The digital, knowledge and innovation nexus: mapping synergies and charting a research agenda

Olga Grieva, Fátima Guadamillas, Mario J. Donate and Francesco Paolo Appio

Abstract

Purpose – *The convergence of digitalization, knowledge management (KM) and innovation has emerged as a critical research topic, yet from the theoretical and practical viewpoints, the interrelations among these domains remain fragmentedly studied. To address this research gap, this paper aimed at systematizing the knowledge base on the pattern of these interrelations.*

Design/methodology/approach – *Using bibliometric analysis technique, this study examined 277 scientific publications spanning from 2005 to 2023, and mapped the conceptual evolution of the intersection digitalization–KM–innovation, categorizing thematic clusters across key evolutionary stages: (1) from digitization to innovation through KM, (2) from KM to digital transformation (DT) through innovation and (3) KM as a primary driver of research.*

Findings – *The research findings highlight critical themes such as the pivotal role of KM mechanisms, the dual-edged nature of digital technologies in enhancing and complicating organizational practices and the cyclical and reinforcing relationship among the digitalization, KM, innovation and DT that propels innovation performance. Drawing from these findings, this study elaborated an extensive agenda for future research, including the exploration of green KM practices, the scalability of knowledge-based systems in low digital maturity industries and the ethical dimensions of artificial intelligence in data-driven innovation.*

Originality/value – *The analysis was conducted distinguishing between digitalization and DT as distinct but interconnected processes that exert varying impacts on KM and innovation, what makes it original in relation to the existing literature. This approach not only advances the theoretical understanding of the studied synergies but also offers actionable insights for practitioners seeking to navigate the complexities of DT.*

Keywords *Digitalization, Knowledge management, Innovation, Digital transformation, Bibliometric analysis, Research agenda*

Paper type *Literature review*

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1. Introduction and motivation

In the digital era, business organizations confront numerous challenges, including global economic uncertainty, rapidly evolving market trends, continuously shifting customer behaviour, cybersecurity threats, advancements in artificial intelligence (AI) and sustainability concerns, among others. To stay competitive in this constantly changing business environment, innovation is vital (Florek-Paszkowska *et al.*, 2021; Nambisan *et al.*, 2019; Nwankpa *et al.*, 2022; Svahn *et al.*, 2017; Teece, 2018). Innovation transforms organizational processes, products and services, aiming to outperform competition and enhance performance (Ferreira *et al.*, 2019; Sarwar *et al.*, 2023). Gao and Sarwar (2022) identified additional challenges associated with innovation, such as the complexity of product and service development processes and shorter product life cycles. Influenced by these adversities, modern companies increasingly rely on knowledge and its exploitation to foster innovation and sustain a long-term competitive advantage (Khilji and Nicolic, 2024).

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Previous studies acknowledge that efficient knowledge management (KM) and learning orientations are paradigms of innovativeness, competitiveness and performance (Sarwar *et al.*, 2023). KM refers to the identification and use of collective knowledge in an organization to help it compete, which is achieved through processes of creation, storage, retrieval, transfer and application of organizational knowledge (Alavi and Leidner, 2001; Arias-Pérez *et al.*, 2020a, 2020b). To enhance efficiencies in KM, Cenamor *et al.* (2019) recommended implementing the latest information and communication technology (ICT) systems. Empirical findings confirm that the proliferation of digital technologies and increased access to data and information have a significant impact on knowledge dynamics at the firm level (Massa *et al.*, 2023). Based upon these theoretical lenses, KM as a discipline emphasizes the importance of digital technologies in facilitating the development of effective processes for knowledge creation, retention and recombination, which further potentiate innovation (Santoro *et al.*, 2018; Zhengang *et al.*, 2023).

Stemming from these interdependencies, a joint analysis of digitalization, KM and innovation provides effective means of tackling contemporary socio-economic issues (Benitez *et al.*, 2018; Joshi *et al.*, 2010; Sánchez Ramírez *et al.*, 2022; Soto-Acosta *et al.*, 2018). The existing body of knowledge on the interrelations between digitalization, KM and innovation indicates a certain level of theoretical and empirical consistency (De Bernardi *et al.*, 2020). However, the systematization of accumulated knowledge on their interrelatedness and the future-oriented potential of their synergetic confluence has only recently become a focused area of academic research (de Bem Machado *et al.*, 2022; Elgargouh *et al.*, 2024; Khilji and Nicolic, 2024). We acknowledge that significant research efforts have been made in this area.

One of the first referential works laying the ground for the current discussion is a structured literature review (SLR) on the intersection between KM and digital transformation (DT) in the context of Industry 4.0, elaborated by de Bem Machado *et al.* (2022). The authors approach the topic by analysing the Industry 4.0 paradigm, DT and KM to enhance the competitive advantage of manufacturing industries. Their study reveals several research clusters: KM and DT; KM and innovation ecosystems; KM and frontier technologies; and KM, decision-making and Industry 4.0. Elgargouh *et al.* (2024) have recently published a meta-analysis on the indispensability of effective KM processes for enhancing operations, customer relations and innovation in the insurance industry, which is undergoing profound DT. Their examination focuses on the diverse implementation processes of KM worldwide, emphasizing the integration of information technologies to enhance data collection, analysis, processing and distribution within insurance companies. The latest systematic review embracing the intersection of KM, DT and innovation domains is authored by Khilji and Nicolic (2024). They investigated the role of KM and its influence on DT, while assessing how organizations manage change and innovation to enhance business performance. Their manuscript proposes a collaborative framework that links recent research on DT with exploratory studies of KM in the context of managing change and innovation. Their study provides insights from emerging technological developments to the evolving KM perspective, and the collaborative framework is intended to offer a logical basis for future research aimed at enhancing business performance.

To identify what our research may contribute to the existing knowledge base in line with the aforementioned works, we examined other theme-related bibliometric studies and SLRs on topics such as KM in the digitalization era (Hustad *et al.*, 2017); digital innovation and knowledge management systems (KMSs) (Di Vaio, Hassan, *et al.*, 2020; Di Vaio *et al.*, 2021); AI and sustainable business models (Di Vaio, Palladino, *et al.*, 2020); DT in SMEs (Ben Slimane *et al.*, 2022; Bin and Hui, 2021; De Bernardi *et al.*, 2020); KM and Industry 4.0 (Ardito *et al.*, 2022; Manesh *et al.*, 2020); digital technologies and KM (Massa *et al.*, 2023; Yan *et al.*, 2023); KM in SMEs (Fauzi *et al.*, 2024); DT and KM (Ratna *et al.*, 2024); intellectual capital and DT (Yilmaz and Tuzlukaya, 2023); digitalization and artificial knowledge (Di Vaio *et al.*, 2023); and KM and the digital supply chain (Gagliardi *et al.*, 2023).

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Our analysis of the current state of research on the interrelatedness of digitalization, KM and innovation reveals that a significant challenge for scholars and practitioners is to deepen understanding and strengthen the connections between these domains (de Bem Machado *et al.*, 2022; Elgargouh *et al.*, 2024; Khilji and Nicolic, 2024). Therefore, exploring the linkages in these scientific fields and further systematizing the findings could make a valuable contribution to management sciences. However, despite the increasing number of studies published in recent years, the existing literature in the intersection of digitalization, KM and innovation does not yet provide a systematization of the research with the principle to explicitly differentiate the concepts of digitalization and DT in the defined settings. In particular, the nexus between digitalization, KM and innovation and, on the other side, between KM, innovation and DT has not been deliberately investigated, delineated and contrasted. In our opinion, the novel theoretical perspective, consisting in differentiating between the three evolutionary stages of DT[1] (digitization, digitalization and digital transformation), will allow not only addressing the identified research gap, but also deriving substantially new insights about distinct character of interactions, ties and interdependencies digitalization and DT have in relation to KM and innovation.

Digitalization consists of the adoption or the increased use of digital technologies by a firm to optimize business operations or increase customer value (Ritter and Pedersen, 2020). By definition, digitalization is a process-oriented phenomenon, which enables firm's KM and innovation. Meanwhile, DT refers to a fundamental change process enabled by the innovative use of digital technologies, accompanied by the strategic leverage of key resources and capabilities, with the aim of radically improving a firm and redefining its value proposition to its stakeholders (Gong and Ribiere, 2021). In contrast to digitalization, DT as a strategy-oriented phenomenon perceives influence from KM and innovation. Taking into account the considerable differences regarding the impact that each process exerts in the studied relationship, we build our investigation upon the following sequence: digitalization → KM → innovation → DT. From our point of view, drawing on the extensive scope of literature that regards the targeted phenomenon, the research aimed at systematizing the knowledge base on the pattern of interrelations between digitalization, KM and innovation will definitely advance the overall understanding that this interrelatedness forms a cyclical and reinforcing relationship that propels organizations towards enhanced innovation performance and successful DT.

In light of these circumstances, we set out the following research questions (RQs):

RQ1. What is the conceptual structure of the common knowledge base of digitalization, KM and innovation?

RQ2. How has this conceptual structure developed over time?

RQ3. What are the influential research topics and potential directions for future research associated with the particular research line?

To answer these RQs, we explored the common knowledge base of digitalization, KM and innovation by analysing scientific production from the 1990s onward through bibliometric research technique. By means of science mapping of co-word networks, we identified the pattern of the examined interrelations by interpreting the strategic diagrams generated by SciMAT software[2] with thematic networks. Specifically, we categorized the research topics within clusters according to their status and studied the connections of these topics with other clusters.

Regarding the rest of this article, we adhere to the practical guidelines suggested by Öztürk *et al.* (2024), who provided an overview and a framework proposal on how to design rigorous bibliometric research. According to this framework, the article structure should include the headings of introduction, method (data, analysis, results/findings) and

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conclusion/discussion. Speaking of "conceptual framework/literature review/research background", it is not included in bibliometric research since bibliometric analysis is already a tool for analysing the relevant literature.

2. Methodology

Bibliometric analysis, also referred to as bibliometrics, is an analytical technique widely used to explore the knowledge structure and development of research fields by analysing related publications (Donthu *et al.*, 2021; Mukherjee *et al.*, 2022). According to Cobo *et al.* (2011), there are two general methods of bibliometric analysis applied to visualize the qualitative, quantitative and structural changes in a specific research area: performance analysis and science mapping. Performance analysis uses a wide range of bibliometric indicators to evaluate the productivity of authors, journals, institutions and countries, as well as the impact of their contributions to research fields (Durieux and Gevenois, 2010). By comparison, science mapping is used to establish conceptual, intellectual and social linkages among different units of analysis (e.g. documents, citations, authors and keywords), thus enabling the structural mapping of a scientific field (Agostini *et al.*, 2020).

Because science mapping analysis represents a combination of bibliometric analysis with graphical visualization, depending on the unit of analysis, it may involve various techniques such as co-authorship analysis, co-citation analysis, bibliographic coupling or keyword co-occurrence analysis (Mukherjee *et al.*, 2022). Among the manifold network analysis techniques available, the most appropriate technique to uncover the theoretical foundations and key concepts that underpin the interrelations between digitalization, KM and innovation, as well as to reproduce their evolution and the agenda for further development of the research area is the keyword co-occurrence analysis, also known as co-word analysis (Hulland, 2024). The application of this bibliometric research technique promises to enable a highly robust, structured and comprehensive review of the rapidly expanding research domain, as it is the only method that uses the actual content of the documents to construct a similarity measure, while others connect documents indirectly through citations or co-authorships (Zupic and Čater, 2015).

There are hardly any transparent and reproducible guidelines for conducting an SLR with bibliometric methods. One of the few is Zupic and Čater (2015), who provided efficient workflow guidance for bibliometric analysis in the field of Management and Organization, conceptualize principles that constitute the current research management model. Specifically, the steps recommended for science mapping analysis were applied to successfully accomplish the research process.

Drawing from this methodological pattern (Figure 1), we developed the following research structure: Research design serves as the preliminary step that precedes the research process and entails determining the inclusion and exclusion criteria, identifying the information source(s), and explaining the search strategy (Step 1). The next step comprises data selection, which includes database search, refinement process, qualitative assessment, data export, and final core document set composition (Step 2). In the third step, the bibliometric analysis is conducted (Step 3). The last step involves the interpretation and reporting of results (Step 4).

Figure 1 Stages of the research

Source: Zupic and Čater (2015)

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The methods and results at each stage of the bibliometric analysis should be reported in sufficient detail to allow users to assess the trustworthiness and applicability of the review findings. Hence, in the present research, the bibliometric analysis is undertaken adhering to the PRISMA 2020 guidelines proposed by Page *et al.* (2021). However, as this approach is quite extensive, it was adapted to fit the scope of our research project.

2.1 Research design

2.1.1 Inclusion and exclusion criteria. To decide whether or not a retrieved document is suitable for inclusion in the review, we set the specific criteria (Paré *et al.*, 2015; Paul and Criado, 2020): year (up to 2023); subject area (business, management and accounting; computer science; social sciences; decision sciences; engineering; economics, econometrics and finance), document type (article and conference paper); publication status (final); the language of publication (English) and the study orientation (if the focus of the study is out of the effect produced from the synergy between digitalization, KM and innovation, an analysed item is to be excluded).

2.1.2 Information sources. Bibliographic data may be obtained from numerous databases, including Scopus, Web of Science (WoS), Google Scholar, among others (Paoloni *et al.*, 2020). Because the validity of research depends on an adequate selection of the bibliographic database (Granda-Orive *et al.*, 2013), we decided to work with Scopus, which contains the largest multidisciplinary abstract and citation database of a peer-reviewed literature, covering scientific journals, conference proceedings and books (Borregan-Alvarado *et al.*, 2020; Di Vaio *et al.*, 2023; Mele *et al.*, 2023; Paul and Criado, 2020). Even though there are sources that claim the contrary, first, scholars usually suggest avoiding consulting more than one database in conducting bibliometric analysis, due to homogenization issues (De Bernardi *et al.*, 2020; Donthu *et al.*, 2021; Öztürk *et al.*, 2024), and second, because each database uses different selection criteria, exclusively using Scopus database, that applies consistent criteria, reduces the risk of including duplicate articles or those of lower relevance (Mele *et al.*, 2023).

2.1.3 Search strategy. Setting search criteria. Search strategy is a crucial component of any SLR, and the PRISMA-S, an extension to the updated PRISMA 2020 Statement, is the most budding reporting guidance for that (Rethlefsen *et al.*, 2021). To verify that each stage of the search is completely reported and, therefore, replicable, we apply this interdisciplinary guidance tool:

- *Keyword(s) and/or search term(s) selection.* We performed a preliminary review of the most relevant terms, associated with the "digitalization", "knowledge management" and "innovation" concepts, within the Business and Management literature. In the first place, the former "digitalization" in front of the definitional ambiguity (Plekhanov et al., 2023; Weinmann, 2019) has been misleadingly compiled with the digit* terms, such as "digitization" and "digital transformation". In addition to including these terms, we consider possible spelling versions, both British and American, "digitiSation" and "digitiZation" or "digitaliSation" and "digitaliZation", ensuring that none of the potentially valuable pieces of scientific contribution is excluded. At this point, there can arise a question why the terms such as "information technolog*" or "information system*", or others closely linked to specific technologies widely used in business are not regarded in the query construction. There is a certain standpoint to justify that without compromising the research results. In our opinion, the specification of the technological aspect is seen more appropriate in the context of having Industry 4.0 as a focal construct of research. However, while our study is evolving around more holistic concepts that comprise the information- or technology-related terms in their definitions themselves, the inclusion/exclusion of these terms can be considered optional. Moreover, we will see further that anyway the Industry 4.0 thematic cluster appears in the conceptual framework mapped using the SciMAT, also the terms

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such as “digital technologies” and “artificial intelligence” show up as fundamental elements of the studied field due to their undeniable relatedness to the research subject. In this case, we believe that the inclusion of the optional terms will definitely provide a wider literature scope to some extent, however, the layout of the conceptual framework will not significantly differ, what can be checked in future research. Speaking of “knowledge management”, de Bem Machado *et al.* (2022) identified that this term is among the most relevant occurrences and related to a unique strand of literature, however, with increasing cross-functional connections between research topics, such as “knowledge management strategy”, “knowledge strategy”, “knowledge management activities”, “knowledge management processes”, “knowledge management practices”, “knowledge management systems”, “knowledge-based systems”, “knowledge creation”, “knowledge acquisition”, “knowledge application”, “knowledge sharing”, “knowledge transfer”, “knowledge storage” and “knowledge dissemination”. The third term “innovation” has not shown a multi-syntax character (Table 1).

- *Source document selection.* Because academic journals might lag behind due to the time needed for the publication process, and our studied research field has a novel character, to embrace the timely information in addition to journals, we also included conference proceedings and book series (Culot *et al.*, 2020).

2.2 Selection process

Because the input for the bibliometric analysis requires a representative sample of selected documents to which the technique can be applied, the first phase involved identifying and systematizing the main contributions of scientific research relevant to our investigation. To achieve this, a search was performed in the Scopus database within article title, abstract and keywords using the following query: TITLE-ABS-KEY (“digitisation” OR “digitization” OR “digitalisation” OR “digitalization” OR “digital transformation” AND “knowledge management” OR “knowledge management strateg*” OR “knowledge strateg*” OR “knowledge management activit*” OR “knowledge management process*” OR “knowledge management practice*” OR “knowledge management system*” OR “knowledge-based system*” OR “knowledge based system*” OR “knowledge creation” OR “knowledge acquisition” OR “knowledge application” OR “knowledge sharing” OR “knowledge transfer” OR “knowledge storage” OR “knowledge dissemination” AND “innovation”).

The Scopus database was browsed in October 2024. The application of inclusion and search criteria ensured not only the identification of records in a systematic and unbiased manner, but also an adequate number of documents – 277 ($n = 277$) – for further manual screening. This gave a start to the second phase, in which all co-authors worked

Table 1 Keywords used in query construction

Concepts	*Keywords*
Digitalization	Digitisation, digitization, digitalisation, digitalization, digital transformation
Knowledge management	Knowledge management strategy, knowledge strategy, knowledge management activities, knowledge management processes, knowledge management practices, knowledge management systems, knowledge-based systems, knowledge based systems, knowledge creation, knowledge acquisition, knowledge application, knowledge sharing, knowledge transfer, knowledge storage and knowledge dissemination
Innovation	Innovation

Source(s): Authors’ own work

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systematically and independently, analysing the full-length content of each record to ensure consistency with the research theme. All the documents were judged against the research relevance (e.g. intersection of digitalization, KM and innovation). We summarized each article separately in the table to fully understand its scope, focus, design and findings for more detailed screening [3]. The results were subsequently compared. In case of disagreement, consensus on which record to include in final sample was reached by discussion. Because neither records were excluded because of not meeting the inclusion criteria nor duplicate entries were identified, 277 ($n = 277$) documents constituted the final knowledge data set for the consecutive analysis. The accorded sample was exported into SciMAT for its further pre-processing (the Scopus documents in a *RIS* format).

At the stage of documents' manual screening, we derived a list of ten most productive journals in terms of publications corresponding to the analysed framework (Table 2). According to the bibliographic statistics, the top three most publishing journals in the intersection of digitalization, KM and innovation is headed by *Journal of Knowledge Management*, *Technological Forecasting and Social Change* and *Knowledge Management Research and Practice*. These journals move across two major fields of research such as technological innovation and KM.

2.3 Elaboration of scientific maps

Considering that SciMAT is the only open-source software tool that incorporates methods, algorithms and measures for all steps of the general science mapping workflow – from data loading to the interpretation of results (Figure 2) – we continued to work with this software to delineate the conceptual structure of digitalization, KM and innovation as a joint research domain.

The pre-processing stage started with the knowledge base correction of misspellings in titles and author names (which were consequences of text format conversion). Furthermore, we continued with the keyword normalization process. In the normalization process, the initial 2.085 items were manually allocated into 1.236 working groups of keywords, applying the investigators' personal criteria. According to Cobo *et al.* (2012), the science mapping software tools available have different characteristics, and no single tool implements all the steps necessary to carry out a science mapping analysis. Taking into consideration, that SciMAT (Cobo *et al.*, 2012) does not provide pre-processing module that allows users to automatically normalize the keywords, the keyword normalization process must be performed manually. To do this, we defined the word groups, unifying those terms (lexical items) that represent the same concept. This was done using the Word Group's manual set capability; that is the special manager to perform the de-duplicating process. To give an example, the word group "DIGITIZATION" was constituted by "DIGITIZATION",

Table 2 List of 10 most productive journals in terms of publications

No.	*Journal*	*Number of publications*
1	*Journal of Knowledge Management*	5
2	*Technological Forecasting and Social Change*	5
3	*Knowledge Management Research and Practice*	4
4	*Journal of Business Research*	3
5	*Electronic Journal of Knowledge Management*	3
6	*Communications in Computer and Information Science*	3
7	*Administrative Sciences*	3
8	*Journal of Entrepreneurship, Management, and Innovation*	2
9	*Journal of Innovation and Knowledge*	2
10	*Journal of Technology Transfer*	2

Source(s): Authors' own work

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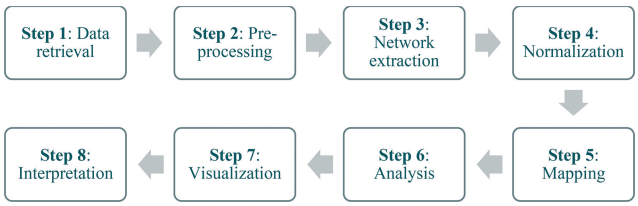
Figure 2 The general workflow of science mapping analysis



Source: Cobo *et al*. (2011, 2012)

"DIGITISATION" and "ANALOG-TO-DIGITAL-CONVERSION" keywords. After pre-processing stage, we followed 11 steps configured to visualize and create networks and clusters through graphical representation (Cobo *et al*., 2011):

1. *Selecting the periods* [4] – there are three evolution periods analysed: the first starts with the publication date of the premier theme-related document (2005) and continues until 2016; the second covers the term from 2017 to 2020; and the third period regards next three years 2021–2023 (Figure 3). Speaking of quantitative composition of each period, the term 2005–2016 is characterized by a stable minimal research production resulting in 13 studies published over 12 years; a second period underwent a piecemeal progress from 2017 to 2020 with a total of 109 documents; and a third term demonstrated a strengthened growth in scientific production from 2021 to 2023 with a 40% increase (155 documents). If the cut established between the first and second periods in 2016 and 2017 is majorly subjected to a significant multiplication and diversification in the theme-related research production, the cut between the second and third periods in 2020 and 2021 requires an additional justification. Having studied several SLRs (Donthu and Gustafsson, 2020; Verma and Gustafsson, 2020) on the COVID-19 research trends in the field of Business and Management, we identified that the evolution of the COVID-19 literature in the business domain exhibits a distinct pattern. First, the diversity of topics and sub-topics addressed by scholars related to the COVID-19 crisis indicated that the virus has impacted both present and future way of life on various fronts. Disruptions in value chain, supply chain management, innovation, service industry and employment induced a rather large volume of research, aiming to understand the impact of the pandemic on future economic growth. These new perspectives on research defined a substantially renewed conceptual landscape and evidence of the emerging discourse in the intersection of digitalization, KM and innovation that is worthy to be analysed as an independent evolution

Figure 3 Research evolution in digitalization, KM and innovation over the period 2005–2023

Source: Authors' own work

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period. Moreover, the period 2021–2023 witnesses a slight drop in scientific production detected in 2022. This u-shape tendency can indicate that in the timeframe from 2021 to 2022, academics and practitioners of the field were experimenting the renewal of needs, priorities and thoughts in relation to the implementation of DT (Appio *et al.*, 2021). At this stage, the white spots and budding research streams came to the fore to get addressed and, thereby, to drive further conceptual development of the research area. Overall, the discussion of how these periods correspond to significant shifts in the conceptual development of the common knowledge base of digitalization, KM and innovation over 18 years is presented in 3.1.1 Period view and systematic review section and 4. Discussion).

2. *Selecting the units of analysis* – to unfold the fundamental topics and their linkages that reflect the conceptual landscape of the studied research field, a series of keywords (author, source, added) are to be explored.
3. *Selecting the data reduction methods* – the minimum number of documents in which a keyword must appear in a selected time span is established with the value 2, because it is the inferior limit recommended by the software.
4. *Selecting the kind of matrix* – to lay out the pattern of interrelationships within the common digitalization, KM and innovation conceptual base, we appeal to the keyword co-occurrence analysis.
5. *Selecting the network reduction method* – the minimum value that allows reducing the network extracted from the analysis equals to 2.
6. *Selecting the normalization measure* – the Equivalence index was selected, because it is the most adequate similarity measure for network normalization (Callon *et al.,* 1983).
7. *Selecting a clustering algorithm* – the Simple centres algorithm (Coulter *et al.,* 1998) was selected, with a minimum value of 3 clusters and a maximum value of 12 clusters, as recommended by Cobo *et al.* (2012).
8. *Selecting the document mappers* – in this study, the core mapper and the union mapper are used.
9. *Selecting the quality measures* – h-index and the sum citations were selected.
10. *Selecting the measures for the longitudinal map* – to attain the evolution map of the concepts we opted for the Jaccard index, which detects the transition of clusters between different periods. Meanwhile, to gain the overlapping map, the Inclusion index was used, which measures the degree of overlap of the clusters in various periods.

Once all the indicators of the aforementioned steps were determined, the keyword co-occurrence analysis' results were generated and a visual representation of these was obtained – Step 11.

3. Findings

3.1 Interpreting and reporting the results

A keyword co-occurrence refers to the number of times two terms appear together in a set of documents (Callon *et al.*, 1983). Based on the presence of these co-occurrences and their frequency in the common knowledge base of digitalization, KM and innovation, we obtain a series of strategic diagrams for each analysed period that allow us to observe the relationships between clusters of keywords, where each cluster is considered a research theme. Furthermore, a longitudinal view is gained, enabling us to understand the evolution of these topics throughout the analysed periods. Then, each research theme disclosed in this process is characterized by two parameters: "density" (*y*-axis) and "centrality" (*x*-axis). Density tends to evaluate the internal strength of the network, while the centrality is

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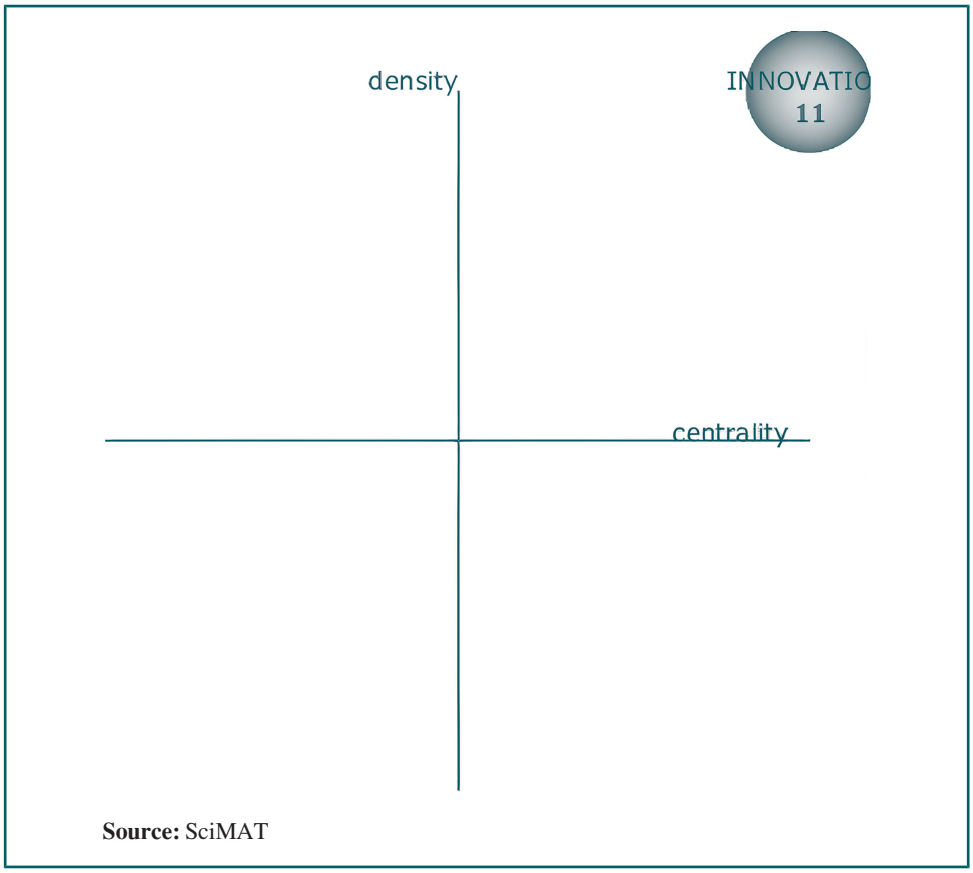
responsible for measuring the degree of interaction of a network with others. Both median and mean values for density and centrality are used in classifying the themes into four groups (Cobo *et al.*, 2012). Four cluster configurations can emerge. Themes in the upper-right quadrant that present strong centrality and high density identify the so-called *motor clusters*. Themes in the upper-left quadrant that have fully developed internal cohesion within the thematic network but nonessential external links with the rest of the research topics identify the so-called *highly developed and isolated clusters*. *Basic and transversal clusters* are identified by those themes showing up in the lower-right quadrant that lack sufficiently developed internal cohesion within the cluster network, whereas opt for a high relevance for the targeted research field due to their rigorous external linkages. Finally, themes in the lower-left quadrant that present weak centrality and low density are categorized as *emerging or declining clusters*.

3.1.1 Period view and systematic review. In this section, we present the bibliometric analysis' results, delineating a research field structure, identifying fundamental dynamics, depicting evolutionary past and disclosing unfulfilled research gaps.

3.1.1.1 Period 2005–2016. At the first stage of development of the academic and business research at the intersection of digitalization, KM and innovation one thematic cluster appears to be prevailing (Figure 4).

Because "innovation" is the only thematic cluster that emerges on the map, there is no possibility to analyse either internal or external associations with the rest of the clusters. However, the "innovation" cluster's network map remains available for further analysis (Figure 5).

Figure 4 Strategic diagram for the period 2005–2016



Source: SciMAT

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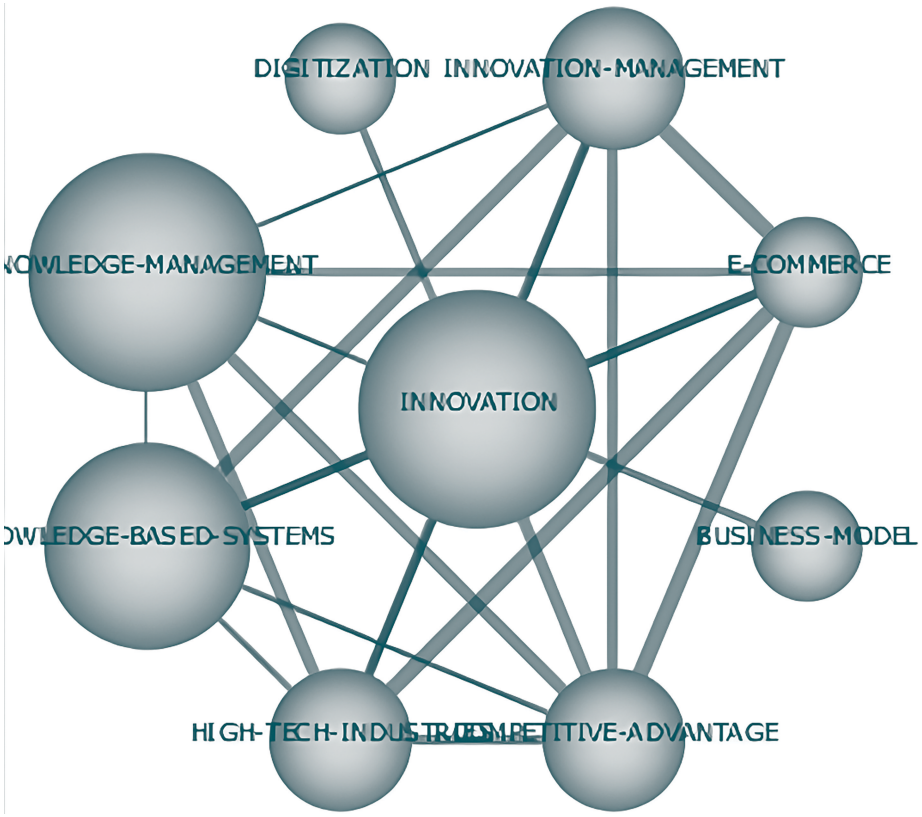
Figure 5 "Innovation" cluster composition in the period 2005–2016



Source: SciMAT

As it emerges from the diagram, the structuring of the studied research field began with the interrelations identified between the concepts of "knowledge-based systems", "knowledge management", "innovation" and "innovation management". In line with this, in the defined time span, the notion of "innovation" becomes more KM-oriented, by referring to the continual process of breaking down knowledge (information) and reintegrating it to create new knowledge-based resources (Barrett *et al.*, 2012). Meanwhile, the concept of "digitization" seems to have undergone a thorough while to reinforce in joint research with innovation, showing a zero association with the KM research realms. This phenomenon does not reject the hypothesized interconnectedness between digitalization, KM and innovation. In fact, what can be learned from the innovation cluster's network is that "digitization" represents the preceding stage to digitalization and the inception of DT, while one of the elements that constitutes the digitalization conceptualization at that time was "knowledge-based systems".

3.1.1.2 Period 2017–2020. The scientific contributions that date back to 2017–2020 period inaugurate a new phase of development for the joint research domain of digitalization, KM and innovation. Stemming from the evolutionary changes (*comparison with the first period*) such as significant increase in scientific production (i.e. from 13 to 109 items), extended thematic scope for research (i.e. from 1 to 5 thematic clusters) and consolidation of the motor theme-cluster "innovation", the conceptual panorama in the intersection of digitalization, KM and innovation has been noticeably modified. As a result, the renewed grouping of research themes was assorted into (Figure 6):

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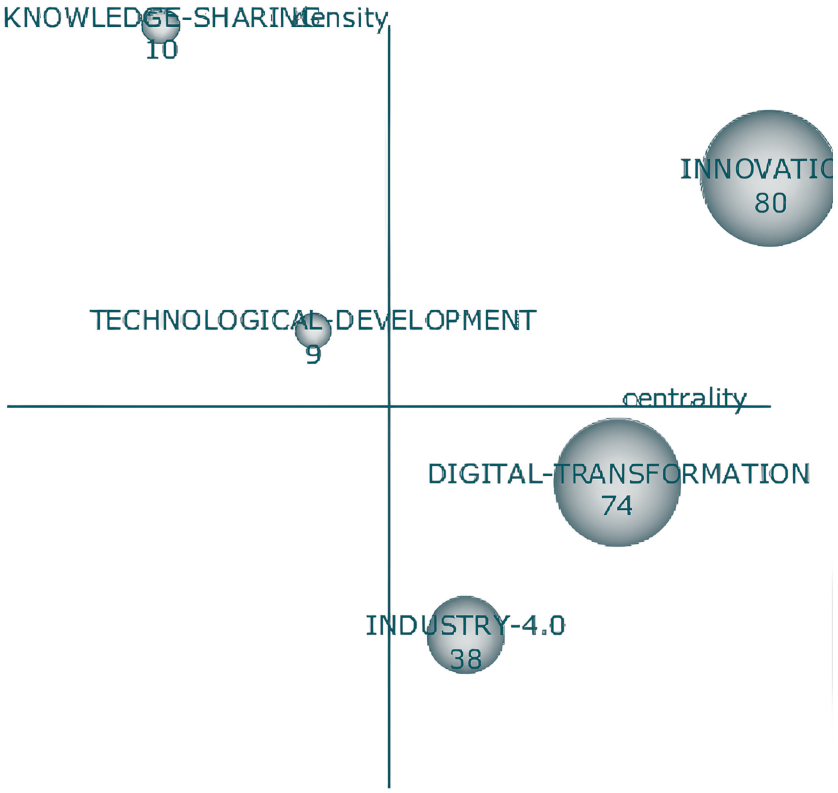
Figure 6 Strategic diagram for the period 2017–2020



Source: SciMAT

When compared to the ex-period, "innovation" cluster is seen to have enhanced its centrality, breaking free greater interaction capabilities with the topics from distinct cluster networks. However, speaking of density, the term 2017–2020 neither brought the new associate elements within the motor cluster network. In this situation, on the basis of "innovation" cluster's network map for the period 2017–2020, we identify the dynamic changes occurred within the cluster in comparison to the previous term (Figure 7).

When it comes to detecting the evolutionary changes in the "innovation" cluster network composition, in the first place, the new research panorama depicts a strengthened "knowledge management" – "innovation" interrelatedness. Secondly, it reflects a theoretical breakthrough consisting in enriching the linkages between "innovation" concept and some of the KM research constraints: if earlier the investigation emphasis was put on "knowledge-based systems" – "innovation" association, latter the research interest shifted towards "knowledge acquisition" – "innovation" and "absorptive capacity" – "innovation". Thirdly, a group of DT-related concepts consisting of "digitization" was enlarged with "digitalization", "digital technologies" and "technological transfer", demonstrating their increased research value for the development of conceptual connections between digitalization, KM and innovation.

"Knowledge sharing" and "technological development" are highly developed and isolated clusters. The internal cohesion between these specialized topics can be explained by Trantopoulos *et al.* (2017) and Ilvonen *et al.* (2018) drawing from the information systems and innovation theories: "technological development" positively affects many aspects of

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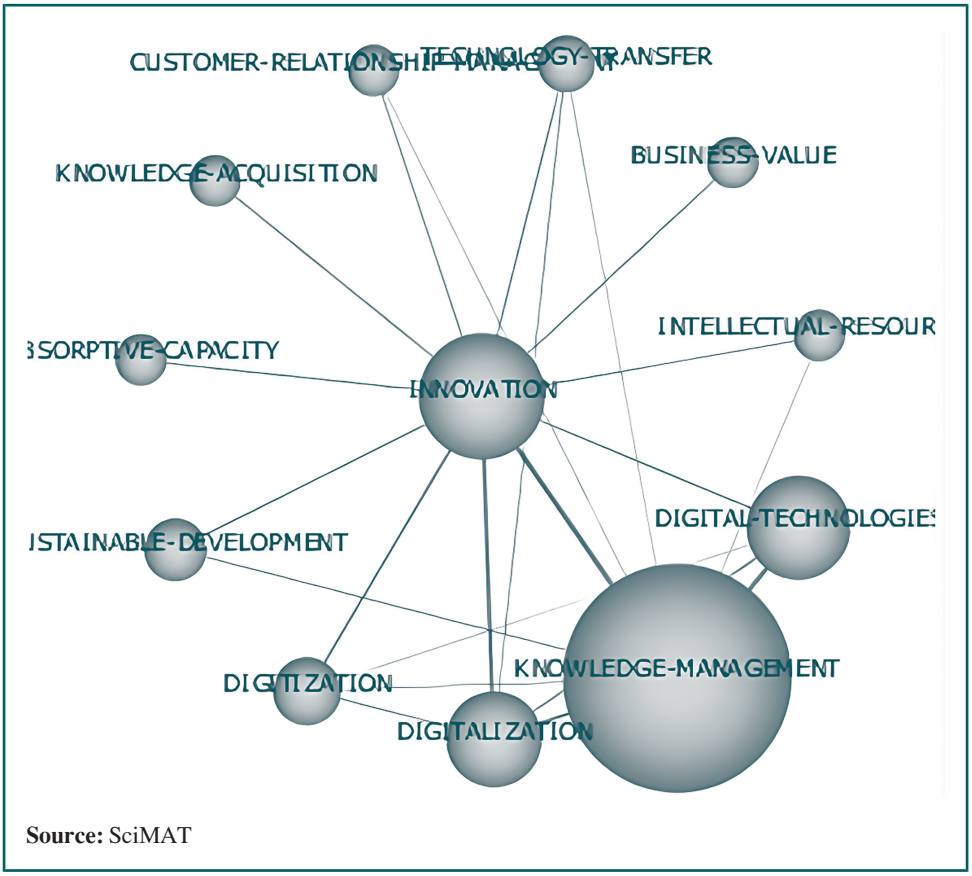
Figure 7 "Innovation" cluster composition in the period 2017–2020



Source: SciMAT

corporate innovation, specifically, by supporting knowledge-intensive activities related to innovation, such as "knowledge sharing". ICTs improve knowledge creation and sharing thanks to bringing together partners and/or employees with different know-how and experience and, in turn, enabling open and closed innovation (Soto-Acosta *et al.*, 2018). Furthermore, "knowledge sharing" attracts attention in terms of digitalization, especially regarding transformation of knowledge to digital form. On the other hand, digitalization might derail creating favourable environment for knowledge sharing and mutual trust that is based on face-to-face contact due to extensive use of ICTs (Danko and Crhová, 2020). Consequently, apart from underlying a strong correlation existing between "technological development" and "knowledge sharing", the resulting associations with "innovation" and "digital transformation" through digitalization come into light.

"Digital transformation" and "Industry 4.0" constitute basic and transversal clusters. The paradigm of "Industry 4.0" has arisen as a major opportunity for promoting "digital transformation" in manufacturing. Industry 4.0 digital operations require the completion of the industries' and businesses' DT in a way that IT systems, machines and humans interact in real-time and create a more flexible, resource-efficient, customized and optimal way of manufacturing, i.e. the Smart Factory (Stathaki *et al.*, 2020). Insufficiently developed internal cohesion between "digital transformation" and "Industry 4.0" research domains in the period 2017–2020 can be subjected to several factors. Firstly, the introduction of the concept "Industry 4.0" into the common knowledge base of digitalization, KM and innovation happened in 2018. The manuscript of Wilkesmann and Wilkesmann (2018) developed a theoretical framework to analyse different applications of Industry 4.0 on an

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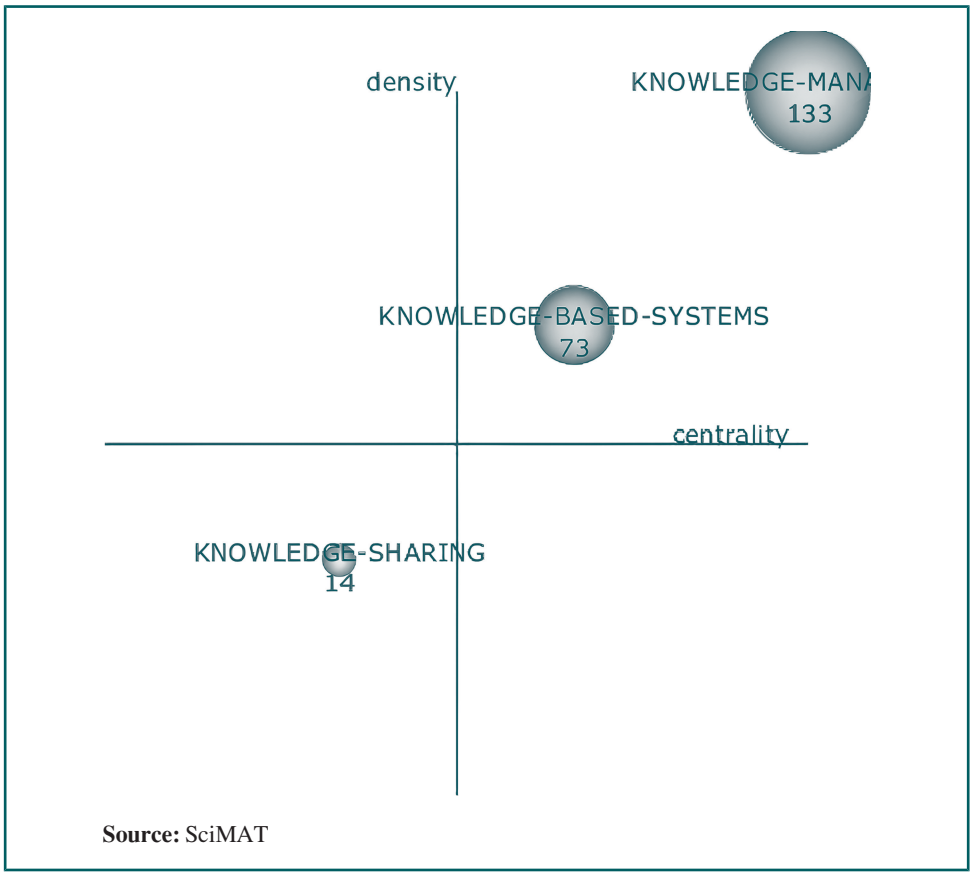
organizing continuum, laying the ground for establishing coherence with the DT. In addition to that, firms were facing the fundamental challenges in mastering the DT, such as isolatory thinking, no active KM, underestimation of digitalization and lack of knowledge, no resources and no awareness of digitalization (Wolf *et al.*, 2018). These deficiencies could point at the fact that the research on interconnectedness between "digital transformation" and "Industry 4.0" was at the incipient stage. However, regarding centrality, while discussing "technological development" and "knowledge sharing" clusters' network, their external interactions with "digital transformation" as whole has been outlined. At the same time, defined as the process aimed at redesigning the organizational business through the introduction of digital technologies to achieve benefits such as productivity improvements, cost reductions and innovation (Hess *et al.*, 2016; Moreira *et al.*, 2018), "digital transformation" reports about strong linkages with "innovation". Finally, "innovation" has come to the fore of the 4th industrial era, either as a reinvigorating aspect of established productive procedures or as a force of radical or incremental change, deriving another important association with "Industry 4.0" (Stathaki *et al.*, 2020).

3.1.1.3 Period 2021–2023. The transformative power of the most recent environmental turbulences (e.g. COVID-19 pandemic) propelled each organization to digitally transform to adapt to the disrupting circumstances and leverage the new business opportunities (Feroz *et al.*, 2021). To embrace this newly configured context, academic and business research was exposed to prioritize novel investigative orientations in the Business and Management field, such as "knowledge management", "knowledge-based systems" and "knowledge sharing", what is literally reflected in the strategic diagram, which visualizes the common knowledge base of digitalization, KM and innovation in the period 2021–2023 (Figure 8):

Figure 8 Strategic diagram for the period 2021–2023



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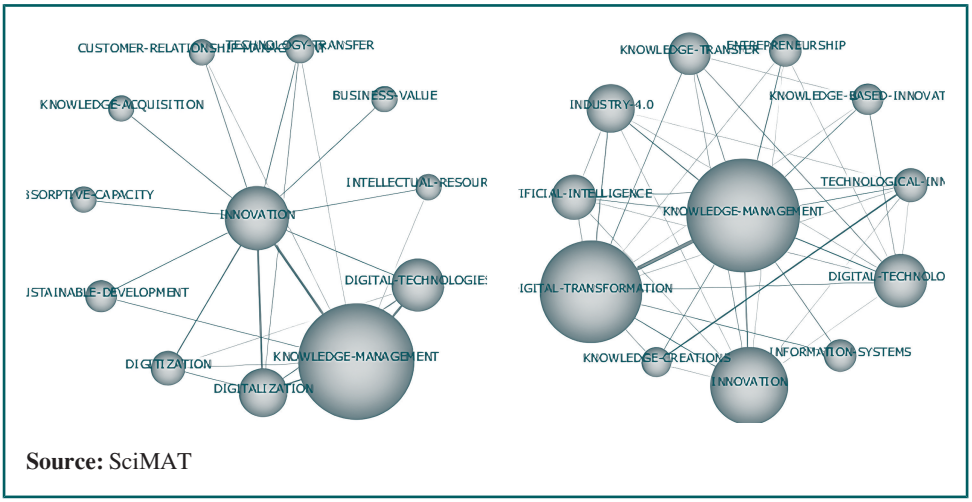
Apart from the evolutionary changes (*comparison with the second period*) (i.e. significant increase in scientific production (i.e. from 109 to 155 items), "knowledge management" appears as a new mature topic with well-developed associations both internally within the cluster network (i.e. "knowledge-based systems") and externally with the rest of the clusters (i.e. "knowledge sharing"). Having compared the positioning of "knowledge management" in the intersection of digitalization, KM and innovation throughout the periods 2017–2020 and 2021–2023 (Figure 9), in the first place, the centrality of the topic has strengthened remarkedly, showing a substantial number of conceptually developed linkages between sub-topics. Secondly, the interrelatedness between "digitization", "digitalization", "knowledge management" and "innovation" has transformed into "knowledge management", "innovation" and "digital transformation" association, indicating that a joint research has reached a certain level of maturity to start contributing to tackling socio-economic concerns by presenting theoretically and empirically valuable results.

Providing a deeper insight into the common knowledge base of digitalization, KM and innovation in the period 2021–2023, the relation between "knowledge management" and "digital transformation" has become much tighter and thicker, than the connections between "knowledge management" and "innovation" or "innovation" and "digital transformation". Basing on the evolutionary dynamics of the first and second periods, this observation can be explained stating that the networks "knowledge management"–"innovation" and "innovation"–"digital transformation" have received sufficient scholarly attention within the studied framework so far, while the "knowledge management"–"digital transformation" association has just recently become a central focus. Moreover, the conceptual advancement of the KM, innovation and DT-related concepts led to the extension of the thematic scope within the research framework of digitalization, KM and innovation: if earlier, in the period 2017–2020, the research efforts were concentrated on the exploration of the "intellectual resources", "absorptive capacity", "knowledge acquisition" and "customer relationship management", the new period 2021–2023 addresses previously identified research gaps and promising lines for future research by studying the role of "knowledge creation", "knowledge transfer" and "knowledge-based innovation" in further development of interdependencies between digitalization, KM and innovation. Furthermore, the DT-related concept, such as "digital technologies", has achieved to develop its interactive capabilities over time (*comparison with the second period*), contributing to the discussion of "technological innovation", "Industry 4.0" and

Figure 9 Comparative analysis of the "knowledge management" theme position in the intersection of digitalization, KM and innovation



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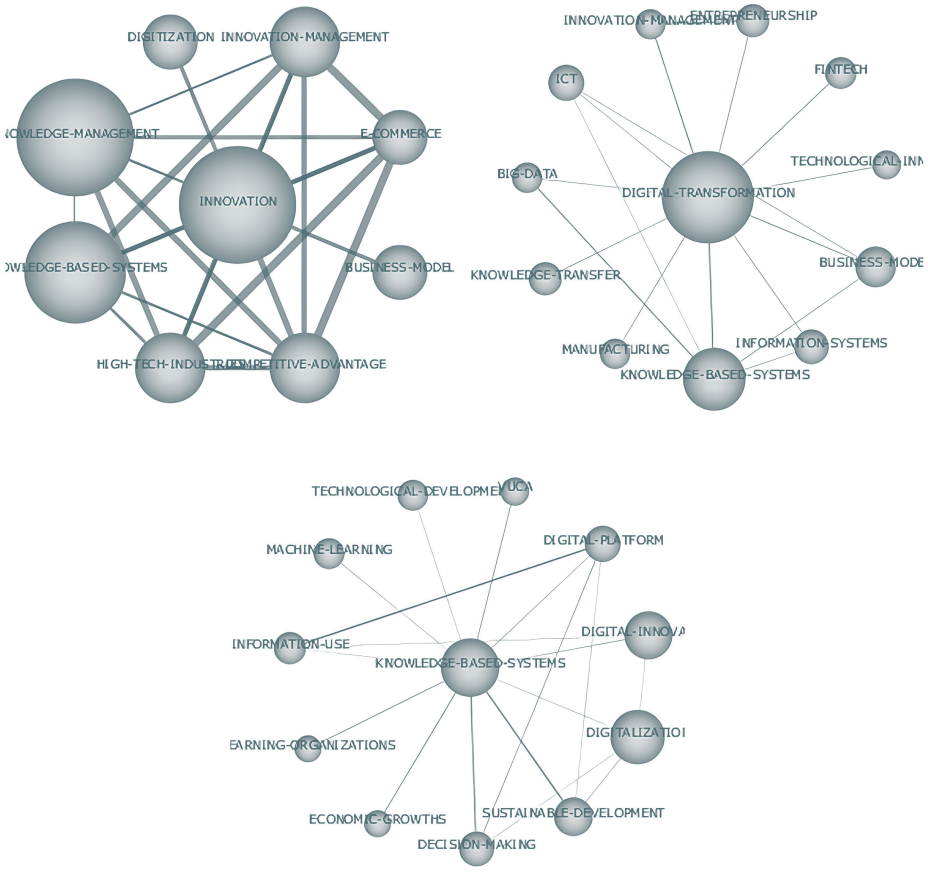
"artificial intelligence" as the main drivers for a joint research of digitalization, KM and innovation.

Another fundamental building block for the digitalization, KM and innovation common knowledge base is "knowledge-based systems" concept. While the entire world has grappled with the global COVID-19 pandemic, organizational research was working on increasing the connections between DT, innovative technologies and intelligent/adaptive KMSs (Obembe and Obembe, 2021). Figure 8 shows that "knowledge-based systems" cluster is seen to have strengthened its centrality, having amplified its ties with the topics from distinct cluster networks too, i.e. "knowledge sharing", at the same time, internally the bond with the "knowledge management" is found rather tight. Figure 10 illustrates the evolution path for the maturity of this domain, taking a start as a connecting link between "knowledge management" and "innovation" (2005–2016); then appearing as a an enabler for the "digital transformation" (2017–2020); finally (2021–2023), serving as a driving force for the "digitalization", "digital innovation", "digital platform" and "technological development" to nurture learning and decision-making capabilities, sustainable development, economic growth for organizations in times of VUCA (volatile, uncertain, complex and ambiguous).

"Knowledge sharing" relates to emerging or declining cluster network. If we look at the preceding stage of development of the conceptual structure for the common knowledge base of digitalization, KM and innovation (2017–2020), "knowledge sharing" constituted the

Figure 10 Comparative analysis of the "knowledge-based systems" theme position in the intersection of digitalization, KM and innovation



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highly developed and isolated cluster of themes. That actually means that this conceptual element has a particular practical role in ensuring the implementation of the digitalization–KM–innovation phenomenon that is thoroughly studied in association with "technological development". Meanwhile, the correlations with other topics of the focal research area, such as "innovation", "digital transformation" and "Industry 4.0" were not discussed that much. With the aim to intensify external relations, the research of "knowledge sharing" has continued in the lens of "knowledge management" and "knowledge-based systems" realm, what is shown in the conceptual panorama of the joint research of digitalization, KM and innovation in the period 2021–2023 (Figure 8). Because the results show the evolutionary transition of the topic to an emerging/declining stage, we do believe, that the concept of "knowledge sharing" comprises a wide variety of principles and activities that have not been discovered and/or explored yet. As a point of fact, the analysis of the latest research discloses that the digital knowledge sharing (Anwar *et al.*, 2024; Smolinski, 2024), online knowledge sharing (Nguyen and Sharma, 2024; Nguyen *et al.*, 2024) and knowledge hiding (Chen *et al.*, 2022; Yao *et al.*, 2023) gain more and more potential for forthcoming investigation. To stress promising research directions in line with RQ3, Table 3 summarizes the emerging clusters' associations deriving from the conceptual evolution of the research framework of digitalization, KM and innovation corresponding to the latest period 2021–2023.

To finalize the interpretation and presentation of the bibliometric analysis' results we introduce the descriptive statistics that increases the transparency and reliability of the reported review findings (Table 4).

*Callon's density, to be referred to as density henceforth, measures the internal strength of the network (Callon *et al.*, 1991) and it can be defined as: $d = 100(\sum e_{ij}/w)$, with i and j keywords belonging to the theme and w the number of keywords in the theme. Density measures the strength of internal ties among all keywords describing the research theme. This value can be understood as a measure of the theme's development.

**Callon's centrality, to be referred to as centrality henceforth, measures the degree of interaction of a network with other networks (Callon *et al.*, 1991) and it can be defined as:

Table 3 The emerging clusters' associations in the period 2021–2023

1.	Knowledge management → innovation → digital transformation
2.	Knowledge management → digital transformation
3.	Knowledge creation → knowledge transfer → knowledge-based innovation
4.	Technological innovation → Industry 4.0 → artificial intelligence
5.	Knowledge-based systems → digital platform → digital innovation
6.	Knowledge sharing → Innovation → Digital transformation → Industry 4.0

Source(s): Authors' own work

Table 4 Key metrics for each thematic cluster

Analysed period	*Thematic cluster*	*Density**	*Centrality***	*Number of documents*
2005–2016	Innovation	100.56	7	11
2017–2020	Innovation	15.98	49.11	80
	Digital transformation	9.73	43.78	74
	Industry 4.0	6.22	20.58	38
	Knowledge sharing	17.14	2.77	10
	Technological development	15.56	10.51	9
2021–2023	Knowledge management	19.94	68.43	133
	Knowledge-based systems	8.53	35.3	73
	Knowledge sharing	7.07	3.57	14

Source(s): SciMAT

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$c = 10 \times \sum e_{kh}$, with k a keyword belonging to the theme and h a keyword belonging to other themes. Centrality measures the strength of external ties to other themes. We can understand this value as a measure of the importance of a theme in the development of the entire research field analysed.

4. Discussion

We conducted a bibliometric analysis on the pattern of interrelatedness between digitalization, KM and innovation. With the primary goal to systematize the common knowledge base of digitalization, KM and innovation, by means of keyword co-occurrence technique and basing on the science mapping analysis we derived, presented and analysed its conceptual structure, as stated in RQ1. Particularly, we discovered the conceptual elements of the research field, defined their interrelatedness pattern and explained the evolutionary dynamics, as requested in RQ2. This facilitated the improvement of the general understanding to what extent and in which context/s digitalization, KM and innovation have been jointly studied by the academy so far. Precisely, we deliberately studied each thematic cluster (i.e. theoretical item), identifying and discussing their internal and external associations within and across the networks of motor, highly developed and isolated, emerging or declining and basic and transversal clusters of themes. The theoretical composition of the joint research domain of digitalization, KM and innovation appears to be constituted by the following elements: "innovation", "digital transformation", "Industry 4.0", "technological development", "knowledge sharing", "knowledge management" and "knowledge-based systems". These are the influential research topics that characterize the structural development of the research field, what was questioned in the first part of the RQ3.

In this bibliometric analysis we have performed both a static outlook of the conceptual structure of the common knowledge base of digitalization, KM and innovation, and a dynamic perspective of the evolution of the influential research topics. Three evolution periods were detected and contrasted – 2005–2016, 2017–2020 and 2021–2023. In this vein, we derive the main conclusions for each period (Table 5).

The term 2005–2016 describes the conception of the research development at the intersection of digitalization, KM and innovation, showing how *digitization, KM-oriented*

Table 5 Bibliometric analysis findings' systematization (analysed period 2005–2016)

Analysed period	*The title of the evolution stage*	*The main interrelations identified, and the impact produced*
2005–2016	"The incipient stage: from digitization to innovation through KM"	1. "Digitization" as an initial evolutionary stage of the DT was first directly associated with "innovation", establishing the orientation of the impact exerted over the processes 2. Since "digitization" represents the preceding stage to digitalization and the inception of DT, this concept appears isolated from the KM research realms 3. However, seeing the "knowledge-based systems" associated with "innovation", we uncover the hidden presence of "digitalization" as an enabler of knowledge-based systems' creation and proliferation 4. The interrelations identified between the concepts of "knowledge-based systems" "innovation", "knowledge management", and "innovation management", indicate that once "digitalization" enables the KM tools creation and the KM practices implementation, these in their turn, stimulate further innovation 5. Building on these premises, we present the first fundamental interrelatedness developed in the period 2005–2016: **digitalization–KM–innovation**

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concepts and *innovation* laid the ground for the current discussion. If we approach the literary sources dated from 2005 to 2016, we will see that for the first time a joint discussion of KM, innovation and high technology appeared in the work of Fu (2005). Specifically, this study explored how innovation reforms in high technology industries impact the entire system of knowledge-based innovation management in line with the environmental dynamics, such as globalization and digitalization. To construct the initial research framework, innovation, as a central construct, was reviewed through a knowledge-based theory lens in the innovation supporting processes. Two years later, the same author published a theme-related paper (Fu, 2007), stating that the KM literature revealed the increasing importance of innovation in high-tech manufacturing firms. In addition, it was found that innovation in high-tech firms had been progressively turning into a systematic process, especially for determined high-tech industries such as electronic products. To finalize the period, the research introduced the discussion of the transformative influence of the pervasive digitization of product innovation on the knowledge creation and sharing in innovation networks (Lyytinen *et al.*, 2016).

The period 2017–2020 depicts further evolution of the research framework of the common knowledge base of digitalization, KM and innovation that has significantly matured drawing from *innovation, digital transformation, Industry 4.0, technological development* and *knowledge sharing* (Table 6). This stage is marked with the work of Trantopoulos *et al.* (2017). They examined the compound effect of external knowledge search combined with IT in the forms of data access systems and network connectivity on firms' process innovation performance. Specifically, the focus of research was placed on exploring how enterprises were adopting digital technologies to improve their KM processes that in turn have an impact on innovation, the market and financial performance.

Finally, the latest period 2021–2023 (Table 7) throws light on the current state of research in digitalization, KM and innovation joint domain. In the new era, *knowledge management*, *knowledge-based systems* and *knowledge sharing* came to the forefront of the theoretical structuring of the field. The renewed conceptual panorama evolving around KM allowed us

Table 6 Bibliometric analysis findings' systematization (analysed period 2017–2020)

Analysed period	*The title of the evolution stage*	*The main interrelations identified, and the impact produced*
2017–2020	"The growth stage: from KM to DT through innovation"	1. In this term, the conceptual interrelatedness between KM and innovation emerges rather consolidated, and the DT-related concepts, such as "digitization" and "digitalization" among others, continue strengthening the groundwork for the evolution of the studied research field. As a result, for the first time, the conceptual maps reflect the connections between **digitalization, KM and innovation** hypothesized at the incipient stage of development of the intersection digitalization–KM–innovation 2. As it derives from the analysis of strategic diagrams, in the second period, the fundamental association of **digitalization–KM–innovation** gains more evidence through the study of the influence produced by the interaction between "technological development" and "knowledge sharing" on "innovation" 3. Further, the growth stage is marked with the consolidation of the "digital transformation" research domain. The conceptualization of DT accorded along this period entails "innovation" as one of the targeted benefits and indicator of a successful DT implementation 4. Based on these antecedents, we present the second central interrelatedness cultivated in the period 2017–2020: **KM–innovation–DT**

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Table 7 Bibliometric analysis findings' systematization (analysed period 2021–2023)

Analysed period	*The title of the evolution stage*	*The main interrelations identified, and the impact produced*
2021–2023	"The new era: KM as the primary driver of research"	1. The renewed business environment configured by the disruptive contingencies of the start of 2020's (i.e. COVID-19 pandemic) puts forward the study of the KM-oriented constructs as powerful drivers of the joint research of digitalization, KM and innovation 2. At the new stage, the common knowledge base of digitalization, KM and innovation has strengthened its maturity firmly stepping from the association formed by "digitization", "digitalization", "knowledge management" and "innovation" to the interrelatedness of "knowledge management", "innovation" and "digital transformation". This conceptual advancement not only enables the effective transformation management aimed at enhancing innovation performance and successful DT but also broadens our understanding of a cyclical nature of the interrelation digitalization–KM–innovation–DT (Figure 11)

Source(s): Authors' own work

to observe and interpret with greater explicitness the distinct character of interdependencies digitalization, KM and innovation have over each other. Thus, through the lens of the analysed knowledge base, firstly, we confirm that the influence of digitalization over innovation is either mediated or moderated by the KM mechanisms and processes (Marion and Fixson, 2021; Nwankpa *et al.*, 2022; Sánchez Ramírez *et al.*, 2022; Weisha, 2021); secondly, we reaffirm that to facilitate the journey towards DT, innovation needs to be embraced, drawing on the internal knowledge-based interfaces (Deist *et al.*, 2023; Firk *et al.*, 2022; Ge *et al.*, 2023); thirdly, we acknowledge that DT nurtures further digitalization of business practices and development of innovative business models (Ramadan *et al.*, 2023; Zhengang *et al.*, 2023). If we recall the research proposal established at the beginning consisting in systematizing the existing literature in the intersection of digitalization, KM and innovation explicitly differentiating between the concepts of digitalization and DT in the defined settings, we will notice that this fresh theoretical perspective allowed us to conceptualize three evolutionary stages of the development of the studied field: "The incipient stage: from digitization to innovation through KM"; "The growth stage: from KM to DT through innovation"; and "The new era: KM as the primary driver of research" (Tables 5–7).

Beyond the descriptive identification of thematic clusters, our bibliometric analysis enables a critical appraisal of how the scholarly discourse on digitalization, KM and innovation has evolved over time, encompassing conceptual maturity, theoretical cohesion and integration gaps. During the initial period (2005–2016), the discourse was nascent and fragmented, primarily emphasizing digitization as a technical foundation for digitalization (Lyytinen *et al.*, 2016). However, the limited integration observed between digitization and KM concepts at this stage reflects early-stage compartmentalization within scholarly discussions. This limitation indicates that digitization was predominantly perceived through a technological lens rather than from a broader managerial perspective, thereby overlooking its wider implications for organizational knowledge processes and innovation capabilities (Fu, 2007). Recognizing this early shortcoming is critical, as it underscores the necessity of interdisciplinary integration from the outset to fully harness digital opportunities and foster a more holistic understanding of digital initiatives in organizations (Barrett *et al.*, 2012; Cenamor *et al.*, 2019).

The subsequent research phase (2017–2020) marked significant conceptual and thematic advancements. A richer dialogue emerged between KM, innovation and DT reflecting a growing awareness of their interconnected roles (Trantopoulos *et al.*, 2017). Particularly

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noteworthy is the scholarly emphasis on absorptive capacity (Cohen and Levinthal, 1990; Volberda *et al.*, 2010) and knowledge acquisition (Marion and Fixson, 2021), indicating a shift towards viewing KM as an active and dynamic capability essential for managing innovation in digitally intensive contexts. Nonetheless, this stage also revealed critical integration challenges. For instance, although Industry 4.0 emerged as a significant conceptual phenomenon, it remained insufficiently connected to broader DT practices, frequently discussed in isolation and predominantly associated with technological upgrades in manufacturing contexts rather than as part of a comprehensive knowledge management and digital transformation strategies (Wilkesmann and Wilkesmann, 2018; Wolf *et al.*, 2018). This fragmented conceptualization potentially limited practical applicability and slowed scholarly progress towards coherent theoretical frameworks (Stathaki *et al.*, 2020).

The most recent period (2021–2023) reflects a conceptual maturation characterized by the increasingly holistic treatment of digitalization, KM and innovation. Specifically, the strengthening of the KM–DT nexus signals a strategic shift from viewing DT merely as technological adoption towards understanding it as an organizational capability deeply intertwined with KM practices (Obembe and Obembe, 2021; Ramadan *et al.*, 2023). Scholars have increasingly acknowledged KM's pivotal role in mediating successful digital transitions, especially under disruptive conditions such as the COVID-19 pandemic (Feroz *et al.*, 2021; Ge *et al.*, 2023). Yet, despite these advancements, our analysis critically highlights ongoing theoretical tensions, particularly around the complexity of digital KM and managerial implications related to knowledge overload and digital fatigue – areas still relatively neglected in the literature (Cox and Evans, 2020; Diener and Špaček, 2021; Mahmood and Mubarik, 2020).

Moreover, the role of knowledge-based systems evolved substantially. Initially regarded merely as repositories or passive tools for organizational KM, these systems have increasingly been perceived as integral strategic assets facilitating innovation and DT (Gupta *et al.*, 2023; Han *et al.*, 2024). However, we highlight the need for caution: over-reliance on such systems without adequate integration with human knowledge-sharing practices may inadvertently lead to organizational silos, stifled creativity or employee resistance (Arias-Pérez *et al.*, 2020a, 2020b; Chin *et al.*, 2023). Thus, the relationship between human knowledge practices and technological interventions remains a critical area warranting more nuanced scholarly attention to optimize the constructive interaction between human and technological capital within organizations.

Overall, our critical reflection on the bibliometric findings reveals that, while conceptual progress in understanding digitalization, KM and innovation has been substantial, significant theoretical and managerial tensions persist. Scholarly efforts moving forward must pay closer attention to these tensions, explicitly acknowledging potential conflicts, unintended consequences and organizational complexities emerging from the interplay among digitalization, KM and innovation (Berardi *et al.*, 2023; Rehman *et al.*, 2022). Confronting these challenges can allow future research to offer more nuanced frameworks and robust managerial strategies, moving beyond the simplistic, overly optimistic assumptions prevalent in earlier scholarship (Bouncken and Qiu, 2021; Nadkarni and Prügl, 2021).

Finally, drawing on the evidence deriving from the evolutionary perspective and an insightful theoretical background of the latest period 2021–2023, we conclude that the interrelatedness between digitalization, KM, innovation and DT forms a cyclical and reinforcing relationship that propels organizations towards enhanced innovation performance and successful DT (Figure 11).

Figure 11 comprises all the fundamental elements identified from the conceptual structuring of the common knowledge base of digitalization, KM and innovation. Basing on the

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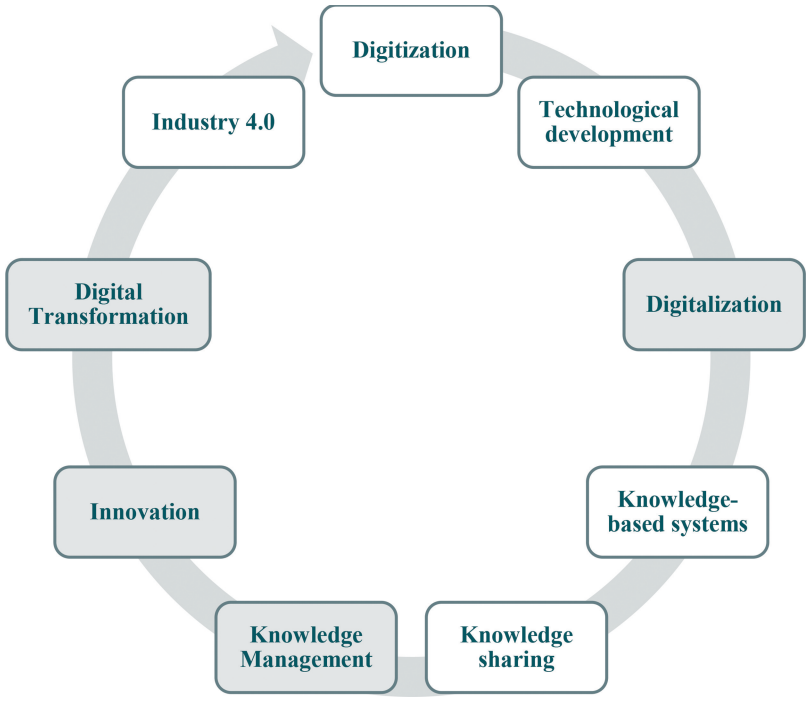
Figure 11 Interrelatedness between digitalization, KM, innovation and DT based on the impact that each process exerts in the studied relationship



Source Authors' elaboration based on bibliometric analysis' results

bibliometric analysis' results, we defined the impact that each process exerts in the studied relationship and assigned particular places in the model for the conceptual elements, respectively. However, if the nexus between digitalization, KM and innovation and, on the other hand, between KM, innovation and DT were thoroughly explored and explained throughout previous stages of our research, it remains unclear how DT and digitalization interact forming a recurrent and reinforcing relationship in the defined settings. To enhance our understanding, we will refer to Warner and Wäger (2019), who studied the dynamic capabilities' building for the DT. Stemming from their findings, the progressive integration of digital technologies into all facets of an organization stimulates a regular digitalization process which takes place both before achieving DT and afterwards to continuously improve it. As we can see in the model (Figure 11), there is a concept of Industry 4.0 which serves as a driver for the digitalization process and, at the same time, as a connecting element between DT implementation and systematic digitalization (Abbate *et al.*, 2023; Bettiol *et al.*, 2022; de Bem Machado *et al.*, 2022).

5. Implications

This research provides significant academic and managerial implications, while also surfacing critical tensions, paradoxes and opportunities that warrant further exploration.

From an academic perspective, our bibliometric analysis contributes to advancing Business and Management sciences by offering a systematic understanding of the interplay between digitalization, KM and innovation. By explicitly differentiating between digitalization and DT, this study provides a theoretical framework to clarify the distinct yet interconnected roles these processes play in enabling organizational KM and innovation. This differentiation

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challenges conventional, often conflated, interpretations in the literature (Bouncken and Qiu, 2021; Hanelt *et al.*, 2021; Nadkarni and Prügl, 2021; Nwaiwu, 2018; Vial, 2019) and opens new avenues for exploring their iterative and reinforcing relationships. Specifically, our findings reveal the cyclical nature of digitalization and DT, wherein DT can stimulate subsequent waves of digitalization aimed at continuous improvement. This raises critical questions about whether a static view of these processes adequately captures their dynamic evolution, and future research must explore these feedback loops in longitudinal and cross-industry studies.

While digitalization is often framed as an enabler of KM (Babkin *et al.*, 2019, 2020), this study identifies tensions that can complicate its implementation. For instance, while digital technologies facilitate knowledge acquisition, sharing and storage (Arias-Pérez *et al.*, 2020a, 2020b; Marchegiani, 2021; Mohsen and Zamzami, 2020), they also risk fostering organizational silos, reducing interpersonal trust or emphasizing codified knowledge at the expense of tacit knowledge (Cox and Evans, 2020; Diener and Špaček, 2021). These outcomes challenge the assumption that digitalization inherently leads to better KM practices. Instead, they highlight the need for more nuanced research to investigate how organizations can align technological advancements with cultural and relational factors to mitigate these risks.

Moreover, the findings underscore the centrality of KM as both a mediator and a driver in the digitalization–KM–innovation nexus. Specifically, KM mechanisms such as knowledge sharing and absorptive capacity play a pivotal role in linking digital technologies with innovative outcomes (Ancillai and Pascucci, 2023; Coronado-Medina *et al.*, 2020; Lozada *et al.*, 2023; Mahmood and Mubarik, 2020; Martínez Falcó *et al.*, 2024; Sun, 2024). However, this centrality raises an important paradox: while KM is critical to innovation, its effectiveness depends on organizational conditions that are often disrupted during periods of rapid DT (Fauzi *et al.*, 2024; Nwankpa *et al.*, 2022). Future research should therefore explore how organizations can design adaptive knowledge management strategies that balance stability with the flexibility required for successful DT.

In addition, the study highlights the emerging importance of context in understanding these dynamics. For example, industries with varying levels of technological maturity may experience different trajectories in the interplay between digitalization, KM and innovation (Ferreira *et al.*, 2024; Schumacher *et al.*, 2016). The rise of Industry 4.0 as a key driver of DT further complicates this interplay, as it necessitates a rethinking of knowledge systems to integrate real-time data, automation and machine learning (Rangaswamy, 2021; Tortorella *et al.*, 2024). Academics must engage in comparative analyses across industries to better understand how these contextual factors influence the effectiveness of knowledge management and innovation strategies.

From a managerial perspective, this study offers actionable insights for organizations aiming to enhance their innovation capabilities and successfully navigate the complexities of DT. Crucially, managers must understand digitalization, KM and innovation not as isolated initiatives but as interconnected components that reinforce one another. However, the practical integration of these domains faces considerable challenges, such as limited resources, skill gaps and resistance to change (Berardi *et al.*, 2023; Rehman *et al.*, 2022; Wu *et al.*, 2022). Managers should actively promote a culture of openness, collaboration and continuous learning. For instance, implementing internal knowledge-sharing platforms such as collaborative digital workspaces and providing training programs on digital skills can empower employees to engage effectively with DT initiatives and overcome resistance. Another important practical insight relates to managing the dual-edged nature of digitalization. Although digitalization fosters efficiency, process standardization and innovation, it can inadvertently suppress creativity and flexibility, leading to overly rigid processes and hindering the organization's adaptability (Teece, 2018; Yao *et al.*, 2023). To address this, managers should deploy modular KMSs that balance standardization with

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flexibility. For example, implementing modular enterprise resource planning (ERP) systems or flexible cloud-based knowledge repositories allows organizations to standardize critical processes, while still enabling customization across different departments, thus avoiding innovation stagnation. The findings also highlight the necessity of integrating sustainability and ethical considerations into digital transformation strategies. DT presents not only opportunities for enhanced organizational performance but also significant risks regarding environmental sustainability and social impacts (Feroz *et al.*, 2021; Gunawan *et al.*, 2024). Managers are encouraged to adopt sustainability-focused digital practices such as energy-efficient data centres, green cloud solutions and promoting eco-friendly remote working policies to reduce carbon footprints. Moreover, proactively managing the social implications of automation – such as potential job displacement – is critical. Organizations might adopt responsible reskilling and upskilling initiatives, thereby supporting employees' transition to new roles created by digital innovation. In addition, our findings reveal the growing importance of KM in supporting organizational resilience and agility amid increasing market volatility and uncertainty. Effective KM practices such as knowledge creation, sharing and transfer become vital for sustaining competitive advantage (Khilji and Nicolic, 2024; Ramadan *et al.*, 2023). For example, organizations should establish formalized knowledge exchange routines – like internal webinars, peer-to-peer mentorship programs or regular innovation workshops – to ensure continuous learning and rapid response to emerging market demands. Managers must align these KM practices closely with their broader digitalization and innovation objectives, investing in robust KM tools (such as AI-powered analytics and real-time decision-support systems) that facilitate quick adaptation and informed strategic decisions. Finally, this research underscores broader societal considerations related to the digitalization–KM–innovation interplay. The digital divide may intensify disparities among organizations or regions with unequal resource access (Guendelman *et al.*, 2017; Habibipour, 2024). Managers and policymakers should collaboratively address this issue by implementing inclusive DT policies. Practical examples include developing industry consortia that provide subsidized access to digital infrastructure for SMEs or fostering public-private partnerships to promote digital literacy and technology adoption in under-resourced communities. Such initiatives ensure that the benefits of DT are equitably distributed and accessible to all organizational actors.

Our findings also highlight crucial societal-level implications related to the digitalization–KM–innovation nexus, particularly emphasizing sustainability and ethical considerations in digital contexts. Although DT is commonly linked with economic performance and innovation efficiency, our analysis underscores that these processes have broader environmental and societal repercussions that demand greater scholarly attention (Gunawan *et al.*, 2024; Martínez Falcó *et al.*, 2024). From a sustainability standpoint, the digitalization and innovation processes inherently involve considerable environmental costs, notably through increased energy demands associated with digital infrastructures, data centres and AI-driven systems (Feroz *et al.*, 2021; Vo-Thai and Tran, 2024). Our bibliometric analysis draws attention to emerging research emphasizing green knowledge management (green KM) practices – such as sustainable data management systems, energy-efficient technologies and eco-friendly digital innovation initiatives – that can help organizations reduce their ecological footprints (Martínez Falcó *et al.*, 2024). Concrete examples for managers to operationalize such strategies include transitioning to cloud-based green data centres, adopting eco-design principles in software and system development and implementing energy management platforms integrated into KMSs to monitor and reduce energy consumption. Furthermore, our research surfaces critical ethical challenges related to the widespread use of digital and AI-driven technologies within organizational knowledge systems. Ethical concerns arise particularly from algorithmic bias, data privacy issues and the potential for automation to displace workers, exacerbating socio-economic inequalities (Al Halbusi *et al.*, 2024; Habibipour, 2024). For instance, the increasing reliance on AI-based decision-making systems poses risks of reinforcing discriminatory practices, if these

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systems are not meticulously designed and governed. To counter these risks, managers should actively integrate responsible AI frameworks within KM practices, including implementing robust data governance standards, ensuring transparency in algorithmic decision-making and fostering diverse teams involved in AI training and implementation processes. Moreover, DT and innovation practices can inadvertently intensify digital divides, creating disparities between organizations or regions that differ significantly in their access to digital resources (Guendelman *et al.*, 2017). Our analysis highlights the necessity for inclusive digital strategies. Managers and policymakers are urged to collaborate closely in developing initiatives that democratize digital infrastructure, such as public-private partnerships for digital literacy programs, targeted investments in under-resourced regions and policies promoting equitable technology distribution.

Finally, from an educational perspective, business schools and executive education providers should consider integrating our insights into their curricula. Courses focusing on innovation management, DT and KM could explicitly incorporate modules that teach students how to recognize and strategically manage the complex interdependencies highlighted in our research. For instance, developing case studies based on our identified themes – such as modular KMSs, responsible AI practices or sustainable digitalization strategies – would equip future managers with both theoretical understanding and practical insights needed for effective decision-making.

6. Future research directions

The findings of this bibliometric analysis underscore the dynamic interplay between digitalization, KM and innovation, while revealing critical gaps that merit further exploration. Addressing these gaps will advance theoretical understanding and provide actionable insights for practitioners and policymakers navigating the complexities of DT.

Thus, answering the second part of the RQ3, consisting in identifying potential directions for future research for the field being analysed, the first key area for future research involves the role of knowledge sharing in DT contexts. Knowledge sharing is widely recognized as a fundamental component of KM, yet its dynamics are significantly altered by the proliferation of digital technologies (Nguyen and Sharma, 2024; Sun, 2024). While platforms enabled by DT, such as AI-powered collaboration tools, have enhanced the efficiency and scalability of knowledge sharing (Anwar *et al.*, 2024; Nguyen *et al.*, 2024), they have also introduced challenges. For example, as Danko and Crhová (2020) and Nylund *et al.* (2023) argued, the extensive use of ICTs may undermine trust-based relationships and limit the sharing of tacit knowledge, particularly in remote or hybrid work settings. Furthermore, cultural and organizational factors influence how these platforms are adopted and used. Comparative studies could examine the extent to which digital technologies either enhance or inhibit tacit and explicit knowledge exchange in various organizational contexts. The role of leadership in fostering a culture of trust and collaboration within digitally mediated environments also requires deeper investigation, particularly in organizations operating across diverse cultural and geographic regions.

Another vital avenue implicates knowledge creation in digitally transformed enterprises, which has been reshaped by the advent of digital tools and platforms (Afzal *et al.*, 2020; Deist *et al.*, 2023). DT enables organizations to create knowledge through enhanced data processing, integration and dissemination capabilities (Chen *et al.*, 2024; Shen *et al.*, 2022). However, the potential for cognitive overload and the deluge of unstructured data present significant challenges, particularly in data-intensive industries (Aviv *et al.*, 2021; Duan *et al.*, 2024). Future research could explore the mechanisms that enable organizations to balance structured and emergent forms of knowledge creation, as well as how leadership and organizational culture influence these processes. For example, smaller organizations such as SMEs often face resource constraints that limit their ability to effectively capitalize on digital opportunities (Tung, 2024). The scalability of digital knowledge creation processes in

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resource-limited contexts remains a critical question, as does the potential for cross-disciplinary collaboration facilitated by digital technologies.

The development and implementation of knowledge-based systems in the digital age also demand further study. As Gupta *et al.* (2023), Cheng *et al.* (2023) and Han *et al.* (2024) highlighted, knowledge digitization forms the foundation of these systems, allowing organizations to store, analyse and retrieve information for decision-making. Yet the scalability and adaptability of knowledge-based systems vary widely across industries, particularly in sectors with differing levels of digital maturity (Charatsari *et al.*, 2024). Industries characterized by high uncertainty, such as technology or finance, require systems that are agile and responsive, whereas traditional sectors may prioritize stability and reliability (Prats and Vallès, 2022; Ratna *et al.*, 2024). In addition, the impact of emerging technologies, such as internet of things (IoT) and edge computing, on the functionality of these systems is underexplored (Fujii and Kamoshida, 2021; Santoro *et al.*, 2018). Understanding how these systems integrate with real-time decision-making processes and organizational goals is an essential research priority.

The integration of advanced technologies, such as AI and Big Data, into KM and innovation processes, represents another burgeoning field of inquiry. While data-driven innovation offers unparalleled opportunities for generating actionable insights and enhancing innovation (Bresciani *et al.*, 2021; Hani *et al.*, 2024; Pietronudo *et al.*, 2022; Sultana *et al.*, 2022; Wong and Ngai, 2024), it also raises ethical and operational concerns. Algorithmic bias, data privacy and governance challenges have emerged as pressing issues (Chen *et al.*, 2022; Habibipour, 2024), necessitating robust frameworks to ensure fairness and transparency. Researchers could examine how organizations balance the efficiency of AI-driven KMSs with the need to preserve employee agency and creativity. In addition, studies could explore how governance frameworks can mitigate risks while maintaining the agility required for innovation.

The intersection of digitalization, KM and sustainability is another critical area for future research. Green KM practices, such as the use of energy-efficient technologies and sustainable knowledge-sharing frameworks, have gained prominence as organizations strive to minimize their environmental impact (Martínez Falcó *et al.*, 2024; Vo-Thai and Tran, 2024). However, the effectiveness and scalability of these practices remain uncertain (Gunawan *et al.*, 2024; Yang *et al.*, 2024). Future studies should investigate how green KM initiatives contribute to organizational resilience and performance, as well as how leadership and culture can embed sustainability into KM practices. Policymakers and researchers alike must consider how digitalization can support sustainable development goals (SDGs) without exacerbating environmental degradation.

The role of contextual influences on digitalization and KM further highlights the complexity of this research domain. Factors such as organizational culture, industry type and geographic region significantly shape the adoption and outcomes of KM practices (Donate and Guadamillas, 2010; Dressel *et al.*, 2023; Grumadaitė *et al.*, 2022; Warrick, 2017). For example, organizations operating in industries with low digital maturity may face unique barriers to implementing advanced KMSs (Di Vaio, Hassan, *et al.*, 2020; Di Vaio *et al.*, 2021). In addition, cultural differences influence trust, collaboration and knowledge sharing, making comparative studies across industries and regions essential. Understanding how organizations balance global standardization with local customization in their KMSs can provide valuable insights for multinational enterprises.

The capacity of organizations to achieve resilience and agility in volatile environments is increasingly tied to their ability to integrate digitalization, KM and innovation effectively. As Joshi *et al.* (2010), Denford (2013) and Anwar *et al.* (2024) noted, dynamic KM capabilities are essential for organizations to adapt to crises and external disruptions. However, the specific practices and processes that foster resilience remain underexplored (Chen *et al.*,

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2022; Mele *et al.*, 2023). Future research could focus on how knowledge-sharing networks support agility and responsiveness in times of uncertainty, as well as how organizations maintain strategic alignment while navigating short-term challenges.

Finally, the human dimensions of digitalization and KM present important research opportunities. While technological advancements have transformed KMSs, the success of these systems ultimately depends on human factors such as motivation, inclusivity and digital literacy (Arias-Pérez and Vélez-Jaramillo, 2022; Chin *et al.*, 2023; Wang and Hou, 2015). Ensuring equitable access to KMSs and addressing the risks of digital exclusion are critical concerns (Prummer *et al.*, 2024). In addition, researchers could investigate how employees perceive the trade-offs between increased automation and their creative or strategic contributions, as well as how organizations can foster engagement and inclusivity in digitally transformed workplaces.

These research directions highlight the complexities and opportunities inherent in the evolving interplay between digitalization, KM and innovation. By addressing these gaps, future studies can advance theoretical frameworks, refine methodologies and provide actionable guidance for practitioners seeking to navigate an increasingly digital and interconnected world. Table 8 summarizes the main future research areas with possible RQs.

7. Limitations

This bibliometric analysis remained subjected to certain limitations. In the first place, there should be mentioned the shortcoming related to the performed Scopus search. In essence, the used search string was exceptionally aimed at publications from the joint knowledge base what might have restricted the reviewed scope of literature. In this respect, to potentiate rather a holistic literature review, the proposition could be to apply a single search query to each subject area (digitalization, KM and innovation) and then connect the results of each search (To accomplish this, please, consult Table 1). Secondly, another disputable point that requires our explanation to ensure the methodological rigour can be associated with the use of articles from predatory journals (as of 2025) such as *Sustainability (Switzerland)*, *Administrative Sciences*, *Journal of Risk and Financial Management*, *International Journal of Engineering and Advanced Technology*, *Future Internet*, *Frontiers in Robotics and AI* and *Energies* (in total 21 articles from 277) (Appendix). The inclusion or exclusion of these documents is a challenging decision due to the concerns about their quality and validity, thus, it can be qualified as a potential research limitation. We do recognize that including articles from predatory journals can indeed compromise the quality of a literature review. Because the number of articles published in predatory journals is growing annually, some academics, for example, Guirao Goris (2015), emphasize the importance of critically evaluating these sources for their inclusion in the review. Conducting a holistic and thorough literature review, we could not avoid reviewing and evaluating this sort of articles for their eligibility. In our case, we considered several practices to justify the final data set as the most relevant and reliable. Firstly, we evaluated the journals' credibility, checking if they are listed in reputable Scimago Journal Rank (SJR) (Table 9). SJR is an indicator of the scientific influence of scholarly journals based on the citations they receive. The results of this check showed that all the journals have either Q1 or Q2 rank except one journal (i.e. *International Journal of Engineering and Advanced Technology*) which was discontinued in Scopus as of 2019. We have one paper from this journal and the date of its publication is 2019, namely, before its expulsion. In addition, we assessed the articles quality and identified that these publications both demonstrate transparent methodologies, clear disclosures and references list constituted by reputable sources and their contextualization and results are relevant to our research. Because currently there are no alternative sources that could have covered their topics, we included these articles from predatory journals in our analysis. In this context, the suggestion for

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Table 8 Main research areas and questions

Research area	*Research questions*
Knowledge sharing and DT	1. How do DT initiatives influence the dynamics of tacit versus explicit knowledge sharing? 2. What organizational factors foster trust in digital knowledge-sharing environments? 3. How do hybrid or remote work settings impact the effectiveness of knowledge-sharing practices? 4. How do cultural and geographic differences shape the adoption of digital platforms for knowledge sharing? 5. What role does leadership play in balancing technological efficiency with relational trust in knowledge sharing? 6. To what extent can AI-powered tools mitigate barriers to effective knowledge sharing across dispersed teams?
Knowledge creation in digitally transformed enterprises	1. How does DT impact the balance between structured and emergent knowledge creation? 2. What are the primary barriers SMEs face in leveraging digital tools for knowledge creation, and how can these be overcome? 3. How do cognitive overload and data deluge affect employees' ability to create meaningful knowledge? 4. How can leadership styles and organizational culture enable effective digital knowledge creation? 5. What strategies enhance cross-disciplinary knowledge creation in digitally transformed enterprises? 6. How does the integration of digital technologies influence knowledge creation processes in resource-constrained settings?
Digitization and Knowledge-Based systems	1. What frameworks can enable the scalability of knowledge-based systems across industries with varying digital maturity? 2. How do knowledge-based systems support decision-making under high levels of uncertainty and complexity? 3. To what extent do emerging technologies, such as IoT and edge computing, enhance the adaptability of knowledge-based systems? 4. How can organizations design systems that balance real-time agility with long-term strategic goals? 5. How does organizational culture influence the adoption and effectiveness of digitized knowledge systems? 6. What role do knowledge-based systems play in driving competitive advantage in high-velocity industries?
Data-Driven innovation and advanced technologies	1. How can organizations mitigate ethical risks, such as bias and privacy concerns, in AI-powered KMSs? 2. What governance frameworks are needed to ensure transparency and fairness in AI-driven KMSs? 3. To what extent do AI-enabled innovations enhance or constrain employee creativity and decision-making? 4. How can organizations balance the trade-offs between efficiency and human-centric innovation in data-driven systems? 5. What role do organizational structures play in enabling ethical and effective data-driven innovation? 6. How do AI and Big Data technologies reshape the dynamics of KM practices across industries?
Green digitalization and KM for sustainability	1. How do green KM practices contribute to environmental sustainability and organizational resilience? 2. What leadership behaviours are most effective in embedding sustainability into KM practices? 3. How can organizations measure the long-term impacts of digitalization initiatives on sustainability goals? 4. What are the trade-offs between operational efficiency and environmental sustainability in digitally driven KM practices? 5. How can green innovation frameworks be adapted to industries with low environmental awareness or regulatory pressures?

(*continued*)

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Table 8

Research area	*Research questions*
	6. What role does green KM play in enhancing the intangible value of organizations, such as brand equity and employee engagement?
Contextual influences on digitalization and KM	1. How do cultural differences affect the adoption and effectiveness of digital KM practices in global organizations? 2. What contextual factors enable or hinder the scalability of KMSs in low digital maturity industries? 3. How do regional economic conditions impact the adoption of digital technologies? 4. What strategies can organizations use to balance global standardization with local customization in KM practices? 5. To what extent do industry-specific regulations influence KMS design and implementation? 6. How do trust and collaboration evolve in culturally diverse, digitally driven KM environments?
Resilience and organizational agility	1. What KM practices are most effective in fostering resilience during crises, such as pandemics or economic downturns? 2. How can knowledge-sharing networks enhance organizational agility in volatile environments? 3. What role do dynamic KM capabilities play in balancing short-term responsiveness with long-term strategy? 4. How can organizations use KMSs to proactively identify and mitigate risks in uncertain environments? 5. To what extent do organizational size and industry context affect the agility of KM practices? 6. How does the integration of KM and innovation practices influence resilience in digitally transformed organizations?
Human dimensions of digitalization and KM	1. How can organizations ensure inclusivity and mitigate the risks of digital exclusion in KMSs? 2. What strategies enhance employee engagement and motivation in digitally transformed KM environments? 3. How do employees perceive the impact of automation and AI on their creative and strategic contributions? 4. What training and development programs best prepare employees for effective participation in digital KMSs? 5. How can organizations foster a balance between human-centric and technology-driven KM approaches? 6. To what extent do demographic factors, such as age or digital literacy, influence the adoption of digital KM practices?

Source(s): Authors' own work

Table 9 Scimago journal rank (2024)

Journal	*SJR (2024)*
Sustainability (Switzerland)	0.688 (Q1)
Administrative Sciences	0.706 (Q2)
Journal of Risk and Financial Management	0.480 (Q2)
International Journal of Engineering and Advanced Technology	Discontinued in Scopus as of 2019
Future Internet	0.762 (Q2)
Frontiers in Robotics and AI	0.719 (Q2)
Energies	0.713 (Q1)

Source(s): Authors' own work

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future research could be to replicate the bibliometric analysis discarding the biased articles. Anyway, we acknowledge that it is crucial to prioritize the quality and validity of the conducted literature review, thus, even if Scopus is recognized as a peer-reviewed literature database, additional verification of the final data set on the presence of articles from predatory journals is compulsory.

Thirdly, when abiding by the "investigators' personal criteria" in normalizing the keywords range, there is no way to make the research results exempt from the authors' bias. The manner to resolve it questions what the exodus would have been if we had used the raw selection of keywords (2.085 instead of 1.236). Next to this, the inclusion of documents basing on the keywords in title, abstract and keywords might represent another aspect for consideration, because it allowed focusing on those studies, in which digitalization, KM, innovation and DT are the backbone, meanwhile, the studies, in which these keywords play a less central role, might have been excluded. This could serve the novel investigators as a well-outlined threshold for capturing hidden and unexpected connections between diverse literature streams.

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Credit author statement: O.G.: conceptualization, methodology, investigation, data curation, software, visualization, formal analysis, validation, writing – original draft, writing – review & editing; F.G.: conceptualization, methodology, investigation, data curation, software, visualization, formal analysis, validation, writing – review & editing, supervision; M.J.D.: conceptualization, methodology, investigation, data curation, software, visualization, formal analysis, validation, writing – review & editing, supervision; F.P.A.: conceptualization, methodology, investigation, data curation, software, visualization, formal analysis, validation, writing – review & editing, supervision.

Notes

[1.] The evolutionary stages of DT (Appio *et al.*, 2021; Venkatesh *et al.*, 2019; Verhoef *et al.*, 2021):

1)"digitization", which regards the conversion of information from analogue to digital;

2)"digitalization", which refers to the automation of processes through information technologies; and

3)"digital transformation", which comprises both digitization and digitalization and, on this basis, enables the value creation of whole businesses and systems.

[2.] https://sci2s.ugr.es/scimat/8

[3.] To avoid overloading of the content of the current paper, the table with the detailed information can be provided upon request.

[4.] To have periods for choosing for the analysis in Step 1, at the pre-processing stage these should be set up by passing to "Knowledge base" module and working with "Periods manager" function.

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Appendix

In our final knowledge dataset (277) we identified 13 papers from Sustainability (Switzerland) published from 2019–2023:

Table A1 List of Predatory Journals 2025

Authors	*Title*	*Year*	*Source title*	*No. of citations*
Czok V.; Krug M.; Müller S.; Huwer J.; Weitzel H.	Learning effects of augmented reality and Game-Based learning for science teaching in higher education in the context of education for sustainable development	2023	*Sustainability (Switzerland)*	20
Ge C.; Lv W.; Wang J.	The impact of digital technology innovation network embedding on firms' innovation performance: the Role of Knowledge Acquisition and Digital Transformation	2023	*Sustainability (Switzerland)*	36
Zhou J.; Shao M.	Evaluation of green innovation efficiency in chinese provincial regions under High-Quality development and its influencing factors: an Empirical Study Based on Hybrid Data Envelopment Analysis and Multilevel Mixed-Effects Tobit Models	2023	*Sustainability (Switzerland)*	10
Xu C.; Zhu S.; Yang B.; Miao B.; Duan Y.	A review of policy framework research on promoting sustainable transformation of digital innovation	2023	*Sustainability (Switzerland)*	21
Feo E.; Burssens S.; Mareen H.; Spanoghe P.	Shedding Light into the Need of Knowledge Sharing in H2020 Thematic Networks for the Agriculture and Forestry Innovation	2022	*Sustainability (Switzerland)*	10
Sun C.; Liu J.; Razmerita L.; Xu Y.; Qi J.	Higher education to support sustainable development: the Influence of Information Literacy and Online Learning Process on Chinese Postgraduates' Innovation Performance	2022	*Sustainability (Switzerland)*	28
Sanchez-Segura M.-I.; González-Cruz R.; Medina-Dominguez F.; Dugarte-Peña G.-L.	Valuable business knowledge asset discovery by processing unstructured data	2022	*Sustainability (Switzerland)*	9
Beranič T.; Heričko M.	The impact of serious games in economic and business education: a Case of ERP Business Simulation	2022	*Sustainability (Switzerland)*	46
Kitsios F.; Kamariotou M.	Artificial intelligence and business strategy towards digital transformation: a research agenda	2021	*Sustainability (Switzerland)*	351
Castagna F.; Centobelli P.; Cerchione R.; Esposito E.; Oropallo E.; Passaro R.	Customer knowledge management in SMEs facing digital transformation	2020	*Sustainability (Switzerland)*	184
Caldarelli G.; Rossignoli C.; Zardini A.	Overcoming the blockchain oracle problem in the traceability of non-fungible products	2020	*Sustainability (Switzerland)*	91
Tsakalidis A.; Gkoumas K.; Pekár F.	Digital transformation supporting transport decarbonisation: Technological developments in EU-funded research and innovation	2020	*Sustainability (Switzerland)*	61
De Bernardi P.; Bertello A.; Venuti F.	Online and on-site interactions within alternative food networks: Sustainability impact of knowledge-sharing practices	2019	*Sustainability (Switzerland)*	95
Three papers from *Administrative Sciences* published from 2022–2023:				

(*continued*)

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Table A1

Authors	*Title*	*Year*	*Source title*	*No. of citations*
Ramadan M.; Bou Zakhem N.; Baydoun H.; Daouk A.; Youssef S.; El Fawal A.; Elia J.; Ashaal A.	Towards digital transformation and business model innovation: the Nexus between Leadership, Organizational Agility, and Knowledge Transfer	2023	*Administrative sciences*	58
Karakose T.; Demirkol M.; Yirci R.; Polat H.; Ozdemir T.Y.; Tülübaş T.	A conversation with ChatGPT about digital leadership and technology integration: Comparative analysis based on human–AI collaboration	2023	*Administrative sciences*	72
Sánchez Ramírez S.; Guadamillas Gómez F.; González Ramos M.I.; Grieva O.	The effect of digitalization on innovation capabilities through the lenses of the knowledge management strategy	2022	*Administrative sciences*	22
One paper from the *Journal of Risk and Financial Management* published in 2021:				
Ferraro O.; Cristiano E.	Family business in the digital age: the State of the Art and the Impact of Change in the Estimate of Economic Value	2021	*Journal of Risk and Financial Management*	39
One paper from the *International Journal of Engineering and Advanced Technology* published in 2019:				
Al-Roubaie A.	Building capacity for digital development in the arab world: the role of education	2019	*International Journal of Engineering and Advanced Technology*	9
One paper from the *Future Internet* published in 2021:				
Pokrovskaia N.N.; Korableva O.N.; Cappelli L.; Fedorov D.A.	Digital regulation of intellectual capital for open innovation: Industries' expert assessments of tacit knowledge for controlling and networking outcome	2021	*Future Internet*	29
One paper from the *Frontiers in Robotics and AI* published in 2021:				
Klemme I.; Richter B.; De Sabbata K.; Wrede B.; Vollmer A.-L.	A Multi-Directional and agile academic knowledge transfer strategy for healthcare technology	2021	*Frontiers in Robotics and AI*	6
One paper from the *Energies* published in 2022:				
Czemiel-Grzybowska W.	Conceptualization and Mapping of Predictors of Technological Entrepreneurship Growth in a Changing Economic Environment (COVID-19) from the Polish Energy Sector	2022	*Energies*	5

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