness to participate in collaborative knowledge processes. Similarly, Malik and Butt (2017) emphasize that rewards enhance creative and collaborative behaviors by reinforcing perceived organizational appreciation. Consistent with Hu et al. (2021), both intrinsic rewards (recognition, professional growth) and extrinsic rewards (bonuses, promotion) reinforce knowledge-sharing intentions, although intrinsic motivation often sustains long-term collaboration more effectively. However, the literature also warns that poorly designed reward systems may undermine intrinsic motivation (Akhavan et al., 2016). This suggests that reward effectiveness depends on whether employees perceive it as supportive reciprocity rather than transactional control.

The significant influence of organizational support on KSW aligns with SET and organizational support theory, which posits that employees reciprocate perceived organizational care with positive work behaviors (Eisenberger et al., 1986; Voogd et al., 2022). In this study, employees who perceive strong organizational support are more willing to share knowledge because they feel valued and psychologically obligated to contribute to organizational success. Prior studies reinforce this finding. Ahmad and Karim (2019) found that organizational support enhances employees' willingness to share knowledge by creating psychological safety and trust in organizational systems. Similarly, Wang (2023) argued that supportive organizational cultures foster open communication and collaborative learning in innovation-driven environments.

In telecommunications R&D settings, organizational support is particularly critical due to technological complexity and rapid innovation cycles (Xiao et al., 2021). Employees require access to digital tools, technical infrastructure, and managerial support to effectively exchange knowledge. When these resources are available, employees perceive a stronger exchange relationship and respond through increased knowledge sharing, consistent with SET's reciprocity mechanism.

The positive relationship between group cohesion and KSW highlights the importance of social identity and interpersonal bonding in knowledge exchange processes. Cohesive teams create stronger emotional attachment, shared identity, and mutual trust, which facilitate communication and reduce relational barriers to knowledge sharing (Carron et al., 2002). From a theoretical standpoint, SET explains cohesion as a mechanism that strengthens reciprocal obligations and cooperative norms. When employees identify strongly with their team, they are more likely to view knowledge sharing as a collective responsibility rather than an individual cost. For instance, Xiao et al. (2021) found that cohesive R&D teams demonstrate higher levels of knowledge integration and innovation performance due to stronger interpersonal collaboration. Similarly, Meixia, Yunxia and Mardani (2023) highlighted that cohesion enhances communication frequency and reduces defensive knowledge behaviors. This suggests that cohesion must be balanced with diversity to sustain innovation effectiveness. In Ghana's telecom context, cohesion is particularly relevant due to culturally embedded collectivist tendencies, where interpersonal relationships significantly influence workplace behavior and collaboration patterns.

The moderating role of trust provides one of the most theoretically important contributions of this study. Trust significantly strengthens the relationship between rewards, organizational support, group cohesion, and KSW, confirming that knowledge sharing is fundamentally a risk-based social exchange behavior (McEvily et al., 2003). Trust reduces perceived vulnerability and uncertainty in exchange relationships, making employees more willing to share tacit and strategic knowledge. Staples and Webster (2008) found that trust is a key determinant of knowledge-sharing behavior across different organizational settings, particularly in virtual and cross-functional teams. In R&D teams, where knowledge hoarding may arise due to competitive pressures, trust ensures that employees perceive knowledge exchange as safe and mutually beneficial. This study extends existing literature by demonstrating that trust does not merely influence KSW directly but also enhances the effectiveness of organizational mechanisms such as rewards, support, and cohesion. In low-trust environments, even well-designed systems may fail to generate knowledge-sharing behavior, whereas high trust amplifies the effectiveness of all enabling conditions.

5.2 Conclusion

This study investigated the factors that influence knowledge sharing willingness within R & D teams. The statistical analysis supported the propositions that group cohesion, team reward, and organizational support have a positive and significant association with knowledge sharing willingness in the R&D team. In a similar way, trust was found to be a significant predictor of knowledge sharing willingness. The moderation results indicated that when trust is high, KSW increases. But at a low level of trust, KSW is low. This study shows the importance of team reward, group cohesion, and organizational support through knowledge sharing willingness on R&D team performance. Previous studies reported that trust influenced knowledge sharing. However, this research discovered that trust facilitates knowledge-sharing willingness, which indirectly influences R&D team performance. The reason can be that members from the R&D team come from diverse backgrounds, and they may not communicate frequently, therefore the confidence level of whom to trust and or distrust is an ethical issue.

Several firms rely on the R&D team to lead innovations in the industry, and researchers are keen to examine the critical success factors. Knowledge transfer, sharing, and creativity are important soft elements that keep successful R&D teams. This study provides empirical support for all the hypotheses (reward, group cohesion, organizational support, and trust) provide directions for consideration in knowledge sharing willingness literature. Given the importance of R&D to firms in today's competitive industry, the study beliefs understanding the influencing factors to KSW will be valuable to theory building and policymakers.

5.3 Implication

This study presents several implications for industry practitioners, policymakers, researchers, and theory. First, telecom managers, the findings highlight the importance of designing reward systems that emphasize collective innovation outcomes rather than individual competition (Cabrera & Cabrera, 2002). Such systems encourage reciprocity and reduce knowledge hoarding. Organizations should strengthen perceived organizational support by ensuring access to digital infrastructure, continuous training, and supportive leadership practices (Ahmad & Karim, 2019). In R&D teams, psychological safety must be actively cultivated to encourage idea sharing (Edmondson, 1999). Managers should also invest in building group cohesion through team-based projects, cross-functional collaboration, and shared goal setting. However, cohesion should be balanced with diversity to prevent group thinking.

Finally, trust-building should be a strategic priority. Transparent communication, fair reward allocation, and ethical leadership practices are essential for sustaining knowledge-sharing cultures in telecom R&D environments.

For policymakers in Ghana, particularly within the telecommunications and digital economy sectors, the findings highlight the importance of strengthening national innovation systems that promote collaborative knowledge ecosystems. Policies should encourage telecom firms to invest in R&D capacity-building, knowledge management systems, and human capital development. Regulatory frameworks should also support inter-firm collaboration and innovation clusters to enhance knowledge diffusion across the industry.

Additionally, government-led digital transformation initiatives should prioritize trust-building ecosystems, data governance frameworks, and innovation incentives that enhance knowledge sharing across the telecommunications sector.

This study extends Social Exchange Theory by demonstrating that knowledge sharing willingness in R&D teams is shaped not only by direct reciprocity (rewards and support) but also by relational structures (cohesion and trust). It confirms that trust acts as a boundary condition that determines the strength of exchange relationships (McEvily et al., 2003). Additionally, the study integrates organizational support theory (Eisenberger et al., 1986) and group cohesion theory (Carron et al., 2002) into a unified framework, advancing knowledge sharing literature by offering a multi-level explanatory model. Researchers could explore the relational factors (cohesion, trust and other demographic factors) on KSW.

5.4 Limitations of the Study

Like all research, this paper has some limitations. First, the sample consisted of 75 R&D team members from mobile telecommunications companies in Ghana. While these individuals were intentionally chosen for their relevance, this may restrict the applicability of the findings to other sectors or contexts. Second, using self-reported questionnaire data may lead to common methods and social desirability biases, even though steps were taken to protect anonymity. Moreover, confidentiality issues restricted access to comprehensive demographic data, hindering subgroup analysis. Finally, regression-based analytical techniques may not fully account for the dynamic and interactive characteristics of knowledge sharing within R&D teams. Subsequent research may mitigate these constraints by employing longitudinal designs, larger and more heterogeneous samples, and mixed-method or sophisticated analytical techniques.

Conflict of Interest, Ethics Statement, and AI Declaration: The authors state that they have no conflicts of interest related to the publication of this research. Furthermore, all participants were duly informed, and their biodata was protected in accordance with ethical standards. Additionally, the authors declare that basic AI tools were used solely to assist with paraphrasing and reference editing. All content was critically reviewed and edited by the authors to ensure accuracy, originality, and scholarly integrity

References

Ahmad, F. & Karim, M. (2019). 'Impacts of knowledge sharing: A review and directions for future research'. *Journal of Workplace Learning, 31*(3), 207–230.

Anwar, R., Rehman, M., Wang, K.S. and Hashmani, M.A. (2019) 'Systematic literature review of knowledge sharing barriers and facilitators in global software development organizations using concept maps', IEEE Access 7, 24231–24247. https://doi.org/ 10.1109/ACCESS.2019.2895690.

Avila, M.M. (2022) 'Competitive advantage and knowledge absorptive capacity: the mediating role of innovative capability', *Journal of the Knowledge Economy*, 13(1), pp. 185–210.

Awad, E.M. and Ghaziri, H.M. (2004) '*Knowledge management*'. New Jersey: Pearson Education.

Ballesteros-Rodríguez, J.L., De Saá-Pérez, P., García-Carbonell, N., Martín-Alcázar, F. and Sánchez-Gardey, G. (2022) 'The influence of team members' motivation and leaders' behaviour on scientific knowledge sharing in universities', *International Review of Administrative Sciences*, 88(2), pp. 320–336.

Barachini, F. (2009) 'Cultural and social issues for knowledge sharing', *Journal of Knowledge Management*, 13(1), pp. 98–110.

Bartol, K.M. and Srivastava, A. (2016) 'Encouraging knowledge sharing: the role of organizational reward systems', *Journal of Leadership and Organizational Studies*, 9, pp. 64–76.

Blau, P. M. (1964) '*Exchange and power in social life*', John Wiley & Sons.

Bonuedie, B. and Fombad, M. (2026) 'A knowledge-sharing practices perspective for poverty eradication among rural women', *The Electronic Journal of Knowledge Management*, 24(1), pp. 43–66.

Cabrera, A. and Cabrera, E.F. (2002) 'Knowledge-sharing dilemmas', *Organization Studies*, 23(5), pp. 687–710.

Castellano, S., Chandavimol, K., Khelladi, I. and Orhan, M.A. (2021) 'Impact of self-leadership and shared leadership on the performance of virtual R&D teams', *Journal of Business Research*, 128, pp. 578–586.

Chen, C.J. and Hung, S.W. (2010) 'To give or to receive? Factors influencing members' knowledge sharing and community promotion in professional virtual communities, *Information & Management*, 47, pp. 226–236.
Chen, K.Y. and Huan, T.C. (2022) 'How SME family businesses in the travel service industry use market knowledge for product innovation', *Journal of Business Research*, 151, pp. 519–530.
Chua, A. (2003) 'Knowledge sharing: a game people play', *Aslib Proceedings*, 55, pp. 117–129.
Connelly, C.E. (2014) 'Antecedents of knowledge sharing under pressure', *Knowledge Management Research & Practice*, 12(1), pp. 74–85.
Coun, M.J.H., Peters, P. and Blomme, R.J. (2019) '"Let's share!" The mediating role of employees' self-determination in the relationship between transformational and shared leadership and perceived knowledge sharing among peers, *European Management Journal*, 37, pp. 481–491.
Davenport, T.H. and Prusak, L. (2000) *Working knowledge: how organizations manage what they know*. Boston, MA: Harvard Business School Press.
Davidavičienė, V., Al-Majzoub, K. and Meidutė-Kavaliauskienė, I. (2020) 'Factors affecting knowledge sharing in virtual teams', *Sustainability*, 12, 6917.
Du, Y., Zhou, H., Yuan, Y. and Liu, X. (2019) 'Knowledge-sharing strategy and evolutionary mechanism for integrated project teams based on an evolutionary game model', *Advances in Civil Engineering*, pp. 1–23.
Edwards, J.S. (2022) 'Where knowledge management and information management meet: research directions', *International Journal of Information Management*, 63, Article 102458.
Eisenberger, R., Huntington, R., Hutchison, S., and Sowa, D. (1986) 'Perceived organizational support', *Journal of Applied Psychology, 71*(3), 500–507.
Feifei, Y. and Miles, Y. (2023) 'Examining the motivation of IT vendors to share knowledge with clients', *International Journal of Information Management*, 71, Article 102646.
Feng, B. and Liu, J. (2007) 'Social network analysis of knowledge sharing in research teams of universities', *Studies in Science of Science*, 6, pp. 1156–1163.
Filipa, P.S., Pilar, M., and Maria, E.S. (2022) 'Factors influencing knowledge sharing among geographically dispersed IT teams', *Technological Forecasting & Social Change*, 174, Article 121238.
Hu, F., Xi, X. and Zhang, Y.Y. (2021) 'Influencing mechanism of reverse knowledge spillover on investment enterprises' technological progress: an empirical examination of Chinese firms', *Technological Forecasting & Social Change*, 169, Article 120797.
Husted, K. and Michailova, S. (2002) 'Diagnosing and fighting knowledge-sharing hostility', *Organizational Dynamics*, 31(1), pp. 60–73.
Ipe, M. (2016) 'Knowledge sharing in organizations: a conceptual framework', *Human Resource Development Review*, 2, pp. 337–359.
Liao, L.F. (2008) 'Knowledge-sharing in R&D departments: a social power and social exchange theory perspective', *International Journal of Human Resource Management*, 19(10), pp. 1881–1895. https://doi.org/10.1080/09585190802324072
Liu, H.D. and Xu, Y.P. (2019) 'Influential effects of key elements of knowledge sharing in cooperative innovation', *Journal of Nanjing Tech University (Social Science Edition)*, 2, pp. 90–97.
Malik, M. A. R., and Butt, A. N. (2017). Rewards and creativity: Past, present, and future. *Applied Psychology: An International Review, 66*(2), 290–325. https://doi.org/10.1111/apps.12080
Meixia, W., Yunxia, W. and Mardani, A. (2023) 'Factors influencing knowledge sharing in industrial technology innovation strategic alliances', *Journal of Business Research*, 157, Article 113635.
Nima, J.N. and Yeganeh, C. (2016) 'Knowledge sharing mechanisms and techniques in project teams: literature review, classification and current trends', *Computers in Human Behavior*, 62, pp. 730–742.
Ortigueira-Sánchez, L.C., Welsh, D.H.B. and Stein, W.C. (2022) 'Innovation drivers for export performance', *Sustainable Technology and Entrepreneurship*, 1(2), Article 100013.
Shao-nan, S., Zi-cheng, Z., Wen-yan, J., and Wang, H. (2023). 'Analysis of collaborative urban public crisis governance in complex system: A Multi-agent Stochastic Evolutionary Game Approach', *Sustainable Cities and Society*, doi: https://doi.org/10.1016/j.scs.2023.104418
Shih, S.C., Hsu, S.H.Y., Zhu, Z. and Balasubramanian, S.K. (2012) 'Knowledge sharing: a key role in the downstream supply chain', *Information & Management*, 49(2), pp. 70–88.
Silva, F. P., Mosquera, P. and Soares, M. E. (2022) 'Factors influencing knowledge sharing among IT geographically dispersed teams', *Technological Forecasting and Social Change, 174*, 121299.
Staples, D. S., & Webster, J. (2008) 'Exploring the effects of trust, task interdependence and virtualness on knowledge sharing in teams'. *Information Systems Journal, 18*(6), 617–640
Tharenou, T., Donohue, R., and Cooper, B. (2007) '*Management research methods',* Cambridge University Press, New York.
Voogd, R., Rudberg, P. M., Jasper, R., Beunen, R., Espiritu, A., Rasmus, K et al. (2022) 'A systematic review on the role of trust in the water governance literature'. *Water Research*, 16, 100147.
Wang, W.T. (2023) 'Knowledge sharing practices of project teams encountering changes in project scope: a contingency approach', *Journal of Information Science*, 38(5), pp. 423–441.
West Africa Telecommunications Regulators Assembly. (n.d.). *Ghana*. Retrieved May 16, 2026, from https://watra.org/ghana/

Xiao, J., Bao, Y., Wang, J., Yu, H., Ma, Z. and Jing, L. (2021) 'Knowledge sharing in R&D teams: a game model', *Sustainability*, 13, 6664.
Xue, Y., Bradley, J. and Liang, H. (2011) 'Team climate, empowering leadership and knowledge sharing', *Journal of Knowledge Management*, 15(2), pp. 299–312.
Xueyan, Z. (2023) 'Knowledge integration in interdisciplinary research teams: role of social networks', *Journal of Engineering and Technology Management*, 67, Article 101733.
Yeboah, A. (2023) '*Knowledge sharing in organization: A systematic review', Cogent Business & Management, 10*(1), 2195027. https://doi.org/10.1080/23311975.2023.2195027
Zahedi, M., Shahin, M. and Babar, M.A. (2016) 'A systematic review of knowledge sharing challenges and practices in global software development', *International Journal of Information Management*, 36(6), pp. 995–1019.
Zhou, G.H., Ma, D., Xu, J. and Ren, J.F. (2014) 'The effect of organizational context on project members' knowledge sharing willingness', *Management Review*, 5, pp. 61–70.
Zhu, Y.Q. (2016) 'Why and how knowledge sharing matters for R&D engineers', *R&D Management*, 47, pp. 212–222.

Appendix A

SECTION A: Background Information

1. Gender [ ] Male [ ] Female
2. Age [ ] Below 25 [ ] 26-35 [ ] 36-45 [ ] 46-55 [ ] Over 55
3. Highest educational level [ ] Diploma [ ] Bachelor's Degree [ ] Master degree [ ] Doctoral Degree
4. Years in organization Below 5 [ ] 6-10 [ ] 11-15 [ ] 16-20 [ ] 21 and above [ ]

SECTION B: Knowledge sharing willingness in R&D team

Keys: Strongly Agree (SA) = 5, Agree (A) =4, Neutral (N) = 3, Disagree (D) = 2 Strongly Disagree (SD)=1

S/N	Knowledge sharing willingness	1	2	3	4	5
KS1	I often communicate work reports and task ideas with my R&D team members.					
KS2	I always provide our R&D team members access to my manuals, techniques, and models.					
KS3	I regularly exchange ideas and experiences with my R&D team members.					
KS4	Whenever our R&D team members ask for information, I freely share instantly					
KS5	I make an effort to transfer knowledge gained from training and experience to my team members.					

SECTION C: Willingness to share knowledge factors

	Items	1	2	3	4	5
	Group cohesion					
GC1	There is a strong sense of unity among members of my team.					
GC2	I communicate to my team members frequently.					
GC3	Members of my R&D team maintain good personal relationships with one another.					
GC4	I feel connected my team members					
	Organizational support					
OZ1	R&D team members receive internet and other technological resources					
OZ2	The organization is committed to the needs of R&D team					
OZ3	Individual team members are reimbursed when they use personal resources for team activities					
OZ4	The organization ensures that R&D teams have what they need to perform work					
	Team Reward					
TR1	Members receive recognition and promotion when they share distinct ideas with others in R&D team					
TR2	Team gets reward (bonus) when I share hard-to-find knowledge					
TR3	The whole team is rewarded based on our team performance					

	Items	**1**	**2**	**3**	**4**	**5**
	Trust					
T1	My team members exhibit a high level of integrity.					
T2	I believe that members of my R&D team are honest in their dealings.					
T3	I can rely on my team members to do what they promise.					
T4	In general, my team members are reliable.					

GenAI, Leadership, and Entrepreneurial Orientation: The Mediating Role of Knowledge Management Capability

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Abstract: This study examines how generative artificial intelligence use and knowledge-oriented leadership influence entrepreneurial orientation through the mediating role of knowledge management capability in postsecondary education institutions . Despite the growing interest in artificial intelligence and entrepreneurship, prior research has predominantly focused on individual-level outcomes, while the organizational mechanisms that translate technological and leadership inputs into entrepreneurial behavior remain insufficiently understood. Addressing this gap, the present study adopts a capability-based perspective grounded in the knowledge-based view. A quantitative research design was employed. Data were collected from 387 academic staff members across 25 colleges in Kazakhstan using a structured questionnaire. The proposed model was tested using partial least squares structural equation modeling (PLS-SEM), enabling the assessment of both direct and indirect relationships among the constructs. The results indicate that knowledge-oriented leadership exerts a strong positive effect on knowledge management capability, which in turn significantly enhances entrepreneurial orientation. Generative AI use demonstrates both a direct effect on entrepreneurial orientation and an indirect effect through knowledge management capability, suggesting a complementary mediation mechanism. The findings further reveal that the impact of GenAI is contingent upon its integration into organizational knowledge processes rather than its isolated or ad-hoc use. The study contributes to the literature by providing a capability-based explanation of how technological and leadership factors jointly shape entrepreneurial orientation at the organizational level. It extends prior research by moving beyond individual-level perspectives and highlighting the central role of knowledge management capability as a transformation mechanism. From a practical standpoint, the findings suggest that educational institutions should prioritize the development of structured knowledge processes and leadership practices that support knowledge sharing and application when implementing GenAI initiatives. Such an approach enhances the sustainability and consistency of entrepreneurial behavior within knowledge-intensive environments.

Keywords: Generative artificial intelligence use, Knowledge-oriented leadership, Knowledge management capability, Entrepreneurial orientation, Postsecondary education

1. Introduction

Postsecondary education (PSE) institutions increasingly face pressure to demonstrate entrepreneurial orientation (EO), reflected in innovativeness, proactiveness, and opportunity-seeking behavior that enables the translation of academic knowledge into societal and economic value. At the same time, the rapid diffusion of generative artificial intelligence (GenAI) is transforming how knowledge is created, accessed, and reused in organizational settings. Despite growing interest, the strategic implications of generative artificial intelligence for entrepreneurial orientation in PSE institutions remain insufficiently theorized and empirically fragmented.

Existing research has largely emphasized individual-level outcomes, including learning performance, self-efficacy, and entrepreneurial intentions, while paying limited attention to organizational-level mechanisms that enable dispersed insights to be translated into coordinated entrepreneurial action (Xie and Wang, 2025).

Recent reviews further note that the GenAI–entrepreneurship relationship lacks clear explanatory pathways, calling for studies that identify intermediate organizational capabilities rather than relying on direct-effect

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models (Pimentel and Veliz Palomino, 2025). In line with this concern, management scholars emphasize that although AI-related trust and governance issues are increasingly discussed, research still rarely specifies concrete organizational mechanisms through which AI use translates into strategic outcomes, underscoring the need for capability-centered explanations (Grabowska and Rzemieniak, 2025).

From a knowledge-based view, organizational outcomes depend not simply on the availability of knowledge but on the ability to coordinate knowledge acquisition, sharing, and application across organizational members (Grant, 1996; Adam et al., 2022). This perspective places leadership and knowledge routines at the center of entrepreneurial behavior. Empirical evidence shows that knowledge-oriented leadership (KOL) positively shapes knowledge management processes and entrepreneurial orientation, yet also indicates that knowledge processes do not automatically translate into performance outcomes across contexts, highlighting a missing conversion mechanism between enablers and strategic results (Latif et al., 2021; Shahzad et al., 2021).

Building on this logic, we position knowledge management capability (KMC) as the key organizational mechanism linking GenAI use and KOL to EO. Prior research conceptualizes KMC as an integrated capability combining knowledge processes and enabling infrastructures, through which organizations transform dispersed knowledge into coordinated action (Gold, Malhotra and Segars, 2001; Latif et al., 2021). Related studies demonstrate that leadership effects on innovation and openness frequently operate indirectly through knowledge process and infrastructure capabilities, underscoring the centrality of KMC in transmitting managerial influence to downstream outcomes (Shahzad et al., 2021; Riaz et al., 2025).

Accordingly, we argue that GenAI use and KOL strengthen EO primarily when they contribute to the development of KMC, rather than when GenAI remains ad-hoc technology use or leadership actions remain symbolic. GenAI may support opportunity exploration and experimentation, but its organizational value depends on whether AI-generated insights are systematically shared, interpreted, and embedded into organizational routines (Alavi, Leidner and Mousavi, 2024; Kirchner et al., 2025). Without such capability, early productivity gains risk remaining fragmented and short-lived.

Accordingly, the present study addresses the following research question: Through what organizational mechanism do GenAI use and knowledge-oriented leadership jointly shape entrepreneurial orientation in PSE institutions?

The purpose of this study is therefore to examine a capability-based model in which GenAI use and KOL influence entrepreneurial orientation directly and indirectly through knowledge management capability in PSE institutions. By empirically testing these relationships and mediation pathways, the study responds to recent calls to integrate GenAI into established knowledge-management frameworks (Alavi, Leidner and Mousavi, 2024) and to clarify how leadership-driven capability building translates into entrepreneurial strategic behavior in knowledge-intensive organizational contexts (Latif et al., 2021; Shahzad et al., 2021).

2. Literature Review and Hypotheses Development

This review establishes the conceptual basis for examining the relationships among GenAI use, KOL, KMC, and EO. Drawing on prior research in knowledge management and entrepreneurship, the review focuses on how technological and leadership-related factors shape organizational knowledge processes and entrepreneurial outcomes. Against this backdrop, the review is structured around (1) the effects of GenAI use on KMC and EO, (2) the effects of KOL on KMC and EO, and (3) the mediating role of KMC and relevant contingencies.

GenAI refers to a class of AI systems that enable the creation and recombination of knowledge artefacts beyond traditional analytical AI, thereby influencing how knowledge is produced and used in organizational contexts (Alavi, Leidner and Mousavi, 2024; Kudryavtsev, Khan and Kauttonen, 2024).

At the same time, existing research highlights important uncertainties surrounding GenAI use, as concerns related to knowledge quality, algorithmic overreliance, and reduced human interaction underscore the need for managerial oversight (Alavi, Leidner and Mousavi, 2024).

Accordingly, the present study conceptualizes GenAI in terms of GenAI use, focusing on individuals' engagement with generative tools in everyday knowledge-related activities, consistent with the approach adopted by Al-Emran et al. (2025).

KMC refers to an organization's ability to acquire, share, and apply knowledge through coordinated organizational processes and supporting infrastructure, drawing on the knowledge process perspective of Gold, Malhotra and Segars (2001) and the operationalization proposed by Aboelmaged (2014).

Conceptualized as an organizational capability rather than a set of isolated practices, KMC encompasses coordinated routines that enable knowledge to be embedded in decision-making and action, allowing firms in knowledge-intensive contexts to mobilize knowledge resources in a repeatable and scalable manner beyond individual initiatives (Gold, Malhotra and Segars, 2001).

Recent research suggests that KMC remains fundamentally human-centered even in AI-rich environments, as effective knowledge utilization continues to depend on managerial coordination, human judgment, and the integration of digital tools into established organizational routines. In the absence of such capability, however, digital technologies may fail to generate meaningful organizational value, as knowledge remains fragmented and insufficiently translated into informed managerial action (Gold, Malhotra and Segars, 2001; Jarrahi et al., 2023; Kudryavtsev, Khan and Kauttonen, 2024).

KOL refers to a leadership approach that emphasizes the creation, sharing, and application of knowledge by fostering learning, collaboration, and supportive knowledge infrastructures within organizations (Donate and Sánchez de Pablo, 2015). Leaders adopting a knowledge-oriented approach shape learning environments that facilitate knowledge diffusion, experimentation, and the integration of individual expertise into collective organizational routines (Chaithanapat et al., 2022).

Recent empirical studies further indicate that KOL plays a key enabling role in the development of knowledge-based organizational capabilities. By shaping organizational norms, values, and routines, knowledge-oriented leaders provide the structural foundation through which knowledge can be systematically mobilized and embedded in organizational processes (Chaithanapat et al., 2022; Riaz et al., 2025; González-Mohíno et al., 2024).

Entrepreneurship is commonly conceptualized as a multidimensional phenomenon encompassing innovation, risk-taking, and proactiveness (Miller, 1983), which later formed the conceptual foundation for the dominant three-dimensional understanding of entrepreneurial orientation. Building on this foundation, Covin and Slevin (1989) formalized EO as a strategic posture reflecting organizations' entrepreneurial behavior at the organizational level.

Importantly, recent research demonstrates that entrepreneurial orientation is not confined to profit-seeking firms. A systematic literature review by Stock and Erpf (2023) shows that EO is increasingly applied in nonprofit, public, and mission-driven organizations, where it functions as a strategic posture supporting organizational adaptability, proactive response to environmental constraints, and the effective mobilization of limited resources. In such contexts, EO supports forms of strategic renewal that are aligned with social value creation, rather than exclusively driven by commercial objectives.

Within the KBV, organizational capabilities develop through the coordinated use of knowledge resources, a process that is increasingly shaped by digital technologies embedded in everyday work practices (Grant, 1996; Alavi, Leidner and Mousavi, 2024).

GenAI use reflects individuals' active engagement with generative tools in knowledge-related tasks. Through this engagement, GenAI supports the core processes underlying KMC by enabling users to synthesize fragmented information, identify non-obvious patterns, and - in partnership with human actors - embed outputs into shared organizational practices (Jarrahi et al., 2023; Kudryavtsev, Khan and Kauttonen, 2024). Over time, such repeated engagement can consolidate dispersed knowledge into coherent representations that are collectively interpretable and actionable across organizational routines.

However, this relationship is contingent on organizational conditions. Jarrahi et al. (2023) caution that the value of AI for knowledge management lies not in technology alone, but in the accompanying people, infrastructure, and processes. Without adequate managerial oversight, AI use may foster cognitive complacency - an uncritical reliance on AI outputs that undermines the human judgment essential to effective knowledge management. Furthermore, Kudryavtsev, Khan and Kauttonen (2024) note that GenAI can reduce rather than enhance knowledge work effectiveness when applied without sufficient data quality controls or organizational readiness.

Building on the above discussion, the following hypothesis is proposed:

H1: GenAI use is positively associated with KMC

From a KBV, organizational behavior under uncertainty is shaped by how organizational members interpret and mobilize knowledge in decision-making processes, a dynamic increasingly influenced by advanced digital technologies (Grant, 1996; Adam et al., 2022).

GenAI use may influence EO by reshaping how organizational members explore opportunities and act under uncertainty. Specifically, GenAI supports innovativeness by enabling idea generation and organizational learning; it reinforces proactiveness through predictive analytics and real-time insights that allow anticipation of environmental shifts; and it facilitates more informed risk-related decision-making by synthesizing information and reducing cognitive uncertainty (Pimentel and Veliz Palomino, 2025). Taken together, these mechanisms suggest that regular engagement with generative tools can strengthen the behavioral dispositions underlying EO at the organizational level.

However, these effects are not uniform across contexts. Pimentel and Veliz Palomino (2025) caution that GenAI's contribution to innovativeness depends heavily on entrepreneurs' absorptive capacity and ethical safeguards, while its benefits for proactiveness are constrained by data biases and limited contextual understanding. These barriers suggest that GenAI may amplify EO in digitally capable organizations while producing uneven or negligible effects elsewhere.

Building on the above discussion, the following hypothesis is proposed:

H2: GenAI use is positively associated with EO

According to the KBV, knowledge resides primarily in individuals, making its coordination and integration within organizations a challenging task/

KOL addresses this by fostering learning-oriented norms, encouraging knowledge exchange, and guiding the effective use of knowledge in organizational activities, thereby shaping a supportive knowledge climate that facilitates acquisition, sharing, and application of knowledge (Shamim et al., 2019).

However, this relationship is not unconditional. Shahzad et al. (2021) found that KOL did not directly predict inbound open innovation, suggesting that its influence on knowledge outcomes depends on organizational and cultural context. Riaz et al. (2023) further showed that technological turbulence can weaken the link between knowledge management process capability and exploitative innovation, indicating that environmental conditions may disrupt the chain from KOL through KMC to innovation outcomes.

Based on this reasoning, the following hypothesis is proposed:

H3: KOL is positively associated with KMC

EO reflects organizational patterns of innovativeness, proactiveness, and risk-related decision-making (Miller, 1983), and its development depends on contexts that support learning and experimentation. By legitimizing experimentation and encouraging knowledge exchange, knowledge-oriented leaders reduce uncertainty surrounding novel initiatives and enable opportunity-oriented behavior (Donate and Sánchez de Pablo, 2015; González-Mohíno et al., 2024).

That said, this effect is not automatic. González-Mohíno et al. (2024) found that KOL did not directly reduce relationship conflict without supporting coordination mechanisms, and Riaz et al. (2025) showed that KOL's influence on innovation operates indirectly through knowledge management capabilities. This suggests that KOL's association with EO may depend on enabling organizational conditions — a relationship that remains empirically underexplored and that this study directly addresses.

Accordingly, the following hypothesis is proposed:

H4: KOL is positively associated with EO

From a KBV, knowledge acquisition, sharing, and application are linked to improved organizational responsiveness and performance (Ha et al., 2021). Yu et al. (2022) show that knowledge management positively predicts entrepreneurial orientation in IT-sector SMEs, and this effect is stronger when leaders have the educational capacity to interpret and mobilize knowledge effectively. Hernández-Linares et al. (2024) corroborate this finding in a broader context, demonstrating that knowledge-based dynamic capabilities — spanning sensing, learning, integrating, and coordinating - are positively associated with entrepreneurial orientation across over 1,000 Iberian SMEs.

Yet the relationship is not automatic. When knowledge processes become routinized over time, they risk generating what Leonard-Barton (1992) called core rigidities - patterns that reinforce existing routines rather than enabling new entrepreneurial action. The KMC → EO link, in other words, depends on whether knowledge is actively directed outward toward opportunities rather than inward toward protecting what already exists.

Accordingly, the following hypothesis is proposed:

H5: KMC is positively associated with EO

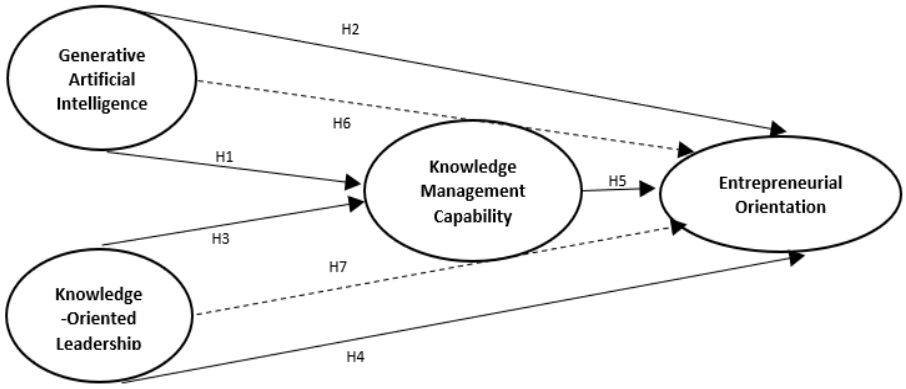
Having established that GenAI use and KOL each strengthen KMC (H1, H3), and that KMC in turn predicts EO (H5), it follows that KMC may serve as a mediating mechanism linking both antecedents to entrepreneurial orientation.

Building on the above discussion, the following hypotheses are proposed:

H6: KMC mediates the relationship between GenAI use and EO

H7: KMC mediates the relationship between KOL and EO

Taken together, the proposed hypotheses form the conceptual framework guiding this research. This framework, which illustrates the direct and mediated relationships between GenAI, KOL, KMC, and EO, is presented in Figure 1.



Source: Authors' own elaboration.

Figure 1: Conceptual framework and hypothesized relationships

3. Research Methodology

All constructs were measured on 5-point Likert scales (1 = "strongly disagree", 5 = "strongly agree").

- GenAI use - adapted from Al-Emran (2025) captured the frequency/extent of GenAI use in work routines (3 items).
- KOL - adapted from Donate and Sánchez de Pablo (2015) captured leadership behaviors (6 items).
- KMC - following Aboelmaged (2014), KMC was operationalized as a three-dimensional construct comprising knowledge acquisition - KAC (4 items), knowledge sharing – KSH (4 items), and knowledge application – KAP (4 items), with item content adapted from Masa'deh et al. (2017).
- EO - adapted from Covin and Slevin (1989) tradition, EO was conceptualized as three dimensions—innovativeness – INN (3 items), proactiveness – PRO (3 items), and risk-taking – RT (3 items).

All measurement items were contextually reworded for public sector educational institutions (colleges) while preserving the original content domain. The instrument underwent expert review and a small-scale pretest, after which minor wording adjustments were made for clarity. The resulting factor structures, as well as reliability and validity evidence, are reported in the measurement model results.

The complete list of measurement items and their sources is presented in Appendix A.

The participants in this study consisted of academic staff (teachers) from 25 colleges in Northern Kazakhstan, representing a broad range of disciplines. The participating institutions accounted for approximately 74% of all colleges in the Kostanay region (25 out of 34 colleges). Given that participation depended on institutional willingness to participate, a non-probability convenience sampling approach was employed.

Data were collected via an online questionnaire (Google Forms) administered between January and February 2025. Participation was voluntary; electronic informed consent was obtained before the survey began (see Ethical Statement); no monetary incentives were offered, and confidentiality and anonymity were assured.

Because the survey was distributed through institutional channels, the exact number of staff members who received the invitation could not be verified; therefore, a response rate was not calculated. In total, 483 questionnaires were received; after excluding outliers and straight-line responses, 387 valid questionnaires were retained for statistical analysis.

To assess indicator collinearity within the reflective measurement model, we inspected variance inflation factors (VIFs) for all indicators. All values were below the commonly used cutoff of 5.0 (range = 1.664–3.926), indicating no critical redundancy among items. Although two indicators (KAP3 = 3.926; KAP4 = 3.620) exceeded the stricter heuristic of 3.3, they remained well below 5.0 and were retained to preserve content coverage, consistent with recommended practice for reflective indicators (Hair et al., 2021).

Because all constructs were measured through a single self-administered questionnaire, common method bias was assessed using Harman's single-factor test. All 30 items were entered into an unrotated principal axis factor analysis with the number of factors constrained to one. The single factor accounted for 48.9% of the total variance, below the 50% threshold (Podsakoff et al., 2003), indicating that common method bias is unlikely to substantially distort the findings. This is further supported by procedural safeguards applied during data collection, including respondent anonymity and assurance of confidentiality.

Given the small effect size of the GenAI–KMC path ($\beta = 0.086$, $f^2 = 0.012$), a post-hoc power analysis was conducted ($N = 387$, $\alpha = 0.05$, two predictors). The achieved power was 0.58, below the conventional 0.80 threshold.

Because response rate could not be calculated, non-response bias was assessed by comparing early and late respondents (first and last thirds of the response distribution by submission time) on the study's key constructs. No significant differences were found (all $p > 0.10$), suggesting that non-response bias is unlikely to be a major concern.

4. Research Results

The measurement model was evaluated to confirm the constructs' reliability and validity. Two

items (KAP1 and KSH1) were deleted from the data because of low factor loadings lower than the specified value of 0.50, all other items were included in the measuring model. As a result, all factor outer loadings in Table 1 are more than the recommended value of 0.50 (Hair et al., 2021).

The values of Cronbach's alpha are more than the advised value of 0.70 (Hair et al., 2021). Moreover, CR values are also greater than the recommended threshold of 0.70 (Ringle et al., 2020). The next step was to test the convergent validity which was also established because the AVE values are equal to or greater than 0.50.

Reliability and validity results with factor loadings are presented in Table 1.

Further discriminant validity was assessed (Table 2). The square roots of AVE of the constructs are greater than the correlation of inter constructs. Moreover, discriminant validity was also examined with the heterotrait-monotrait ratio of correlation (Henseler, Ringle and Sarstedt, 2015) and the resulting values are less than the recommended value of 0.90. Hence, discriminant validity was established.

Table 1: Measurement model results

	Outer loadings	Cronbach alpha	CR	AVE
GenAI		0.824	0.884	0.737
GenAI1	0.913			
GenAI2	0.840			
GenAI3	0.818			
KOL		0.907	0.914	0.683
KOL1	0.873			
KOL2	0.847			
KOL3	0.784			
KOL4	0.817			
KOL5	0.861			

	Outer loadings	Cronbach alpha	CR	AVE
KOL6	0.772			
KAC		0.904	0.905	0.777
KAC1	0.858			
KAC2	0.903			
KAC3	0.896			
KAC4	0.869			
KSH		0.871	0.871	0.795
KSH2	0.873			
KSH3	0.902			
KSH4	0.899			
KAP		0.879	0.900	0.807
KAP2	0.819			
KAP3	0.940			
KAP4	0.930			
INN		0.858	0.864	0.779
INN1	0.889			
INN2	0.913			
INN3	0.845			
PRO		0.811	0.822	0.725
PRO1	0.868			
PRO2	0.858			
PRO3	0.828			
RT		0.821	0.826	0.736
RT1	0.869			
RT2	0.881			
RT3	0.822			

Source: Authors' elaboration based on SmartPLS 4

Table 2: Discriminant validity (HTMT criterion)

	GenAI	KOL	KAC	KSH	KAP	INN	PRO	RT
GenAI								
KOL	0.121							
KAC	0.118	0.758						
KSH	0.162	0.781	0.888					
KAP	0.218	0.792	0.864	0.886				
INN	0.227	0.696	0.743	0.744	0.792			
PRO	0.308	0.759	0.746	0.739	0.790	0.864		
RT	0.236	0.672	0.656	0.638	0.683	0.796	0.894	

Source: Authors' elaboration based on SmartPLS 4

To validate the higher-order formative constructs, multicollinearity among the lower-order dimensions was assessed using variance inflation factors (VIF). All VIF values were below the threshold of 5.0, indicating no collinearity concerns (Hair et al., 2021). The significance and relevance of outer weights were examined (Sarstedt et al., 2019), and all outer weights were statistically significant, while outer loadings were additionally inspected

to assess the absolute contribution of each dimension. Overall, the results support the validity of the higher-order constructs (Table 3).

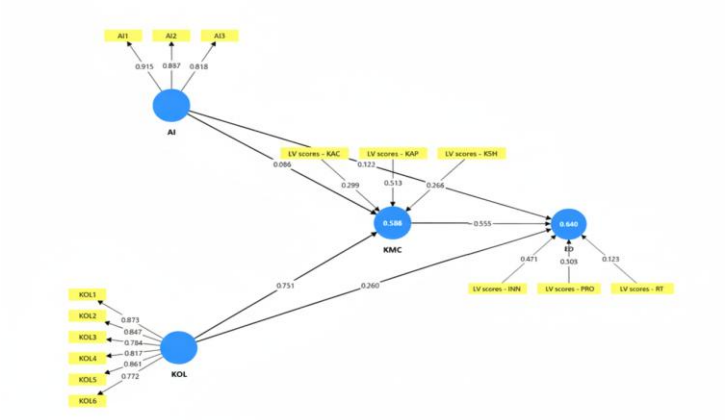
Table 3: Higher order construct validation

	VIF	Weights	Loadings
KAC → KMC	3.204	0.299	0.907
KSH → KMC	3.262	0.266	0.903
KAP → KMC	3.134	0.513	0.953
INN → EO	2.318	0.471	0.917
PRO → EO	2.728	0.503	0.933
RT → EO	2.367	0.123	0.807

Source: Authors' elaboration based on SmartPLS 4

The structural model (Figure 2) demonstrates the hypothesized paths in the research framework.

The structural model was assessed using standardized path coefficients (β) obtained via nonparametric bootstrapping with 10,000 resamples (two-tailed, 95% confidence intervals). Multicollinearity was examined using inner VIF values, all of which were below 5.0.



Source: Authors' elaboration based on SmartPLS 4

Figure 2: Structural model results with standardized path coefficients (β) and endogenous R^2 values (R^2_KMC = 0.586; R^2_EO = 0.640; SRMR = 0.046)

The model's explanatory power was evaluated using R^2 values exceeding the minimum threshold of 0.10 (Falk and Miller, 1992), while predictive relevance was confirmed by Q^2 values greater than zero (Table 4). Model fit was assessed using the standardized root mean square residual (SRMR = 0.046), indicating an acceptable fit (Hair et al., 2021).

Table 4: R^2 and Q^2

	R^2	Q^2
KMC	0.586	0.576
EO	0.640	0.500

Source: Authors' elaboration based on SmartPLS 4

Table 5 presents the structural path results. GenAI use has a positive and significant effect on KMC (β = 0.086, p = 0.013), supporting H1, and on EO (β = 0.122, p = 0.001), supporting H2. KOL shows a strong positive effect on KMC (β = 0.751, p < 0.001), confirming H3, and also positively influences EO (β = 0.260, p < 0.001), supporting H4. In addition, KMC is positively associated with EO (β = 0.555, p < 0.001), supporting H5.

Table 5: Hypothesis test results (structural paths)

Hypothesis Path	β (O)	STDEV	t-statistics	p-value	Decision
H1: GenAI → KMC	0.086	0.035	2.479	0.013	Supported
H2: GenAI → EO	0.122	0.035	3.450	0.001	Supported
H3: KOL → KMC	0.751	0.027	27.515	< 0.001	Supported
H4: KOL → EO	0.260	0.061	4.270	< 0.001	Supported
H5: KMC → EO	0.555	0.057	9.686	< 0.001	Supported

Source: Authors' elaboration based on SmartPLS 4

Mediation analysis based on bootstrapped indirect effects indicates that KMC partially mediates the relationship between GenAI use and EO (VAF = 28%), supporting H6. A substantial partial mediation is also observed between KOL and EO through KMC (VAF = 62%), supporting H7. Mediation results are reported in Table 6.

Table 6: Mediation analysis

Path (mediation)	β (O)	STDEV	t-statistics	p-value
GenAI → KMC → EO	0.048	0.020	2.416	0.016
KOL → KMC → EO	0.417	0.048	8.765	< 0.001

Source: Authors' elaboration based on SmartPLS 4

5. Discussion

The findings indicate that GenAI use and KOL jointly contribute to entrepreneurial orientation through their effects on knowledge management capability. All hypothesized relationships are positive and statistically significant, and the mediation results highlight the central role of KMC as the mechanism translating technological and leadership inputs into entrepreneurial behavior.

Regarding H1, the results indicate that GenAI use strengthens KMC by supporting knowledge access, interpretation, and reuse in everyday work activities, consistent with research on AI-enabled knowledge processes (Jarrahi et al., 2023; Kudryavtsev, Khan and Kauttonen, 2024). However, the modest effect size (β = 0.086) warrants closer examination. Two complementary explanations are plausible. First, the measurement of GenAI use in this study captures frequency of engagement rather than the quality or depth of integration into organizational routines. As Jarrahi et al. (2023) caution, the organizational value of AI for knowledge management depends not on technology alone but on the accompanying people, infrastructure, and processes — conditions that may vary considerably across institutions. Second, the institutional context likely plays a role. Government-led AI initiatives in Kazakhstan have traditionally prioritized the university sector over colleges; indicatively, the national AI-Sana programme targets students and faculty of higher education institutions, with no parallel provision for the PSE college system (Ministry of Science and Higher Education of the Republic of Kazakhstan, 2025).Under these conditions, GenAI use among college staff may remain largely informal and individually driven, limiting its capacity to strengthen collective knowledge management routines. Evidence from postsecondary education institutions in Kazakhstan further confirms that KMC serves as the central conversion mechanism through which GenAI generates organizational value, while GenAI alone does not directly enhance institutional performance (Amantayeva, Sartanova and Baizhanova , 2026).

With respect to H2, the results confirm that GenAI use directly strengthens EO across all three of its dimensions. For innovativeness, generative tools support idea generation and organizational learning, though this benefit is bounded by absorptive capacity and the availability of ethical safeguards (Pimentel and Veliz Palomino, 2025). For proactiveness, GenAI enables real-time synthesis of environmental signals, yet data biases and limited contextual understanding can distort rather than sharpen strategic foresight (Pimentel and Veliz Palomino, 2025). For risk-taking, GenAI reduces cognitive uncertainty by processing large volumes of data and generating evidence-based recommendations — provided that data quality and interpretive capabilities are adequate (López-Solís et al., 2025). Notably, part of this direct effect likely operates at the level of individual cognition rather than through collective knowledge routines: generative tools enable users to reframe problems and construct alternative scenarios in ways that shift strategic thinking dispositions independently of shared organizational processes.

In line with H3, KOL emerges as the primary driver of KMC (β = 0.751), substantially outpacing the effect of GenAI use (β = 0.086). This finding aligns with evidence showing that knowledge-oriented leaders strengthen KMC by motivating employees to create, share, and apply knowledge, by reinforcing this through reward structures and communication, and by shaping the cultural and structural infrastructure that embeds knowledge use into organizational routines (Shahzad et al., 2021; Riaz et al., 2025). Through these mechanisms, leadership translates individual knowledge into collective organizational capability.

In the PSE context, such practices may take the form of regular cross-departmental knowledge-sharing sessions, structured mentorship between experienced and early-career faculty, recognition systems that reward knowledge contributions, or institutionalized digital repositories consolidating pedagogical best practices.

The findings support H4 (β = 0.260, $p < 0.001$), confirming that KOL strengthens EO by fostering learning-oriented norms and guiding knowledge application in organizational activities. By legitimizing experimentation and reducing uncertainty surrounding novel initiatives, knowledge-oriented leaders create conditions under which opportunity-oriented behavior can emerge (Donate and Sánchez de Pablo, 2015; González-Mohíno et al., 2024). This suggests that in the PSE context, leadership influence on entrepreneurial behavior operates not only indirectly through KMC but also through the direct shaping of organizational norms that support innovativeness, proactiveness, and risk-taking.

The findings also support H5, confirming that KMC positively predicts EO. This is consistent with Hernández-Linares et al. (2024) and Yu et al. (2022), who report similar effects across SME contexts. The result suggests that colleges with stronger knowledge management routines are better positioned to recognize and act on emerging opportunities — because systematic knowledge acquisition and sharing reduce the uncertainty that typically inhibits proactive and risk-taking behavior. However, this effect is likely conditional: when knowledge processes become overly routinized, they may reinforce existing practices rather than stimulate new ones (Hernández-Linares et al., 2024; Leonard-Barton, 1992).

The findings support both H6 and H7, confirming the mediating role of KMC. For H6, KMC accounts for approximately 28% of the total effect of GenAI use on EO, suggesting that while GenAI exerts a direct influence on entrepreneurial behavior, a meaningful share of its effect operates through organizational knowledge processes. For H7, the mediating share is substantially larger (VAF ≈ 62%), indicating that KOL influences EO primarily through the knowledge management capability it develops — consistent with evidence that leadership effects on innovation-related outcomes operate indirectly through knowledge processes rather than through direct behavioral influence alone (Shahzad et al., 2021; Riaz et al., 2025).

An alternative explanation should also be considered: institutions with already strong EO may be more inclined to invest in GenAI and KM practices, rather than the reverse. The cross-sectional design of this study cannot rule out this possibility, and the observed relationships should be interpreted as associations rather than confirmed causal effects.

6. Conclusion

Returning to our central research question, the findings indicate that KMC is the key mechanism through which GenAI use and KOL jointly shape EO in PSE institutions.

This study examined how GenAI use and KOL influence EO through KMC in PSE institutions. The findings show that both technological and leadership-related factors contribute to EO, with KMC serving as the central mechanism through which these influences are translated into entrepreneurial behavior.

The results indicate that KOL affects EO primarily by strengthening KMC, whereas GenAI use operates through both direct and indirect pathways. This pattern suggests that entrepreneurial orientation is fostered not by isolated technology adoption or leadership actions, but by the development of organizational knowledge capability that enables systematic knowledge acquisition, sharing, and application.

From a theoretical perspective, this study contributes by clarifying a capability-based mechanism underlying entrepreneurial orientation. It demonstrates that leadership-driven KMC represents the key channel through which managerial intent and digital technologies are converted into coordinated organizational action. In addition, the findings extend emerging GenAI research by showing that AI-related effects on EO are more likely to persist when GenAI use is embedded within organizational knowledge structures rather than applied in an ad-hoc manner.

These findings challenge the prevailing assumption that GenAI adoption alone is sufficient to drive strategic outcomes, highlighting instead the enduring centrality of human-centered knowledge processes in converting technological inputs into entrepreneurial behavior.From a managerial perspective, the results highlight the importance of strengthening KMC before scaling GenAI initiatives. Leaders should focus on institutionalizing knowledge routines, shared repositories, and clear responsibility for knowledge validation, while reinforcing norms that encourage knowledge sharing and application. Such arrangements support the development of more consistent and sustainable entrepreneurial behaviors over time.

Therefore, before investing heavily in GenAI tools, educational leaders should first strengthen knowledge management routines — such as cross-departmental knowledge reviews, faculty mentorship programs, and structured pedagogical repositories. These arrangements form the organizational foundation upon which GenAI initiatives can generate sustainable entrepreneurial value.

This study has several limitations. The data were collected from colleges within a single national context, which may limit generalizability. The cross-sectional and self-reported design constrains causal inference. The post-hoc power for the GenAI–KMC path (0.58) suggests that larger samples are needed to reliably detect such small effects in future research. In addition, construct operationalization can be further refined, particularly with respect to measuring the quality and maturity of GenAI use rather than its intensity alone. Future research should replicate the model across different educational segments and national settings, adopt longitudinal and multi-source designs, and examine contextual boundary conditions that may shape the observed relationships.

Use of AI-Assisted Language Tools: The manuscript was proofread using grammar-checking tools to improve clarity and readability. All theoretical development, research design, data analysis, and interpretation were carried out independently by the authors. The tools were used solely for language editing and did not contribute to the conceptual or analytical content.

Ethical Statement: The Declaration of Helsinki was followed in conducting the study, and the protocol was approved by the Ethics Committee of Akhmet Baitursynuly Kostanay Regional University (Approval No. 25-B/2024 on December 20, 2024).

Conflict of Interest: The authors declare no conflict of interest.

Data Availability Statement: The data supporting this study are available from the corresponding author upon reasonable request.

References

Aboelmaged, M. G. (2014). Linking operations performance to knowledge management capability: The mediating role of innovation performance. *Production Planning & Control,* 25(1), 44–58.

Adam, S., Fuzi, N. M., Ramdan, M. R., Mat Isa, R., Ismail, A. F. M. F., Hashim, M. Y., ... and Ramlee, S. I. F. (2022). Entrepreneurial orientation and organizational performance of online business in Malaysia: the mediating role of the knowledge management process. *Sustainability*,14(9), 5081.

Al-Emran, M., Al-Qaysi, N., Al-Sharafi, M. A., Khoshkam, M., Foroughi, B., and Ghobakhloo, M. (2025). Role of perceived threats and knowledge management in shaping generative AI use in education and its impact on social sustainability. *The International Journal of Management Education*, 23(2), 101105.

Alavi, M., Leidner, D. E., and Mousavi, R. (2024). A knowledge management perspective of generative artificial intelligence. *Journal of the Association for Information Systems*, 25(1), 1–12.

Amantayeva, R., Sartanova, N., and Baizhanova, L. (2026). GenAI–Sustainability Nexus: Mediating Roles of Knowledge Management and Social Responsibility in HEIs. *Electronic Journal of Knowledge Management*, *24*(1), 140.

Chaithanapat, P., Punnakitikashem, P., Oo, N. C. K. K., and Rakthin, S. (2022). Relationships among knowledge-oriented leadership, customer knowledge management, innovation quality and firm performance in SMEs. *Journal of Innovation & Knowledge*, 7(1), 100162.

Covin, J. G., and Slevin, D. P. (1989). Strategic management of small firms in hostile and benign environments. *Strategic Management Journal*, 10(1), 75–87.

Donate, M. J., and de Pablo, J. D. S. (2015). The role of knowledge-oriented leadership in knowledge management practices and innovation. *Journal of Business Research*, 68(2), 360–370.

Falk, R. F., and Miller, N. B. (1992). A primer for soft modeling. University of Akron Press.

Grabowska, M., and Rzemieniak, M. (2025). Trust and Artificial Intelligence–a review of research trends. *Polish journal of management studies*,32(2), 78-94.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic management journal*, 17(S2), 109-122.

Gold, A. H., Malhotra, A., and Segars, A. H. (2001). Knowledge management: An organizational capabilities perspective. *Journal of management information systems*, 18(1), 185-214.

González-Mohíno, M., Donate, M. J., Guadamillas, F., and Cabeza-Ramírez, L. J. (2024). Knowledge-oriented leadership for improved coordination as a solution to relationship conflict: effects on innovation capabilities. *Knowledge Management Research & Practice,* 22(4), 388-403.

Ha, S. T., Lo, M. C., Suaidi, M. K., Mohamad, A. A., and Razak, Z. B. (2021). Knowledge management process, entrepreneurial orientation, and performance in SMEs: Evidence from an emerging economy. *Sustainability*, 13(17), 9791.

Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., and Ray, S. (2021). Partial least squares structural equation modeling (PLS-SEM) using R: A workbook (p. 197). Springer Nature.

Henseler, J., Ringle, C. M., and Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115–135.

Hernández-Linares, R., López-Fernández, M. C., García-Piqueres, G., Pina e Cunha, M., and Rego, A. (2024). How knowledge-based dynamic capabilities relate to firm performance: The mediating role of entrepreneurial orientation. *Review of Managerial Science,* 18(10), 2781–2813.

Jarrahi, M. H., Askay, D., Eshraghi, A., and Smith, P. (2023). Artificial intelligence and knowledge management: A partnership between human and AI. *Business Horizons*, 66(1), 87–99.

Kirchner, K., Bolisani, E., Kassaneh, T. C., Scarso, E., and Taraghi, N. (2025). Generative AI meets knowledge management: Insights from software development practices. *Knowledge and Process Management, 32(4), 223-235.*

Kudryavtsev, D., Khan, U., and Kauttonen, J. (2024). Transforming knowledge management using generative AI: From theory to practice. In Proceedings of the 16th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (Vol. 3, pp. 362–370). SciTePress.

Kusa, R., Suder, M., Duda, J., Czakon, W., and Juárez-Varón, D. (2024). Does knowledge management mediate the relationship between entrepreneurial orientation and firm performance? *Journal of Knowledge Management*, 28(11), 33–61.

Latif, K. F., Afzal, O., Saqib, A., Sahibzada, U. F., and Alam, W. (2021). Direct and configurational paths of knowledge-oriented leadership, entrepreneurial orientation, and knowledge management processes to project success. *Journal of Intellectual Capital*, 22(1), 149–170.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: a paradox in managing new product development. *Strategic Management Journal*, 13(S1), pp. 111–125.

López-Solís, O., Luzuriaga-Jaramillo, A., Bedoya-Jara, M., Naranjo-Santamaría, J., Bonilla-Jurado, D., and Acosta-Vargas, P. (2025). Effect of generative artificial intelligence on strategic decision-making in entrepreneurial business initiatives: A systematic literature review. *Administrative Sciences*, 15(2), 66.

Masa'deh, R. E., Shannak, R., Maqableh, M., and Tarhini, A. (2017). The impact of knowledge management on job performance in higher education: The case of the University of Jordan. *Journal of Enterprise Information Management*, 30(2), 244–262.

Miller, D. (1983). The correlates of entrepreneurship in three types of firms. *Management Science*, 29(7), 770–791.

Ministry of Science and Higher Education of the Republic of Kazakhstan (2025). AI-Sana: AI Innovation Acceleration Programme. Available at: https://aisana.gov.kz (Accessed: 15 June 2026).

Pimentel, M., and Palomino, J. C. V. (2025, September). Charting the Future of Entrepreneurial Orientation: A Systematic Review and Science Mapping of Generative AI's Emerging Impact. In European Conference on Innovation and Entrepreneurship (pp. 921-924). Academic Conferences International Limited.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., and Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. Journal of Applied Psychology, 88(5), 879–903.

Riaz, M., Jie, W., Ali, Z., Sherani, M., and Yutong, L. (2025). Do knowledge-oriented leadership and knowledge management capabilities help firms to stimulate ambidextrous innovation? The moderating role of technological turbulence. *European Journal of Innovation Management*, 28(2), 235–270.

Ringle, C. M., Sarstedt, M., Mitchell, R., and Gudergan, S. P. (2020). Partial least squares structural equation modeling in HRM research. The International Journal of Human Resource Management, 31(12), 1617–1643.

Sarstedt, M., Hair, J. F., Jr., Cheah, J.-H., Becker, J.-M., and Ringle, C. M. (2019). How to specify, estimate, and validate higher-order constructs in PLS-SEM. *Australasian Marketing Journal*, 27(3), 197–211.

Shahzad, M. U., Davis, K., and Ahmad, M. S. (2021). Knowledge-oriented leadership and open innovation: The mediating role of knowledge process and infrastructure capability. *International Journal of Innovation Management*, 25(3), 2150028.

Shamim, S., Cang, S., and Yu, H. (2019). Impact of knowledge oriented leadership on knowledge management behaviour through employee work attitudes. *The International Journal of Human Resource Management*, 30(16), 2387-2417.

Stock, D. M., and Erpf, P. (2023). Systematic literature review on entrepreneurial orientation in nonprofit organizations–Far more than business-like behavior. Journal of Philanthropy and Marketing, 28(4), e1753.

Xie, Y., and Wang, S. (2025). Generative artificial intelligence in entrepreneurship education enhances entrepreneurial intention through self-efficacy and university support. *Scientific Reports*, 15(1), 24079.

Yu, Q., Aslam, S., Murad, M., Jiatong, W., and Syed, N. (2022). The impact of knowledge management process and intellectual capital on entrepreneurial orientation and innovation. *Frontiers in Psychology*, 13, 772668.

Appendix A

Generative AI Use	1. I frequently use Generative AI tools for my academic endeavours. 2. I spend a lot of time working with Generative AI tools. 3. I exert considerable effort toward understanding and using GenAI.
Knowledge Oriented Leadership	Over the last three years: 1. The Institution has been fostering an environment that encourages responsible behavior and teamwork. 2. The Institution has seen academic leadership (managers) take on the role of knowledge leaders, characterized by openness, tolerance of mistakes, and mediation to achieve institutional goals. 3.The Institution has managers who promote learning from experience while tolerating mistakes up to a certain point. 4.The Institution has managers who act as advisers, with controls serving primarily as an assessment of goal achievement. 5.The Institution has encouraged managers to facilitate the acquisition of external knowledge. 6. The Institution has rewarded employees who share and apply their knowledge.
Knowledge Management Capability	The institution…
Knowledge Acquisition	…collects useful knowledge identified from various sources. …provides opportunities to ask for specific knowledge when needed. …shares information about existing knowledge within the organization. …allows colleagues to inquire about skills when they need to learn something.
Knowledge Sharing	…ensures that knowledge is readily accessible to educators who need it. …distributes timely reports with relevant information to educators. …provides libraries, resource centers, and other platforms to display and distribute knowledge. …organizes lectures, conferences, and training sessions to facilitate knowledge sharing.
Knowledge Application	…offers various methods for educators to further develop their knowledge. …has mechanisms to safeguard knowledge both inside and outside the organization. …applies knowledge to meet critical needs and efficiently connects knowledge sources for problem-solving. …utilizes various methods to analyze and evaluate knowledge, generating new insights for future use.
Entrepreneurial Orientation	
Innovativeness	1. Our institution actively supports the development and implementation of new ideas and innovative solutions. 2. Over recent years, our institution has introduced several new programs, initiatives, or organizational practices. 3.Changes implemented in our institution are typically substantial rather than minor or incremental.
Risk-taking	4. The management of our institution is willing to support initiatives that involve uncertainty and potential risk. 5. To achieve institutional development goals, our organization is prepared to pursue bold and unconventional actions. 6. When facing uncertainty, our institution prefers active decision-making rather than a wait-and-see approach.
Proactiveness	7. Our institution tends to initiate changes rather than merely respond to external developments. 8. Our institution is often among the first to implement new initiatives or managerial practices. 9. The management of our institution emphasizes proactive leadership and anticipatory development.

