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Knowledge management in the digital age: A systematic review of fourth industrial revolution technologies and sustainable transformation

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Background: Sustainable digital transformation requires more than technological adoption; it depends on strategic knowledge management (KM). Fourth Industrial Revolution (4IR) technologies such as artificial intelligence (AI), the Internet of Things (IoT), blockchain and big data have reshaped organisational knowledge creation, sharing and application. However, the mediating role of KM between digital capability and sustainability outcomes remains insufficiently integrated in the literature.

Objectives: This review examines how KM supports sustainable digital transformation, how 4IR technologies influence KM processes, and which barriers and enablers shape knowledge-sharing ecosystems. It also develops a conceptual framework grounded in the knowledge-based view and dynamic capabilities theories to explain how KM converts digital capability into sustainable organisational performance.

Method: A systematic literature review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. Peer-reviewed publications from 2015 to 2024 were retrieved from IEEE Xplore, Scopus, SpringerLink, Web of Science and the ACM Digital Library. Selected studies were screened and thematically analysed.

Results: Five themes emerged: KM and Industry 4.0, Digital Transformation and KM, Strategic KM Frameworks, Challenges in KM Implementation, and General KM Insights. The findings of this study indicate that KM enhances innovation, organisational agility and sustainability when aligned with 4IR technologies. Cultural, infrastructural and knowledge-security barriers remain significant constraints.

Conclusion: Knowledge management is central to sustainable digital transformation. Organisations must adopt adaptive and technology-aligned KM strategies to achieve long-term value.

Contribution: The study synthesises dominant research themes and proposes an integrative framework positioning KM as the mediating mechanism through which 4IR technologies generate sustainable organisational outcomes.

Keywords: knowledge management; digital transformation; Fourth Industrial Revolution; AI; big data; sustainability; systematic literature review.

Introduction

The rapid evolution of fourth industrial revolution (4IR) technologies, such as artificial intelligence (AI), blockchain, the internet of things (IoT) and big data, has fundamentally reshaped how organisations generate, store and disseminate knowledge. As businesses, governments and institutions increasingly integrate these technologies, the role of knowledge management (KM) has become critical in ensuring that digital transformation is efficient, scalable and sustainable (Padeli et al. 2024). Effective KM strategies enable organisations to leverage data-driven insights, facilitate innovation and enhance decision-making processes, ultimately driving long-term success in an increasingly competitive and digitised environment (Ribeiro et al. 2022).

Despite the recognised significance of KM in digital transformation, the adoption of KM remains fragmented, with organisations facing numerous barriers, including technological complexities,

organisational resistance and the lack of well-defined KM frameworks (Savickas & Užienė 2024). Moreover, while KM and digital transformation have been extensively studied as separate domains, there is limited research examining the intersection of KM and digital transformation, particularly regarding their impact on sustainability and the development of intelligent, knowledge-sharing ecosystems (Radavičius & Tvaronavičienė 2022). As organisations transition towards smart, data-driven environments, understanding the role of KM in fostering sustainability, ethical AI governance and collaborative knowledge networks is crucial for long-term digital resilience. Despite this progress, much of the existing literature treats KM and 4IR technologies as parallel streams rather than interdependent systems. There is limited theorisation of how KM mediates the technological, organisational and sustainability dimensions of digital transformation. This gap underpins the present review, which adopts a systematic approach to integrating these dimensions into a unified analytical framework.

Addressing this intersection is timely, given the global interest in knowledge-driven sustainability. By synthesising evidence across sectors, the review seeks not only to describe existing approaches but also to theorise how KM mediates technology–sustainability linkages, providing a coherent foundation for future empirical validation.

This systematic literature review (SLR) seeks to bridge these gaps by analysing:

- The way KM principles support sustainable digital transformation.
- The impact of 4IR technologies on KM frameworks.
- The key barriers and enablers influencing sustainable knowledge-sharing ecosystems.

By synthesising findings from peer-reviewed literature, this review provides thematic insights, identifies research gaps and highlights emerging trends in KM and digital transformation. The study is structured to explore the prevalence of research themes, citation distribution, academic discipline representation and keyword frequency trends, offering a comprehensive analysis of KM's evolving role in the digital age. The findings of this review will contribute to both academic discourse and practical KM implementation, guiding researchers, policymakers and industry practitioners in developing adaptive, knowledge-driven strategies for sustainable digital transformation.

In addition to identifying key thematic trends, this study proposes a unifying conceptual model that integrates KM, 4IR technologies and sustainability. The framework underscores that sustainable digital transformation emerges when KM processes mediate the relationship between technological capability and long-term organisational learning. This theoretical integration addresses the previous limitations in fragmented KM–4IR research and situates sustainability as both an outcome and a guiding principle for future research.

Background

In the era of digital transformation, organisations are increasingly leveraging KM frameworks to facilitate innovation, decision-making and operational efficiency. The emergence of 4IR technologies, such as AI, blockchain, the IoT and big data, has revolutionised how knowledge is created, stored, shared and utilised within enterprises and society (Padeli et al. 2024). As businesses and institutions transition towards smart, data-driven ecosystems, the ability to effectively manage and sustain knowledge flows has become a key determinant of long-term success.

However, despite KM's recognised importance, the integration of KM with digital transformation efforts remains fragmented, with organisations facing numerous challenges in adoption, sustainability and scalability (Ribeiro et al. 2022). Many enterprises struggle to align KM practices with rapidly evolving technologies, leading to barriers in knowledge-sharing ecosystems, resistance to change and underutilisation of AI-enhanced KM tools (Savickas & Užienė 2024). Moreover, while KM and digital transformation have been extensively studied as separate disciplines, there is limited research examining their intersections and synergies – particularly regarding their role in promoting sustainability, ethical AI and circular knowledge economies (Radavičius & Tvaronavičienė 2022).

This SLR seeks to address these gaps by analysing how KM principles contribute to sustainable digital transformation, the impact of 4IR technologies on KM frameworks and the key barriers and enablers influencing knowledge-sharing ecosystems. By synthesising existing research, this review aims to identify trends, highlight challenges and propose future research directions that will enable organisations to develop adaptive, intelligent and sustainable KM strategies.

This study is structured to explore the thematic prevalence, citation distribution, academic discipline representation and keyword frequency trends within KM literature, providing a holistic perspective on KM's evolving role in the digital age. The insights derived from this review will contribute to both theoretical and practical advancements, offering recommendations for KM scholars, practitioners and policymakers in navigating the complexities of KM in the 4IR landscape.

Research problem

The rapid evolution of 4IR technologies, such as AI, blockchain, the IoT and big data, has transformed how organisations manage, share and utilise knowledge (Padeli et al. 2024). In this era of digital transformation, KM plays a pivotal role in ensuring that organisations can effectively integrate these technologies to enhance decision-making, innovation and operational efficiency (Ribeiro et al. 2022). However, despite the growing recognition of KM as a critical enabler of digital transformation, there remains a lack of structured and sustainable KM frameworks that can

seamlessly integrate with emerging technologies while addressing the challenges of implementation (Savickas & Užienė 2024).

Existing research highlights that organisations struggle to adopt KM strategies that align with sustainability goals and long-term digital transformation initiatives (Tzavaras & Karamanoli 2023). Many companies face significant barriers, including technological complexities, organisational resistance, data security concerns and inadequate leadership support for knowledge-sharing ecosystems (Nashikha et al. 2024). Moreover, while KM and digital transformation are often studied independently, limited research explores their synergistic relationship in driving sustainable and intelligent knowledge-sharing environments (Obembe & Obembe 2021).

Furthermore, the integration of 4IR technologies into KM remains fragmented, as organisations often implement AI-driven KM systems without fully considering the ethical implications, human–machine collaboration dynamics and knowledge equity issues (Ansari 2019). The lack of comprehensive frameworks that address both technological and human-centric KM perspectives raises concerns about sustainability, adaptability and knowledge retention in digital enterprises (Shenkoya & Kim 2023).

Given these challenges, there is a critical need for a systematic examination of how KM principles support sustainable digital transformation, how 4IR technologies enhance or disrupt KM practices and what barriers and enablers shape sustainable knowledge-sharing ecosystems. This SLR seeks to address these gaps by synthesising existing research on KM, digital transformation and 4IR technologies, providing strategic insights for organisations navigating the evolving digital landscape.

Research question

- *How do KM principles contribute to the sustainability of digital transformation across different organisational contexts?*
- *What is the impact of 4IR technologies on KM practices in promoting sustainability?*
- *What are the key barriers and enablers affecting the development of sustainable knowledge-sharing ecosystems in digitally transforming organisations?*

Literature review

This study employs an SLR methodology to thoroughly examine how KM facilitates sustainable digital transformation, specifically focusing on the integration of 4IR technologies, associated barriers and the development of robust knowledge-sharing ecosystems. An SLR approach was selected for its capability to systematically, transparently and reproducibly identify, evaluate and synthesise existing literature, ensuring the reliability and validity of the resultant insights.

The methodological framework aligns with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines proposed by Moher et al. (2009). The review followed PRISMA's structured approach with the comprehensive identification of relevant scholarly articles through targeted searches in high-quality databases, such as IEEE Xplore, Scopus, SpringerLink, Web of Science and ACM Digital Library, ensuring interdisciplinary and domain-specific coverage. A precise search string integrating key terms was developed to accurately capture pertinent literature: ('Knowledge Management' OR 'Knowledge Sharing') AND ('Sustainability' OR 'Sustainable Digital Transformation') AND ('Artificial Intelligence' OR 'Blockchain' OR 'IoT' OR 'Big Data'). Searches were refined by applying stringent criteria, restricting the review to publications between 2015 and 2024, peer-reviewed journal articles and conference proceedings and English-language sources, to maintain scholarly rigour.

Following identification, the articles underwent meticulous screening to eliminate duplicates and irrelevant studies. Subsequent eligibility evaluations involved in-depth full-text analysis against explicitly defined inclusion and exclusion criteria. Articles selected for inclusion explicitly discussed KM within the context of digital transformation, addressed the role and impact of specific 4IR technologies and analysed key barriers and enablers of sustainable KM ecosystems. Conversely, studies lacking direct relevance to KM, digital transformation or sustainability, as well as non-peer-reviewed sources or inaccessible full texts, were systematically excluded. To ensure theoretical coherence, the synthesis explicitly aligned the findings with the knowledge-based view and dynamic capabilities theory, providing the conceptual grounding for the integrative framework presented in Figure 4.

Coding reliability was established through repeated cross-checks of thematic classifications and iterative comparison of extracted data to enhance analytical transparency. This ensured consistent categorisation of studies according to the five dominant themes and alignment with the conceptual dimensions of KM, 4IR technologies and sustainability. The final sample comprised 25 articles meeting all inclusion criteria, ensuring representativeness across the business, public sector and educational contexts.

The data extraction phase was comprehensive, capturing detailed information such as author(s), year of publication, research objectives, methodological approaches and significant findings related to KM, sustainability and 4IR technology implementation. Critical challenges and strategic recommendations identified in each article were also carefully documented. This structured extraction facilitated the subsequent thematic synthesis, yielding five key thematic categories: Knowledge Management and Industry 4.0, Digital Transformation and Knowledge Management, Strategic Knowledge Management Frameworks, Challenges in KM Implementation and General Knowledge Management

Insights. Each theme emerged organically from recurrent patterns within the analysed literature, reflecting diverse scholarly perspectives and offering comprehensive insights into KM's evolving role.

A rigorous quality assessment was performed by utilising the Critical Appraisal Skills Programme checklist (CASP 2018). This assessment ensured that only studies exhibiting clarity of objectives, methodological rigour, direct relevance to KM and sustainability, and transparent findings were retained. Studies scoring low on these dimensions were excluded to uphold the review's credibility and methodological robustness.

The analytical depth of this SLR was enhanced through the integration of descriptive statistical analyses, qualitative thematic categorisation, network mapping and explicit gap identification. The thematic prevalence analysis underscored a significant interdisciplinary shift within KM research, with information systems dominating but revealing gaps in contributions from computer science and engineering disciplines. Citation distribution analysis identified a skewed impact, with few highly influential foundational studies, indicating opportunities for increasing the visibility and impact of emerging research. Additionally, the keyword frequency analysis highlighted sustainability, ethical AI governance and interdisciplinary integration as critical emergent themes, reinforcing the review's core focus on sustainability-oriented KM practices.

Through gap identification, the review recognised critical areas warranting further exploration, notably the adaptation of KM frameworks to Industry 5.0, the development of ethically guided AI-driven KM systems and enhanced cross-sectoral collaboration.

This methodological approach, underpinned by systematic search strategies, rigorous thematic synthesis, comprehensive quality assessments and multifaceted analytical techniques, presents a robust foundation for understanding KM's role in sustainable digital transformation. This SLR contributes significantly to theoretical developments and practical implementations, guiding future research towards adaptive, interdisciplinary and ethically sound KM strategies suitable for evolving digital ecosystems.

Analysis of academic disciplines represented by articles

The histogram of academic disciplines illustrates the distribution of research articles across various fields of study within the SLR on KM, 4IR technologies and sustainable digital transformation. The findings highlight key trends and gaps in how different academic disciplines contribute to the discourse on KM and digital transformation.

Dominance of interdisciplinary and miscellaneous research

The largest category, labelled 'Other', encompasses studies that fall outside conventional disciplinary boundaries, underscoring the increasingly interdisciplinary nature of KM research in the digital transformation era (Figure 1). This category includes contributions from fields such as education technology, public administration, communication studies, environmental management and development studies, which apply KM principles to diverse societal and organisational contexts. For example, education and learning sciences often explore knowledge-sharing through digital pedagogy and e-learning systems, while public administration examines KM for governance transparency and citizen participation. Similarly, research in environmental management and sustainability studies investigates KM as a mechanism for managing ecological knowledge and supporting green innovation. The prominence of this heterogeneous category suggests that KM scholarship is expanding its epistemic reach, integrating social, environmental and policy-oriented perspectives alongside the traditional technical and business disciplines that have historically dominated the field.

Strong representation from information systems

The second-most represented discipline, Information Systems (IS), reflects the core role of KM in digital transformation. As IS research focuses on technology adoption, IT-enabled knowledge sharing and organisational knowledge systems, many studies are expected to fall under this category. The prominence of IS research aligns with existing literature emphasising knowledge-based digital infrastructures, data-driven decision-making and AI-enhanced KM strategies (Padeli et al. 2024).

Limited contributions from computer science and engineering

Interestingly, computer science and engineering contribute fewer studies compared to those from IS and business and economics. This fact suggests that while technological advancements (AI, blockchain, and IoT) are central to KM, the theoretical and strategic frameworks for implementing

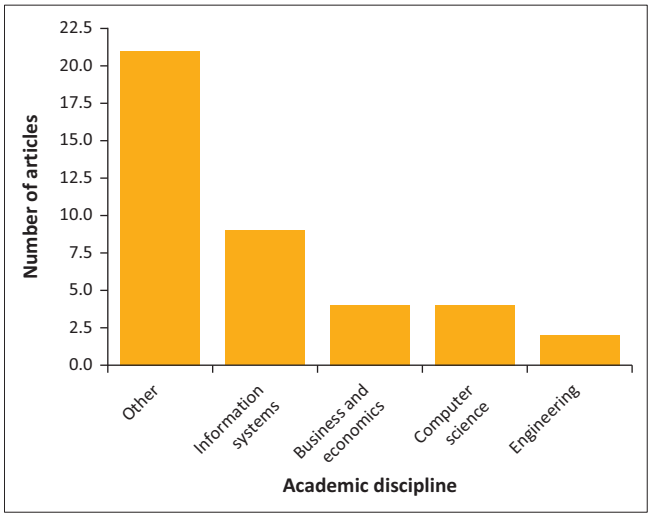


FIGURE 1: Histogram of academic disciplines represented by articles included in the systematic literature review.

KM in digital transformation are more often studied within the IS and business disciplines rather than from purely technical perspectives. The relatively low representation from computer science suggests a gap in research on the direct technological development of KM tools.

Business and economics perspective on knowledge management and digital transformation

The moderate presence of business and economics research in KM studies highlights the importance of KM for organisational competitiveness, innovation and strategic decision-making. Many articles within this category explore themes related to KM's role in digital business models, corporate knowledge ecosystems and economic sustainability. However, the relatively low number of studies in this category suggests that there is still room for further economic and managerial research on KM-driven sustainability frameworks (Savickas & Užienė 2024).

Key takeaways and research gaps

- Interdisciplinary Growth – KM research is becoming increasingly interdisciplinary, spanning fields beyond IS, computer science and business.
- Gap in Computer Science Contributions – There is less focus on AI-driven KM architectures, highlighting the need for more technical innovations in KM systems.
- Limited Business and Economics Focus – Future research could explore how KM contributes to economic sustainability, knowledge-driven business models and corporate decision-making.
- Engineering Under-representation – As KM is crucial for smart factories, Industry 4.0 and digital manufacturing, more studies from engineering disciplines could enrich the understanding of industrial knowledge-sharing systems.

The histogram provides valuable insights into the distribution of KM research across disciplines, emphasising an interdisciplinary approach to sustainable digital transformation. However, there are notable gaps in computer science, engineering and business research, suggesting areas for future exploration and deeper technological integration in KM frameworks.

Analysis of citation distribution

The citation distribution histogram illustrates the impact and academic visibility of the studies included in this SLR on KM, 4IR technologies and sustainable digital transformation. The visualisation in Figure 2 reflects how frequently these works have been cited, signalling their relative influence and diffusion within the research community.

Highly skewed citation distribution

The distribution is markedly skewed, with most articles receiving fewer than 50 citations, while a small number surpass 100. This pattern suggests the presence of a limited

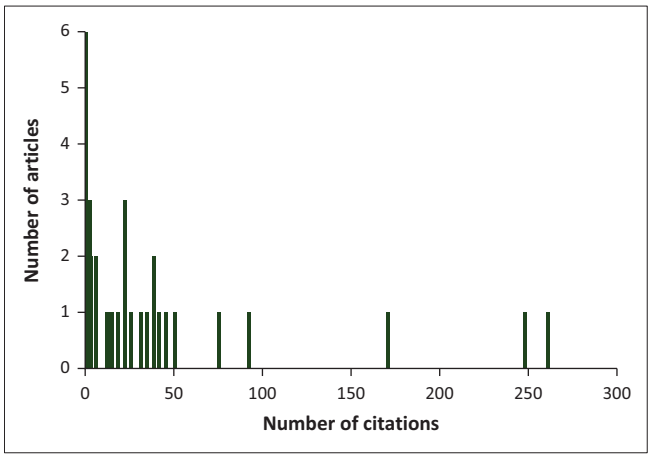


FIGURE 2: Citation distribution histogram of articles included in the systematic literature review.

group of foundational or widely referenced studies that have set the theoretical or methodological direction for subsequent KM–4IR research. In particular, these highly cited papers typically introduce early KM conceptual frameworks that integrate digital technologies into organisational knowledge processes, or they advance maturity models assessing an organisation's readiness for digital transformation. Others establish key theoretical linkages, such as how AI-enabled knowledge systems enhance dynamic capabilities or how big data analytics strengthen knowledge-based competitiveness. Their enduring citation frequency reflects both their originality and their continued relevance in shaping discourse on technology-driven KM ecosystems.

Large number of low-citation papers

In contrast, a considerable number of articles have fewer than 10 citations, with several showing none. This lacuna is partly attributable to the recency of the publication. Many of these works were published between 2021 and 2024 and have not yet accumulated visibility. Others focus on niche applications of KM, such as sector-specific digital innovation or localised sustainability practices, which naturally attract narrower scholarly audiences. Limited access to some conference proceedings and journals may also constrain their citation reach.

Presence of highly cited papers

The small subset of highly cited works (those exceeding 150–250 citations) represents seminal contributions that anchor this research field. These studies commonly feature:

- Integrated KM–Digital Transformation Frameworks, linking knowledge processes with organisational agility, innovation and resilience.
- Theoretical extensions connecting the knowledge-based view (KBV) and dynamic capabilities (DC) to 4IR technologies.
- Empirical validations of how AI, IoT and big data analytics transform KM practices in manufacturing, education and public sector contexts.

By articulating these early models and theoretical bridges, such papers provided the scaffolding for later research exploring sustainability, ethics and cross-sectoral adaptation in digital knowledge ecosystems. Their influence demonstrates how early conceptual clarity can shape and sustain scholarly inquiry over time.

Research impact and visibility

The uneven citation distribution underscores persistent disparities in research impact. A small number of high-impact studies define conceptual frontiers, while numerous emerging papers contribute incrementally to context-specific insights. This pattern mirrors the 'long-tail' phenomenon in academic publishing, in which a few seminal works anchor the field, and newer studies gradually diversify it.

To enhance future visibility and impact, scholars are encouraged to build on these foundational frameworks by extending them to underexplored areas such as AI ethics in KM, sustainability metrics and knowledge-sharing in developing economies. Strengthening interdisciplinary engagement and promoting open-access dissemination could further democratise knowledge and expand the global reach of KM–4IR research.

Analysis of keyword frequency (word cloud) in systematic literature review

The word cloud visualisation in Figure 3 presents a keyword frequency analysis, offering insights into dominant themes, research focus areas and emerging trends within the SLR on KM, 4IR technologies and sustainable digital transformation. Larger and more prominent words indicate higher frequency and relevance across the reviewed studies, while smaller words represent less frequently mentioned but still significant topics.

Dominance of knowledge management as a central theme

The most visually prominent keyword is 'Knowledge Management', reinforcing its foundational role in the review. This finding aligns with the core research question examining how KM facilitates sustainable digital transformation. Sub-themes such as 'Sharing', 'Practice' and 'Model' suggest that research in KM heavily emphasises frameworks, methodologies and knowledge dissemination strategies (Padeli et al. 2024).

The frequent mention of 'Systematic', 'Literature Review' and 'Analysis' further validates the structured approach of this study, indicating a focus on synthesising existing research rather than purely empirical exploration.

Intersection of knowledge management with digital transformation and Industry 4.0

The keywords 'Digital Transformation' and 'Industrial Revolution' appear frequently, demonstrating the growing integration of KM within 4IR advancements. This finding suggests that KM is increasingly being studied in relation to smart technologies, automation and digital ecosystems (Ribeiro et al. 2022).

Additionally, the presence of 'Fourth Industrial' and 'Technologies' indicates a technological perspective on KM implementation, emphasising the importance of AI, IoT, blockchain and big data in knowledge-sharing ecosystems (Savickas & Užienė 2024).

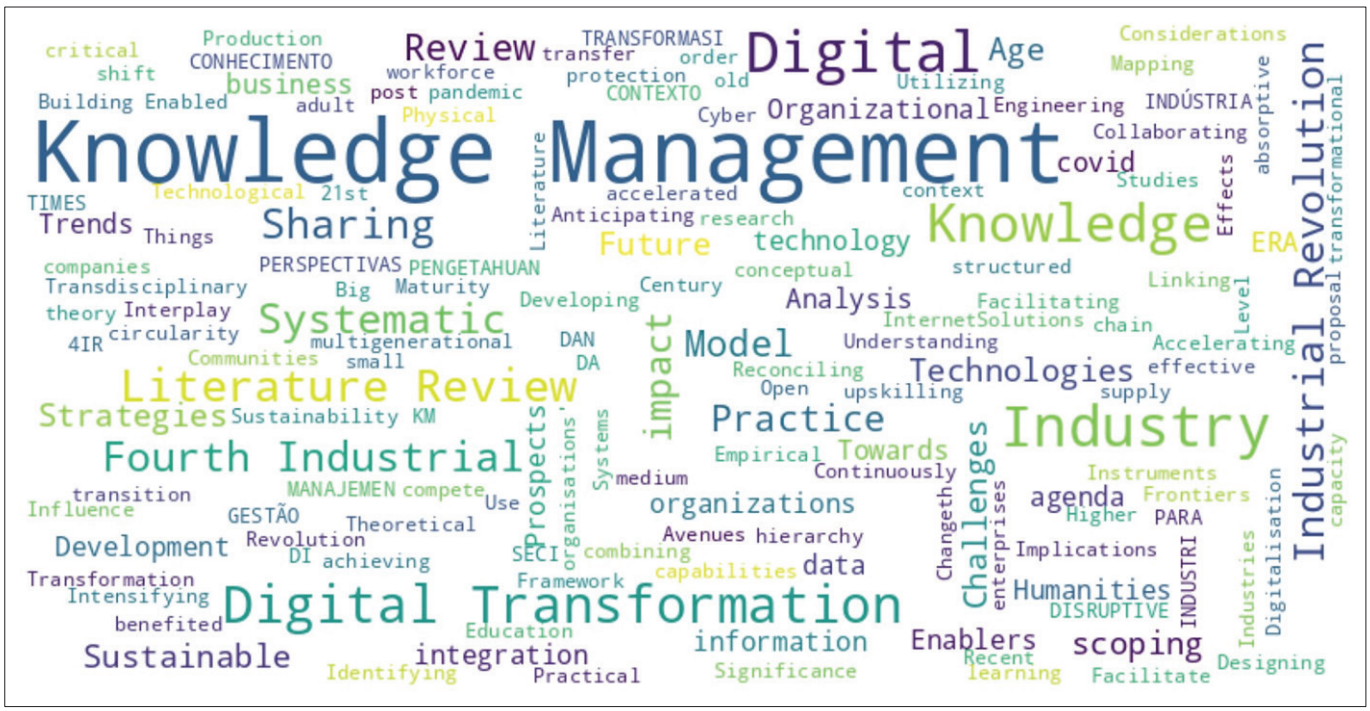


FIGURE 3: Keyword frequency word cloud generated from titles, abstracts and keywords of the reviewed articles.

Emphasis on sustainability and future-oriented research

The recurring mention of 'Sustainable', 'Future' and 'Impact' suggests a strategic shift in KM research towards long-term sustainability and future-proofing digital transformation efforts. This shift aligns with the review's focus on identifying barriers and enablers for sustainable KM ecosystems (Tzavaras & Karamanoli 2023).

The presence of 'Challenges' and 'Enablers' highlights a growing research interest in addressing obstacles in KM adoption, further supporting the review's objective of understanding knowledge-sharing constraints and opportunities.

Multidisciplinary and interdisciplinary dimensions

The inclusion of terms such as 'Education', 'Humanities' and 'Business' suggests that KM is being explored across multiple disciplines, not just within IS or engineering. This observation further validates findings from the histogram of academic disciplines, which indicated a broad interdisciplinary approach to KM and digital transformation.

Additionally, terms like 'Organisations', 'Workforce' and 'Training' suggest a practical research orientation, focusing on how KM strategies are applied in business, education and public sector innovation (Shenkoya & Kim 2023).

The word cloud analysis reinforces key themes identified in the SLR's thematic synthesis, demonstrating that KM research is increasingly interdisciplinary, future-oriented and closely linked with digital transformation. However, challenges in KM adoption, sustainability and cross-sectoral integration remain pressing areas for future research.

Conceptual framework for sustainable knowledge management in the fourth industrial revolution context

To address the identified conceptual gap, this review proposes a unifying framework that integrates KM, 4IR technologies and sustainability outcomes. This conceptualisation is derived from the thematic synthesis of the reviewed literature and serves as a bridge connecting technological capability with sustainable value creation in digitally transforming organisations.

At the foundation, 4IR technologies, including AI, IoT, blockchain, big data and cloud computing, serve as enablers of digital transformation. These technologies expand an organisation's capacity for knowledge creation, real-time analytics and collaborative intelligence, facilitating dynamic decision-making across distributed ecosystems (Padeli et al. 2024; Ribeiro et al. 2022).

At the core, KM operates as a mediating mechanism that transforms these technological inputs into actionable organisational knowledge. KM does so through four interlinked processes:

- Knowledge creation (leveraging AI and data analytics for new insights).
- Knowledge storage and organisation (using cloud and blockchain technologies for secure and traceable repositories).
- Knowledge sharing (through IoT-enabled connectivity and collaborative platforms).
- Knowledge application (embedding learning into innovation, policy and operations).

These processes are grounded in the KBV, which positions knowledge as a strategic resource, and the DC theory, which emphasises the capacity to sense, seize and transform opportunities in rapidly evolving environments (Savickas & Užienė 2024). The integration of KBV and DC theories in this framework underscores that knowledge resources gain strategic value only when continuously renewed through sensing and adaptive learning cycles. This dual-theoretical alignment reflects a socio-technical understanding of digital transformation, in which human cognition and machine intelligence co-evolve within sustainable systems. This interaction emphasises that sustainability is both an outcome and a dynamic capability. Organisations continually recalibrate KM practices through feedback from socio-technical environments, ensuring ethical governance and adaptive learning within digital ecosystems.

At the outcome level, effective KM facilitates sustainable digital transformation, manifested in three interdependent dimensions:

- Economic sustainability, achieved through efficiency, innovation and competitive advantage.
- Social sustainability through equitable access to knowledge, inclusion and ethical AI governance.
- Environmental sustainability, via data-driven monitoring of ecological performance and circular knowledge flows (Radavičius & Tvaronavičienė 2022).

Feedback loops within the framework reflect continuous learning and adaptation. Insights from sustainability outcomes inform KM strategies and technology governance, fostering resilience and ethical alignment in future digital initiatives. The model thus conceptualises KM as the connective tissue that translates 4IR-driven technological potential into sustainable, human-centric transformation. This reflexive component ensures that sustainability outcomes are not static but continually shape KM strategy, technological governance and organisational learning cycles, thereby reinforcing adaptive capability and ethical alignment across digital ecosystems.

Knowledge management in the era of Industry 4.0

The Role of 4IR Technologies in Knowledge Management

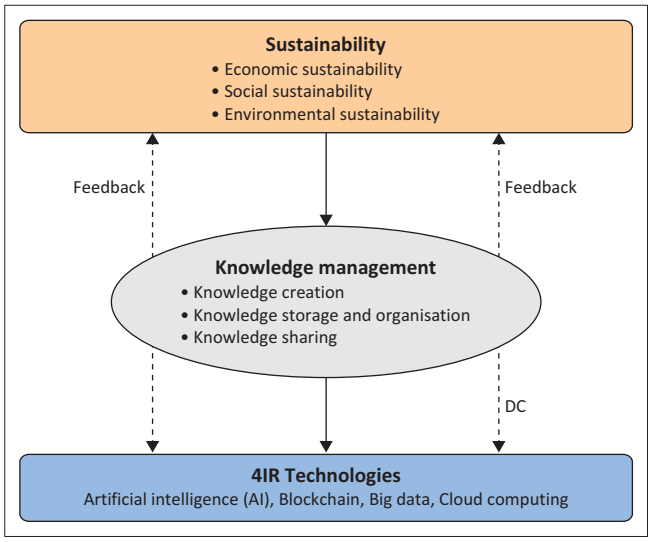
The 4IR has revolutionised the way organisations create, store, share and apply knowledge. Organisations are increasingly leveraging Industry 4.0 technologies such as the IoT, big data, AI and cloud computing to enhance their KM processes (Padeli et al. 2024). The adoption of these technologies facilitates knowledge transfer across different levels of an organisation, thereby reinforcing learning and collaboration (Lista et al. 2021).

Research highlights that integrating Industry 4.0 technologies significantly contributes to organisational learning by automating knowledge-sharing mechanisms and reducing knowledge silos. Companies that successfully implement these technologies experience enhanced decision-making capabilities, as real-time data insights improve knowledge utilisation and dissemination (Ribeiro et al. 2022).

These insights directly align with the proposed conceptual framework (Figure 4), in which 4IR technologies form the foundational enablers that support the KM processes of creation, storage, sharing and application. The framework provides a theoretical lens through which such technological integration can be understood as a pathway to sustainable transformation rather than mere automation.

Strategic approaches to knowledge management in the fourth industrial revolution

Organisations must adopt a strategic and adaptable KM approach to fully benefit from 4IR technologies. Studies suggest that a combination of strong organisational culture, leadership support and technological infrastructure is critical for knowledge sustainability in the digital age (Padeli et al. 2024). A situational approach to strategic KM allows firms to customise their KM practices based on their Industry 4.0 maturity levels (Kolyasnikov & Kelchevskaya 2020).



DC, dynamic capabilities; 4IR, Fourth Industrial Revolution.

FIGURE 4: Conceptual framework linking knowledge management, Fourth industrial revolution technologies and sustainability.

Additionally, KM frameworks tailored to Industry 4.0 should include mechanisms for the continuous reskilling and upskilling of employees. The digital transformation of workplaces requires organisations to address skill gaps by implementing structured knowledge-sharing programmes that facilitate collaborative learning and human–machine interaction (Anshari et al. 2022). Ethical considerations, including job security and employee well-being, must also be incorporated into KM strategies (Mitra Zuana & Sopiah 2022).

Challenges in implementing knowledge management in Industry 4.0

Despite the potential benefits, organisations face several challenges in implementing effective KM strategies in the context of Industry 4.0. Research identifies organisational resistance, cybersecurity risks and limited understanding of knowledge-sharing technologies as key barriers (Machado et al. 2021). The literature also suggests that while digital tools facilitate KM, the human factor remains central, necessitating a balance between technology adoption and behavioural considerations (Sartori et al. 2021).

Another challenge is ensuring environmental and social sustainability while integrating Industry 4.0 technologies into KM frameworks. Studies have found that firms can reduce waste and emissions through better knowledge-tracking mechanisms enabled by IoT and AI (Yaqub & Alsabban 2023). However, the success of these initiatives depends on an organisation's ability to align technological advancements with sustainable business practices.

These findings reaffirm the mediating role of KM in balancing technological innovation with organisational learning, as outlined in the conceptual framework. The evidence suggests that sustainability is not an external outcome but a property that emerges when KM processes continuously adapt to technological and human factors, reinforcing dynamic capabilities within digital enterprises.

These observations substantiate the proposed conceptual framework by demonstrating that KM's mediating role extends beyond efficiency to strategic renewal. Sustainability, therefore, functions as an emergent property of well-integrated knowledge and technology systems, not as a peripheral goal.

Digital transformation and knowledge management

The role of knowledge management in digital transformation

Knowledge Management is recognised as a fundamental pillar of digital transformation, alongside infrastructure and Application Programming Interface (API) management (Erceg & Zoranović 2022). Organisations leveraging KM effectively can maintain a competitive edge by integrating digital solutions into their knowledge processes. A strong KM framework fosters innovation, facilitates continuous improvement and enhances operational efficiency in digital enterprises (Putra et al. 2024).

Organisational culture and knowledge sharing in the digital age

Successful digital transformation is dependent not solely on technology adoption but also on a significant shift in organisational culture (Erceg & Zoranović 2022). Knowledge sharing plays a pivotal role in this process, but it also introduces challenges related to knowledge protection and inter-organisational collaborations (Ilvonen et al. 2018). Research suggests that digital transformation necessitates re-evaluating traditional KM practices, as the nature of knowledge creation, storage and dissemination is continuously evolving (Thornley et al. 2016).

Intelligent and adaptive knowledge management systems

The emergence of intelligent and adaptive KM systems is crucial in the digital era, particularly in times of crisis. The COVID-19 pandemic accelerated digital transformation and demonstrated the need for dynamic KM strategies capable of generating actionable intelligence (Obembe & Obembe 2021). These systems integrate AI, agile methodologies and open innovation to enhance knowledge-sharing capabilities (Marchegiani 2021).

Digital transformation in different sectors

Digital transformation has varied implications across industries, including higher education, business enterprises and SMEs. In higher education, KM plays a crucial role in developing sustainable curricula and advancing Education 4.0, driven by AI and augmented reality (Shenkoya & Kim 2023). However, SMEs face challenges in adopting digital KM strategies as a result of rigid, top-down knowledge-sharing structures and inadequate IT infrastructure (Ajibade, Ondari-Okemwa & Matlhako 2019). Organisations must, therefore, implement flexible and scalable KM models that facilitate real-time knowledge exchange and business intelligence integration.

Industry 4.0 and digital transformation have fundamentally reshaped KM by introducing innovative tools that enhance knowledge creation, storage and dissemination. However, the successful implementation of KM requires organisations to address cultural, technological and structural challenges. While research underscores the advantages of KM-driven digital transformation, future studies should focus on knowledge-sharing ecosystems, digital knowledge security and the impact of AI on collaborative learning. Sustainable KM strategies will be critical for organisations navigating the evolving digital landscape.

Strategic knowledge management frameworks

The role of digital humanities in knowledge management

Strategic KM frameworks have evolved to incorporate interdisciplinary approaches, including digital humanities, which blend traditional humanities research with computational and digital methodologies (Tzavaras & Karamanoli 2023). This integration enables a more comprehensive analysis of cultural and historical phenomena, leveraging linked data sets through the semantic web to facilitate complex knowledge representation and retrieval.

Enhancing collaboration and interdisciplinary research

The semantic web has been identified as a critical tool in modern KM frameworks, particularly in fostering interdisciplinary research and knowledge-sharing among scholars (Tzavaras & Karamanoli 2023). By providing a structured framework for organising and linking knowledge, digital humanities initiatives facilitate the creation of dynamic, interconnected knowledge repositories that enhance collaborative research efforts across various domains.

Structuring strategic knowledge management frameworks for the digital age

The evolution of strategic KM frameworks is closely tied to advances in digital infrastructure and AI-driven knowledge curation. Digital transformation necessitates more sophisticated data organisation and sharing mechanisms, which have led to the adoption of semantic web technologies to enhance KM capabilities (Tzavaras & Karamanoli 2023). Organisations are increasingly integrating these digital tools into their KM strategies to foster more agile and adaptive knowledge systems.

Future directions in strategic knowledge management

The integration of digital humanities within strategic KM frameworks represents an emerging research frontier with significant implications for the future of KM in various sectors. Future research should explore the intersection of digital transformation, AI-driven KM systems and interdisciplinary collaboration to develop innovative KM frameworks that are responsive to the rapidly evolving digital landscape (Tzavaras & Karamanoli 2023). Moreover, future KM frameworks should embed ethical AI principles, data transparency and environmental accountability within their architectures – an orientation consistent with the sustainability outcomes depicted in Figure 4.

Collectively, these developments reinforce that future KM frameworks must transcend static information repositories to become adaptive, intelligent systems embedded within wider digital and social infrastructures. Such frameworks should operationalise the conceptual model presented in this study, ensuring that KM practices serve as the ethical, cognitive and strategic bridge between technological advancement and sustainability imperatives.

Challenges in knowledge management implementation

Organisational barriers to knowledge management implementation

The effective implementation of KM is often hindered by a range of organisational challenges, including data management

complexities, cultural barriers and difficulties in technology adoption (Nashikha et al. 2024). Many organisations struggle to align KM initiatives with their strategic goals, leading to inefficiencies in knowledge sharing and retention. Additionally, the resistance to change among employees and inadequate leadership support further exacerbate these challenges (Laycock 2005).

Technological challenges in knowledge integration

The integration of emerging technologies such as AI, big data and the IoT can significantly enhance KM effectiveness. However, organisations must undergo substantial adaptation to ensure that their systems and processes can accommodate these advancements (Kaivo–oja et al. 2015). The shift from traditional knowledge production to knowledge integration is a key concern, requiring organisations to develop open-system thinking to facilitate knowledge-based decision-making. Without a robust technological infrastructure, organisations may face difficulties in managing large-scale knowledge repositories and ensuring data accuracy.

The need for integrated knowledge management and digital transformation frameworks

Research highlights the complementary nature of KM and digital transformation, emphasising the need for integrated frameworks to maximise their combined potential (Savickas & Užienė 2024). A structured approach that considers core KM foundations, potential risks and synergistic solutions is necessary for a sustainable transition towards Industry 5.0. By aligning KM with digital transformation strategies, organisations can improve continuous learning, enhance collaboration and drive innovation.

Overcoming knowledge management challenges: Strategic solutions

To address these challenges, scholars recommend several strategic solutions, including the adoption of international KM standards such as ISO 30401, stakeholder collaboration and leveraging of smart technologies for knowledge dissemination (Nashikha et al. 2024). Implementing best practices from both private and public organisations can also enhance knowledge-sharing mechanisms and create more adaptable KM systems (Laycock 2005). Future research should explore the dynamic role of emerging technologies in mitigating KM challenges and fostering sustainable digital knowledge ecosystems.

Industry 4.0 and digital transformation have fundamentally reshaped KM by introducing innovative tools that enhance knowledge creation, storage and dissemination. However, the successful implementation of KM requires organisations to address cultural, technological and structural challenges. While research underscores the advantages of KM-driven digital transformation, future studies should focus on knowledge-sharing ecosystems, digital knowledge security and the impact of AI on collaborative learning. Sustainable KM strategies will be critical for organisations navigating the evolving digital landscape.

General knowledge management insights

The evolving role of knowledge management in the digital era

Knowledge Management is increasingly recognised as a critical driver of organisational success in the digital era, shaping how knowledge is created, accessed and utilised. Successful KM implementation requires organisations to establish clear objectives, foster a knowledge-sharing culture and invest in advanced KM technologies, including AI and big data analytics, to enhance knowledge storage, retrieval and decision-making (Yao, Patterson & Taylor 2024).

Organisational factors influencing knowledge sharing

Several organisational factors significantly impact knowledge-sharing effectiveness, including trust, communication, leadership and reward systems (Cormican et al. 2021). Research indicates that organisations fostering an environment of trust and transparency experience enhanced collaboration and knowledge flow, which contributes to sustained competitive advantage.

Digital technologies supporting knowledge management

Digital technologies support KM by enabling core processes such as knowledge creation, storage, retrieval and dissemination. Technologies like cloud computing, IoT and cybersecurity mechanisms contribute to the seamless integration of knowledge-sharing platforms within organisations (Ardito et al. 2018). Furthermore, KM 4.0 emphasises the balance between knowledge generation and utilisation, reinforcing human–machine collaboration to enhance value creation in smart environments (Ansari 2019).

Knowledge management and organisational learning

The integration of KM with adult learning theories is vital for organisations looking to foster continuous learning across different generations. Addressing generational knowledge-sharing gaps enhances KM adoption and ensures smooth transitions in digital workplaces (Viterouli et al. 2023). Effective KM practices also facilitate circular economy strategies, supporting sustainable knowledge transfer across supply chains (Radavičius & Tvaronavičienė 2022).

Future directions in knowledge management

Future research should explore sustainable KM frameworks that integrate digital transformation while addressing cybersecurity concerns and ethical AI use. Additionally,

organisations should invest in adaptive KM systems capable of responding to disruptive changes, such as the post-pandemic landscape (Dutta, Vedak & Sawant 2022). Advancing KM strategies through technology transfer and open-source initiatives will further strengthen knowledge ecosystems and cross-sector collaboration (Russ 2021).

Industry 4.0 and digital transformation have fundamentally reshaped KM by introducing innovative tools that enhance knowledge creation, storage and dissemination. However, the successful implementation of KM requires organisations to address cultural, technological and structural challenges. While research underscores the advantages of KM-driven digital transformation, future studies should focus on knowledge-sharing ecosystems, digital knowledge security and the impact of AI on collaborative learning. Sustainable KM strategies will be critical for organisations navigating the evolving digital landscape.

Contribution of the study

This SLR makes several key contributions to the fields of KM, 4IR technologies and sustainable digital transformation. By synthesising findings from a diverse body of literature, this study provides theoretical, methodological and practical insights into how KM can be leveraged to support sustainability and digital innovation.

Advancing knowledge on knowledge management's role in sustainable digital transformation

This study contributes to existing knowledge by demonstrating how KM principles serve as a critical enabler of digital transformation across industries (Padeli et al. 2024). The word cloud analysis highlights KM, Digital Transformation and Industry 4.0 as dominant themes, indicating that KM strategies are evolving alongside technological advancements. Additionally, findings from the citation distribution analysis suggest that while a few seminal studies shape the discourse, many KM contributions remain underexplored or emergent, emphasising the need for more holistic and adaptive KM frameworks (Savickas & Užienė 2024). The study's conceptual framework (Figure 4) extends this understanding by explicitly mapping how KM processes mediate the relationship between 4IR enablers and sustainability outcomes. This model offers scholars and practitioners a diagnostic tool for aligning knowledge strategies with digital sustainability objectives.

Practically, the framework provides organisations with a roadmap for aligning digital investments with sustainable knowledge practices. The framework also offers a tool for assessing the maturity of KM processes in relation to their technological infrastructure and sustainability performance indicators.

By aligning KM with 4IR innovations such as AI, IoT and big data, this study underscores the strategic role of KM in shaping intelligent, data-driven decision-making ecosystems (Ribeiro et al. 2022). The study also identifies how KM can facilitate knowledge-sharing, automation and collaboration, positioning KM as a fundamental component of digital transformation efforts.

Addressing key barriers and enablers of knowledge management adoption

A major contribution of this study is its critical assessment of the challenges and enablers influencing KM adoption in the context of digital transformation. The histogram of academic disciplines reveals that while IS and business research dominate KM studies, there is a research gap in computer science and engineering contributions. This suggests that technical advancements in KM systems (e.g. AI-driven knowledge repositories, automated KM platforms) require more interdisciplinary collaboration (Shenkoya & Kim 2023).

Furthermore, findings from thematic prevalence analysis show that 'Challenges in KM Implementation' remains a prominent research focus. This emphasis aligns with prior studies that highlight organisational resistance, data privacy concerns and knowledge retention issues as key obstacles to sustainable knowledge-sharing ecosystems (Nashikha et al. 2024). The study identifies best practices for overcoming these barriers, including leadership engagement, cultural transformation and technology-driven KM solutions.

Expanding research on knowledge management's intersection with sustainability

The study also contributes to the growing discourse on KM's role in sustainability, particularly in the context of circular knowledge economies and long-term digital resilience. The citation distribution suggests that many KM studies lack significant impact, implying that sustainability-focused KM research is still gaining traction. This gap underscores the need for KM strategies that integrate green innovation, environmental knowledge sharing and ethical AI-driven knowledge processes (Radavičius & Tvaronavičienė 2022).

Moreover, the word cloud analysis highlights keywords such as 'Sustainability', 'Impact' and 'Future', reflecting an emerging research trajectory towards sustainable knowledge ecosystems. This path aligns with calls for more systematic KM frameworks that balance digital efficiency with human-centric and ecological considerations (Dutta et al. 2022).

Providing a structured methodological approach for future research

By adopting the PRISMA framework for SLRs, this study offers a transparent and reproducible methodology for assessing KM's role in digital transformation. The use of quantitative visualisations (e.g. histograms, citation analysis, word clouds) enhances the analytical depth of the review, making the visualisations a valuable reference for future researchers.

Additionally, the identification of under-represented academic disciplines (e.g. computer science, engineering) provides a roadmap for interdisciplinary collaboration, encouraging scholars from technology, business and sustainability backgrounds to engage in KM research.

This study makes a significant contribution by providing a comprehensive synthesis of KM's role in sustainable digital transformation, analysing thematic trends, research gaps and future directions. By integrating 4IR technologies, identifying barriers to KM adoption and highlighting sustainability concerns, the study offers both theoretical and practical insights for researchers, practitioners and policymakers.

Future research should focus on developing AI-driven KM solutions, exploring KM's role in green innovation and addressing ethical concerns in automated knowledge-sharing systems. By bridging these gaps, KM can further evolve as a cornerstone of digital sustainability, shaping the future of intelligent knowledge ecosystems.

Conclusion

This SLR has provided a comprehensive synthesis of KM in the context of sustainable digital transformation and 4IR technologies. The study highlights that KM serves as a critical enabler for organisations navigating digital innovation, automation and knowledge-sharing ecosystems. The thematic analysis revealed that KM and Industry 4.0, Digital Transformation and KM Implementation Challenges are dominant research areas, with growing emphasis on sustainability, AI-driven KM and interdisciplinary collaboration (Padeli et al. 2024; Ribeiro et al. 2022).

Despite the increasing recognition of KM's role in digital transformation, the study identifies key challenges, including technological integration barriers, limited cross-sectoral research and gaps in AI ethics and sustainability-focused KM strategies (Savickas & Užienė 2024). While certain seminal studies have significantly shaped KM research, citation analysis suggests that many contributions remain under-cited, indicating a potential for further exploration and theoretical advancement.

Moving forward, future research should focus on AI-driven KM solutions, ethical considerations in automated knowledge-sharing and the role of KM in circular economies and environmental sustainability. Additionally, bridging the gap among business, IS and engineering disciplines will be crucial in fostering a more holistic and adaptive KM framework for sustainable digital transformation.

In operational terms, the conceptual framework articulated in this study provides a foundation for empirical testing across diverse organisational contexts. Future research should apply and validate this model through quantitative and case-based designs, examining how KM mediates the relationship between technological innovation and sustainability performance. Such work will deepen the theoretical contribution of KM research while advancing actionable insights for achieving ethical, adaptive and future-proof digital transformation.

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CRediT authorship contribution

Peter L. Mkhize: Conceptualisation, Writing – original draft, Writing – review & editing. The author confirms that this work is entirely their own, has reviewed the article, approved the final version for submission and publication, and takes full responsibility for the integrity of its findings.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Disclaimer

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