



Research Paper

Knowledge Management as an Innovation Strategy: Knowledge Management in the Context of Manufacturing and Service Industry**Syed Junaid Abbas^{*1}, Nadira Binte Nazrul^{*2}, and Marzan Kazi Rubye^{*3}**

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Email: jsyed4656@gmail.com**Abstract**

Knowledge management (KM) has become an important strategic tool for innovation, but the way it is applied and its effect is differential between manufacturing and service industries is not well understood. This paper provides an examination of KM as an innovation strategy through the lens of understanding how KM processes – creation, storage, sharing, application and transfer - drive innovation outcomes in manufacturing and service settings. The study draws on the knowledge-based view (KBV) and the SECI model to highlight some of the critical research gaps, such as the lack of comparative cross-industry studies, the underexplored intervening role of innovation between KM and organizational performance, and limited incorporation of digital era enablers like AI and Industry 4.0 technologies. The paper presents a systematic literature review and a comparative analysis which leads to the conclusion that the primary applications of KM are process innovation and operational innovation in manufacturing companies, while customer-centric and service innovation are the main applications of KM in service companies. These investments have become strategic in today's world as the KM software market is expected to grow to USD 74.22 billion by 2034 from USD 20.15 billion in 2024. The results not only advance the theory but also enable better guidance to organizations on how they can use KM as one of the competitive assets in the digital economy.

Keywords: Knowledge Management, Innovation Strategy, Manufacturing Industry, Service Industry, SECI Model, Industry 4.0, Digital Economy

Introduction

With the current global economy of high volatility, uncertainty, complexity and ambiguity, knowledge has become the most important strategic organizational asset that can mean competitive advantage [1]. Therefore, knowledge management (KM), or the systematic knowledge management process, consisting of the creation, capture, storage, sharing, and utilization of organizational knowledge, has become an important leverage point for innovation in various industries [2]. In the manufacturing sector, KM is used to tackle issues like tacit knowledge loss when employees retire, optimizing production processes, and integrating Industry 4.0 technology [3]. In service industry, where services generation is a knowledge process, KM can be used to improve service quality, shorten the service response time and promote service innovation [4]. In spite of this increasing awareness, there are still unknowns about how KM is an innovation strategy differently in manufacturing and service environments. The connection between KM and innovation is far from straightforward and is not applicable everywhere. Previously, it was found that organizational culture, leadership, technological infrastructure and industry specific features mediate the relationship between KM and innovation outcomes [5] [6]. Most of the studies however have focused on the KM-innovation linkages within the context of an individual industry, and have neglected comparative dynamics between industry environments that include different fundamental operational contexts [7]. While manufacturing companies work on tangible production processes, technical documentation and equipment-specific skills, service companies are dependent on knowledge integrated in human interactions, customer relationships, and relational skills [8]. Moreover, the concept of the digital economy, which includes artificial intelligence, cloud computing, and internet of things (IoT), has changed the face of KM [9]. The global KM software market is projected to grow at a CAGR of 13.6% and reach USD 74.22 billion by 2034 [10] and the global AI-driven KM market is expected to grow from USD 3.0 billion to USD 102.1 billion by 2034 [11].

Research Questions and Hypotheses

While there have been extensive studies on KM and innovation, four unmet key gaps need to be filled. First, the comparative analysis gap, as many studies have examined the relationship between KM and innovation at the sector level, few studies have systematically examined the comparative relationships between manufacturing and service industries [7, 12]. There are knowledge paradigms of manufacturing and service which differ markedly: manufacturing is more knowledge about codified knowledge that is explicit and understandable in terms of manufacturing processes, while services are more knowledge about experiential knowledge which is tacit and understood through customers' experience [8], [13]. Second, the gap regarding the mediating mechanism: the specific processes by which KM processes contribute to innovation and how innovation relates to the KM-performance relationship is not well understood across industry contexts [14], [15]. Research based on PLS-SEM identified that the link between KM and performance is partially mediated by innovation and was only examined in a single national context [14]. Third, the gap of integration of digital transformation in KM: the majority of current KM-innovation models date back to before the mainstream use of AI and Industry 4.0 and do not consider their transformative impact on KM processes [3], [9]. Fourth, the contextual boundary condition gap: the organizational culture, leadership, and institutional environments have different influences on the KM-innovation relationship between different industries, but the relationship between these two is still not well understood [16, 17]. In line with the gaps found, the research questions for this study are:

What are the differences between KM processes in relation to innovation outcomes between manufacturing and service industries?

How does the relationship between KM and organizational performance appear to be mediated by innovation in both industry settings?

What is the impact of Industry 4.0 technologies and AI on KM processes and innovation strategies for manufacturing versus service industries?

What are the key organizational and cultural factors and constraints that impact KM-related innovation in these settings?

To systematically compare the role of KM processes on innovation results in manufacturing and service sectors and find patterns in each sector.

To analyze how innovation is a mediator between KM and performance in both industry environments.

To explore the effects of Industry 4.0 and AI technologies on KM processes and innovation strategies, and to create an integrated framework that integrates digital era enablers.

To discover the important organizational and cultural factors that enhance or hinder the effectiveness of KM-driven innovation by sector.

To build a holistic conceptual model of KM processes, KM outcomes, digital enabling factors and contextual factors.

This study has theoretical, methodological and practical implications. In theory, it extends the knowledge-based view (KBV) which is limited to an industry perspective [19], [20]. The study is interesting because it contrasts KM-innovation relationships between manufacturing and service organizations, which helps provide a more fine-grained understanding of how the various types of knowledge contribute to innovation in different operational contexts. Methodologically, the integrated framework proposed here allows cross-industry analyses and includes key variables related to digital transformation to overcome the temporal gap in current models [3, 9]. The study provides managers with practical recommendations. Less than 1% of organizational data is effectively analyzed and less than 1% of Fortune 500 companies are losing USD 31.5 billion per year because of failure in knowledge sharing [21]. The small increase in data accessibility generates a significant gain in terms of net income for Fortune 1000 companies: it's more than USD 65 million [21]. Manufacturing has a serious problem of about 40% of their employees will be eligible for retirement which will lead to untapped knowledge loss [22]. Through the identification of sector specific KM strategies, enablers and barriers, this study serves as a roadmap for organisations that wish to use KM as a conscious innovation strategy. This AI-powered, 42% CAGR projected market for KM [11] only further highlights the importance of comprehending the implications of these technologies on KM-innovation dynamics across sectors.

Literature Review

Knowledge Management: Theoretical Foundations

Knowledge management is based on several theories; the most important are the knowledge-based view (KBV) and Nonaka's SECI model. The KBV suggests that knowledge is the most strategically important asset of the firm and the capacity to integrate, generate and apply knowledge is the key source of competitive advantage in the long term [19] and [20]. In contrast to physical resources which decline with use, knowledge is a resource that can grow with sharing and use [23]. In order to understand knowledge creation as a dynamic interaction between tacit and explicit knowledge, Nonaka and Takeuchi's SECI model, which consists of socialization, externalization, combination and internalization, is introduced [24]. Tacit knowledge is transferred through sharing experiences (socialization); tacit knowledge is translated into explicit knowledge (externalization); explicit knowledge is combined into new systematic knowledge (socialization); and explicit knowledge is internalized to tacit knowledge (internalization) using practice as a means [25]. The model has been tested across the different sectors and was found to be predictive of organizational performance and innovativeness (empirically validated) [26]. But critics say that only two of the four modes of conversion are supported empirically strongly [27] and that the model needs to be rethought with the help of generative AI [28]. These frameworks are complemented by the dynamic capabilities view which focus on how organizations can sense, seize, and transform knowledge resources [29].

KM in the Manufacturing Industry

Production processes, technical knowledge and digital automation are the key factors of the sector that define the challenges for manufacturing KM. Significant amounts of explicit knowledge (specifications, SOPs, quality data, etc.) are produced by manufacturing companies, but critical knowledge is often tacit encoded in the skills and judgment of the experienced operators and engineers [3] [22]. The 'retirement cliff' is a huge challenge: around 10,000 baby boomers are retiring every day and almost 40% of those in manufacturing will be eligible to retire over the next ten years [22]. With Industry 4.0, new opportunities have presented themselves: Cyber-physical systems, IoT sensors and digital twins will make it possible to generate knowledge in real time, and generative AI will provide new possibilities for acquiring tacit knowledge and for connecting departments. Toyota's on-going practices of knowledge sharing involve explicit documentation as well as tacit knowledge transfer through mentoring, which is the hallmark of successful manufacturing KM [30].

KM in the Service Industry

The nature of the service industry differs from the manufacturing industry in that it is intangible, heterogeneous, inseparability, and perishability [4, 33] which determines the paradigm of service industry KM. Knowledge is mostly tacit and relational and is deeply embedded in customer interaction and professional expertise. Service KM puts an emphasis on sharing and applying rather than storing, since value is created in the knowledge application which is directed to customers [12]. Technology enablers include CRM systems, knowledge portals, and AI chatbots. In Saudi Arabia, a research study of service organizations revealed that KM processes, and in particular knowledge sharing, had significant and positive impacts on organizational performance [12]. Unique barriers are turnover, knowledge hoarding and issues in capturing knowledge from fluid interactions in service [34].

Method and Material

The paper presents a systematic literature review and a comparative analysis which leads to the conclusion that the primary applications of KM are process innovation and operational innovation in manufacturing companies, while customer-centric and service innovation are the main applications of KM in service companies.

Results and Discussion

Table I: Comparative KM Characteristics — Manufacturing vs. Service Industry

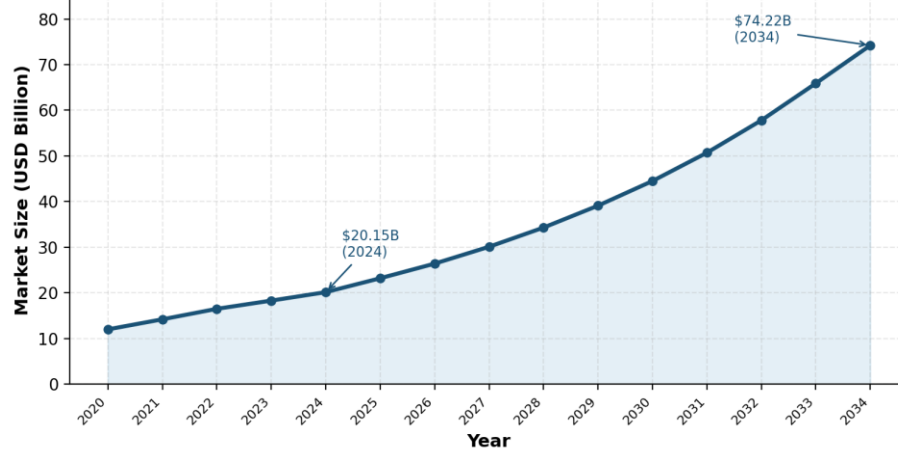
KM Dimension	Manufacturing	Service
Primary Knowledge	Explicit (technical)	Tacit (relational)
Knowledge Creation	R&D, process engineering	Customer interaction
Knowledge Storage	Databases, SOPs, CAD	CRM, case repositories
Knowledge Sharing	Cross-departmental	Cross-functional, customer-facing
Key Technology	MES, ERP, Digital Twins	CRM, AI chatbots, portals
Dominant Innovation	Process & product	Service & business model
Critical Barrier	Tacit knowledge loss	Knowledge hoarding, turnover
Industry 4.0	CPS, IoT, robotics, AI	Cloud, AI, big data analytics

KM an Innovation Strategy

A paradigm shift from a supportive function to a proactive innovation driver has occurred when considering KM as an innovation strategy. The ability of the organization to create, combine and use knowledge new ways is a key component of its innovation capacity [14, 37]. There is empirical evidence throughout that companies with well-developed KM practice have more innovation [5]. KM can be the driver of innovation, in several ways: creating new ideas, sharing to promote cross-pollination, storing to avoid reinvention, and applying to produce new results [2]. Finally, the relationship between KM and performance was found to be mediated by

innovation through a PLS-SEM study which revealed that innovation lies between the two variables [14]. The combination of open innovation with KM further magnifies knowledge flows that transcend the boundaries of the organization and thus the innovation potential [38].

Fig. 1: Global Knowledge Management Software Market Growth (2020-2034)



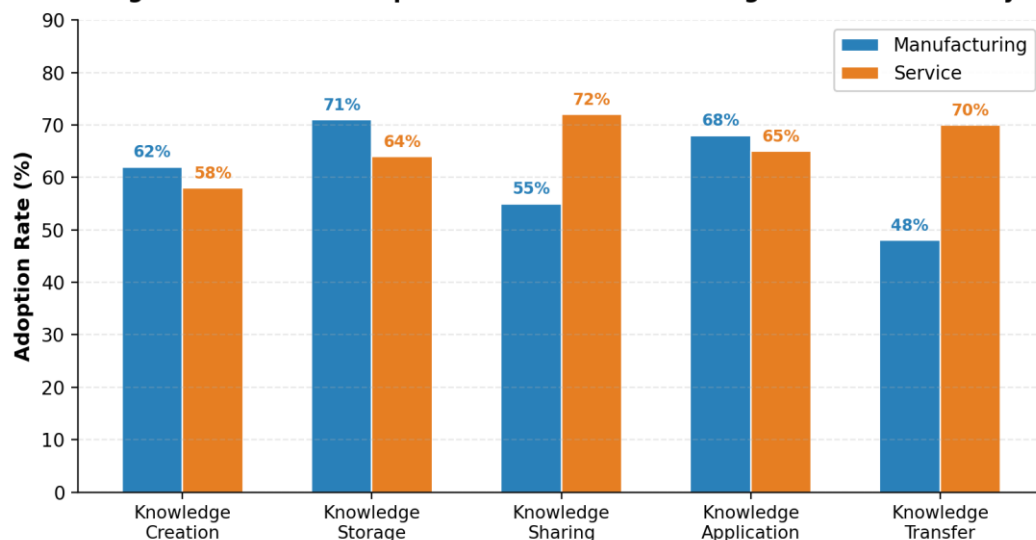
Compiled from Compiled from Grand View Research [10] and Fortune Business Insights [39]

Comparative Analysis: Manufacturing vs. Service Industry

Adopting and maturing processes

There are differences between the KM adoption patterns of manufacturing and service industries. For manufacturing, the highest adoption rate is knowledge storage (~71%) because of the compliance requirements and quality management systems [3] [35]. Knowledge application is followed by (~68%) with the support of Lean and Six Sigma methodology [30]. But the knowledge transfer is around 48%, which shows the importance of the tacit knowledge loss challenge [22]. The collaborative nature of services, as reflected in the collaborative aspects of services, is reflected in the measurement of the extent of sharing of knowledge (~72%) compared with the creation of knowledge (~58%) [12] in services.

Fig. 2: KM Process Adoption Rates — Manufacturing vs. Service Industry

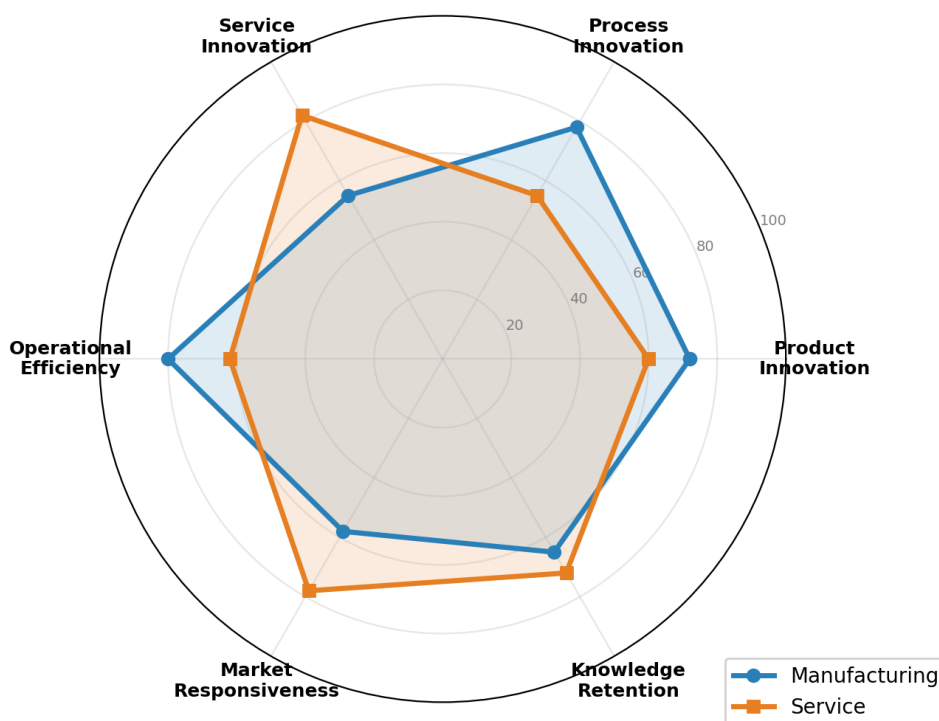


Source: Synthesized from [3], [5], [12], [35], [37]

Innovation Outcomes and KM Pathways

There are significant variations in innovation outcomes across sectors. Process innovation (impact index: 78) and operational efficiency (80) are the key activities in which manufacturing companies use KM, in line with the focus on production optimization [3] [32]. Product innovation (72) is also very pronounced by means of R&D intensive KM (Research and Development) processes [7]. Service firms demonstrate the highest effects in service innovation (82) and market responsiveness (78), which are both indicators of the customers' orientation. But KM is not used sufficiently in manufacturing for service innovation (55), and services do not invest enough in process innovation (55) and operational efficiency (62). These patterns illustrate that there are important cross-sector learning opportunities.

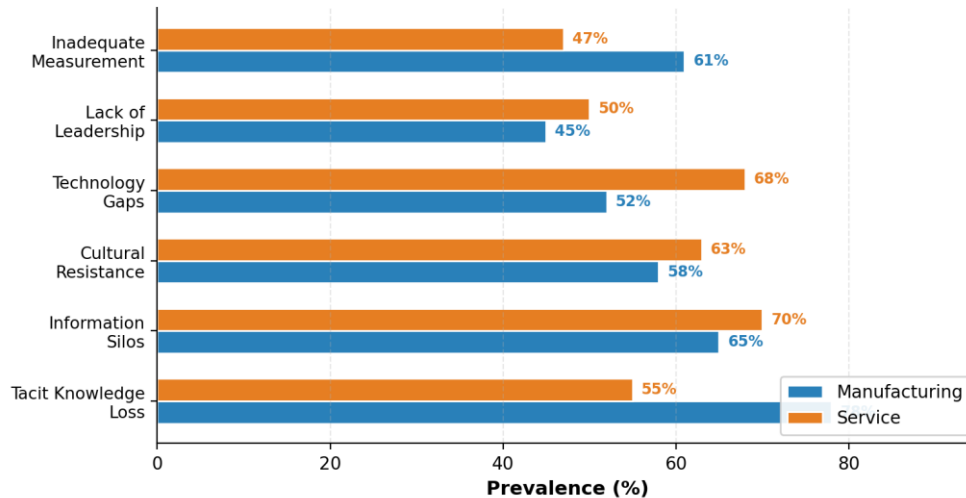
Fig. 5: Innovation Performance Impact of KM — Manufacturing vs. Service



Source: Synthesized from [3], [5], [12], [35], [37]

Barriers to KM-Driven Innovation

There are significant inter-sector differences in barriers. For manufacturing, the top barrier is tacit knowledge loss (78%), which is directly linked to the retirement cliff [22]. Information silos (65%) represent departmental fragmentation [3] and poorly designed measurement systems (61%) make ROI quantification difficult [35]. In services, functional specialization [34] is the driving force behind information silos (70%). Cultural resistance (63%) is attributed to the competitive aspects of how individual expertise is seen as personal gain [16]. It is interesting to note that in services, technology gaps (68%) are much higher, indicating a lack of integrated KM technologies when it comes to capturing knowledge for the customer.

Fig. 3: Key Barriers to KM Implementation — Manufacturing vs. Service Industry

Source: Synthesized from [3], [12], [16], [22], [34], [35]

Conceptual Framework

Based on the theoretical frameworks and the comparative analysis, this research develops a holistic conceptual model of KM processes, innovation outcomes, digital enablers and contextual moderators (Fig. 4). The framework places KM at the center, with four fundamental processes, namely creation, storage, sharing and application, leading to four innovation outcome categories, namely product innovation, process innovation, service innovation, and business model innovation. Different KM processes have varying degrees of importance and effectiveness, depending on the industry context (manufacturing vs. service). The relationship between KM and innovation can vary in strength and direction due to the role of organizational enablers (IT infrastructure, organizational culture, and leadership and AI/digital technologies). What this finally translates to is the organizational performance and competitive advantage, while the mediating mechanism in this instance is innovation.

An important one is its explicit inclusion of enablers from the digital era as moderators. In the field of knowledge creation and sharing, Generative AI transforms the process by making it easier to retrieve information from natural language and automatically extract knowledge [3]. The world of Internet of Things and cyber-physical systems generates new sources of real-time operational knowledge [31]. The framework thereby offers a modern perspective which includes both traditional and digital processes of knowledge.

Fig. 4: Conceptual Framework — Knowledge Management as an Innovation Strategy

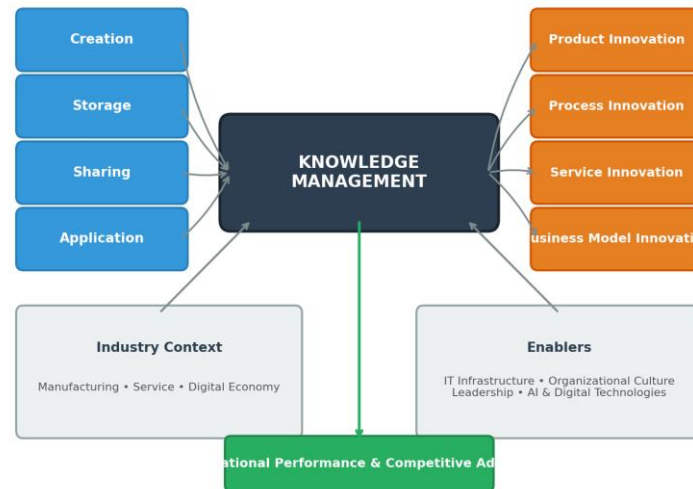


Fig. 4: Conceptual Framework — Knowledge Management as an Innovation Strategy

The components of the Proposed Conceptual Framework are presented in Table II.

Component	Elements	Industry Relevance
KM Processes	Creation, Storage, Sharing, Application	Mfg: Storage dominant; Svc: Sharing dominant
Innovation Outcomes	Product, Process, Service, Business Model	Mfg: Process/Product; Svc: Service/Market
Industry Context	Manufacturing, Service, Digital Economy	Shapes knowledge ontology and KM priorities
Digital Enablers	AI, IoT, Cloud, Big Data, GenAI	Mfg: CPS, robotics; Svc: AI chatbots, analytics
Organizational Enablers	Culture, Leadership, IT Infrastructure	Trust and communication critical in both
Performance Outcome	Competitive Advantage, Financial Performance	Innovation mediates KM-performance link

Discussion

The results show that KM could be an innovation approach via industry-specific routes. For manufacturing, the prevalent stream is that of knowledge storage and application leading to process innovation, operational efficiency and competitive advantage. This falls in line with the sector's focus on production optimization and continuous improvement [3], [30]. This finding of a lower knowledge sharing contribution in manufacturing indicates an opportunity: There is potential for cross-functional sharing mechanisms to drive more innovation potential in product and market. The pathway is service innovation, knowledge sharing and transfer to market responsiveness, with the latter pathway being dominant in services. The smaller role of knowledge creation indicates that service companies might prefer to use unstructured creation processes, with an emphasis on interaction, over structured ones [4]. Innovation productivity can be improved by formalizing knowledge creation, such as customer insight analysis and service design methodology. In terms of mediation (RQ2),

innovation seems to better mediate the link between KM and performance in manufacturing, in which KM links to process and product innovation [14]. Mediation is more distributed along many innovation pathways at the same time in services, which may be why some service firms don't experience as strong direct KM returns. The digital technologies remold KM in various ways across different sectors (RQ3). In the manufacturing industry, IoT and cyber-physical systems present data-driven knowledge ecosystems where knowledge is generated as they operate [3] [31]. In services, AI-powered systems can facilitate knowledge sharing and application, such as with natural language processing (NLP) and intelligent recommendations [33]. The AI-driven KM market is expected to grow at a CAGR of 42% [11] indicating a high rate of adoption, but applications vary: predictive maintenance knowledge in manufacturing and process optimization in services rely on AI-based KM, whereas customer knowledge management and personalization of services in services are driven by AI. In terms of enablers and barriers (RQ4), it is found that organizational culture (including norms and trust) is a universal enabler [16] [17]. Manufacturing, however, needs to deal with hierarchical communication and departmental silos, and services have to deal with competitive individualism and knowledge hoarding [18], [34]. The most important barriers by sector were tacit knowledge loss in manufacturing and technology gaps in services, suggesting various strategic priorities: Knowledge capture/transfer programs in manufacturing and integrated KM technology platform in services.

Counterarguments and Limitations

There are a few caveats. The first is the binary approach of dividing industries into manufacturing and service, which is an oversimplification of the present situation. However, servitisation (service introduction to manufacturing) and the manufacturing-like standardization of some service processes fuzz this distinction [40] and the binary classification may not fully describe the KM-innovation dynamics of the hybrid organisations. Second, it is a methodological limitation to solely use synthesized secondary data instead of empirical primary data. Adoption rates, prevalence of barriers, and impact on innovation are drawn from a range of sources having differing methodology, sample sizes and geographic context, which impacts on comparability. Third, SECI model is one of the theoretical foundations which is limited in support of empirical evidence and oversimplification in the knowledge conversion process [27]. There are other models which may provide complementary insights not covered here. Fourth, existing research is mainly from the Eastern Asian and European context, so it has limited generalizability. Lastly, the KM-innovation landscape is continually changing, with speed of change exceeding the ability of the literature to capture it, and longitudinal studies are needed to capture how dynamics evolve over time.

Conclusion

This study has analyzed the knowledge management as an innovation strategy in manufacturing as well as service sectors while highlighting the critical gaps, research questions and a comprehensive conceptual framework of KM as an innovation strategy. The analysis shows that the KM-innovation pathway fundamentally depends on the context of the industry: Manufacturing: KM-innovation pathway for process and product innovation is related to the knowledge storage and application; Services: KM-innovation pathway for service and market innovation is related to the knowledge sharing and transfer. The proposed framework is contributing by introducing a cross-industry model that links together KM processes, innovation outcomes, digital enablers and contextual moderators. It may be argued that it is the incorporation of AI and Industry 4.0 technologies that are presented as moderating enablers that can fill the temporal void in the current models. Manufacturing companies should focus on knowledge transfer and cross-functional sharing, alongside storage and application capabilities, for practitioners; the retirement cliff calls for knowledge tacit knowledge capture [22]. It is important to formalize the creation of knowledge processes and to invest in integrated KM technology platforms in service firms [33]. Both industries can gain from strategic AI integration, with a

different focus for each sector: Predictive maintenance and process optimization in manufacturing and Customer knowledge management and personalization in services.

Future studies might focus on collecting primary data and verifying the findings of these studies through cross-industry comparative studies. Longitudinal designs are required to document changing KM-innovation processes. A binary classification would be covered by studies of hybrid organizations (servitized manufacturers, industrialized service providers). Global applicability of the framework would be improved if it were studied in developing economies and a variety of cultural contexts.

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