

Exploring dynamic capabilities in digital transformation: A bibliometric and content analysis



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ABSTRACT

This study integrates bibliometric and content analysis methods to provide a comprehensive review of digital transformation dynamic capabilities. Bibliometric analysis is conducted using VOSviewer on relevant publications retrieved from the Web of Science, Scopus, and ProQuest databases to evaluate and visualize the existing literature. The findings identify key publishing trends, leading countries and journals, influential authors, and the most researched sectors in this field. Co-citation and co-occurrence analyses highlight major research topics. Additionally, content analysis is used to categorize digital transformation dynamic capabilities into three dimensions: sensing, seizing, and transforming/reconfiguring. This study offers valuable insights into the capabilities required for digital transformation, supporting both companies and researchers in understanding and applying these concepts effectively.

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1. Introduction

In the digital economy era, characterized by rapid advancements in technologies such as artificial intelligence, blockchain technology, cloud computing, and big data, companies must pursue digital transformation to gain new competitive advantages amid evolving market dynamics and challenges (Schallmo and Williams, 2018). For companies, digital transformation is not merely a trend but a critical imperative. It can facilitate innovation in products, services, and business models (e.g., Bresciani et al. (2021) and Frank et al. (2019)), enhancing operational efficiency and organizational performance (e.g., Dalenogare et al. (2018) and Zhai et al. (2022)). Consequently, companies should actively embrace digital transformation, continually innovate, and optimize to maintain a competitive edge in highly competitive markets. Research on digital transformation has gained significant attention. It is defined as a process that enhances an organization by bringing about

major changes in its core characteristics through the use of information, computing, communication, and connectivity technologies (Vial, 2019). Digital transformation is a continuous and dynamic process that drives change within a company's competitive environment. It is not a one-time effort but requires ongoing adaptation and improvement (Chanias et al., 2019; Vial, 2019). However, many digital transformation efforts fail, with reported failure rates ranging from 60% to 85%.

The theory of dynamic capabilities is considered an extension of the static perspective of the resource-based view (Helfat and Peteraf, 2003). It explains how companies align with their environment to achieve a sustained competitive advantage (Ellström et al., 2021). Dynamic capabilities become more valuable in turbulent environments (Pavlou and El Sawy, 2011), and their complexity makes them difficult to replicate (Galunic and Eisenhardt, 2001). Therefore, many scholars emphasize that dynamic capabilities provide a powerful lens for examining a company's digital transformation (Soluk and Kammerlander, 2021; Warner and Wäger, 2019). Companies must develop robust dynamic capabilities in the digital transformation process to swiftly create, implement, and transform business models, thereby enhancing their adaptability and flexibility in the evolving digital economy (Karimi and Walter, 2015; Matarazzo et al., 2021; Teece, 2018). Teece (2018)

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argued that strong dynamic capabilities typically imply significant strength across all relevant domains of sensing, seizing, and transforming relative to competitors.

The literature indicates that understanding how companies develop dynamic capabilities for digital transformation remains a strategically crucial issue that is not fully understood (Warner and Wäger, 2019). Dynamic capabilities relate to the environment in which a company operates. Companies exhibit different dynamic capabilities because of the different environments and industries in which they operate (Ethiraj et al., 2005). It is argued that the dynamic capabilities required by companies in the digital transformation process should be analyzed. However, existing literature lacks studies dedicated solely to this specific topic. Furthermore, quantitative methods are rarely used to describe the capabilities of digital transformations (Wu et al., 2021). This provides a strong rationale for conducting a bibliometric review. Therefore, this study presents a comprehensive overview of the research in this field through a bibliometric analysis. Additionally, as a supplement, the specific dynamic capabilities required for digital transformation were identified through a content analysis of the literature. The findings can assist companies in achieving digital transformation more effectively.

This study addresses the following questions in the field of dynamic capabilities for digital transformation.

1. How are the publications per year, country, and source?
2. Which are the most influential articles?
3. Which sectors are the most researched?
4. How is co-citation analysis based on journals and authors?
5. How is the distribution of keywords in dynamic capabilities for digital transformation?
6. What dynamic capabilities are required for a company's digital transformation?

The rest of the paper is organized as follows. First, the research methods used in this study are explained. Next, the findings from the descriptive and bibliometric analyses are presented. Then, the dynamic capabilities needed for digital transformation are identified through content analysis. Finally, the main conclusions are discussed, including theoretical and practical implications, and suggestions for future research are provided.

2. Literature review

Digital transformation is inevitable for companies to survive and develop in the digital economy era. Digital transformation is an organizational transformation caused by the integration of digital technology and company production and operation processes (Hess et al., 2016). Vial (2019) defined digital transformation as a process that aims to improve an entity by triggering significant changes

in its properties through combinations of information, computing, communication, and connectivity technologies. Compared with existing concepts, such as information technology adoption, digital transformation has the following three significant characteristics. First, digital transformation is more than a digital technology application (Vial, 2019). This transformation runs through organizational activities such as business models, corporate strategies, organizational operating processes, and organizational structures in the process of organizational management. Second, scholars generally believe that companies are undergoing digital transformation under the premise of the development of digital technology and have demonstrated the role of digital technology in the transformation process (Gong and Ribiere, 2021; Nambisan et al., 2019). Third, digital transformation is an ongoing process (Nwankpa et al., 2022; Ulas, 2019; Vial, 2019), not static. This transformation process consists of different stages (Chanias et al., 2019; Porfirio et al., 2021). The uncertainty and continuity of digital transformation require companies to build dynamic capabilities. This helps them respond to rapidly changing markets and technological advances, enhancing their competitiveness and innovation. Given the disruptive nature of digitalization, dynamic capabilities are considered crucial for examining a company's digital transformation. Velu (2017) emphasized the need for dynamic capabilities that balance effectiveness and flexibility during digital transformation. Teece et al. (1997) defined dynamic capabilities as 'the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments. Zollo and Winter (2002) distinguished dynamic capabilities from operational capabilities, stating that while operational capabilities help companies survive, dynamic capabilities are higher-level abilities that modify operational capabilities to adapt to changes in a dynamic environment. Priem and Butler (2001) highlighted that the resource-based view cannot explain competitive advantages in a changing environment. Companies to succeed in digital transformation, they need to have the dynamic capabilities to sense environmental changes, seize opportunities, and reconfigure existing resources. Scholars have studied various examples of research on dynamic capabilities for digital transformation in different industries, such as manufacturing (Coreynen et al., 2020; Matarazzo et al., 2021; Tortora et al., 2021), services (Khurana et al., 2022; Witschel et al., 2019), and industry (Chirumalla, 2021).

3. Research methodology

To comprehensively understand the dynamic capabilities involved in companies' digital transformations, search keywords in the first phase were identified. This study combined terms related to dynamic capabilities, such as 'dynamic capabilit*',

with terms related to digital transformation, such as 'digital transformation,' 'digital transition,' digitization, digitalization, digitalization, 'Industry 4.0,' and terms related to companies, such as firm*, organization*, compan*, enterprise*, and SME*. This study was conducted across multiple databases, including Web of Science (WoS), Scopus, and ProQuest, resulting in a total of 1,548 documents.

In the second phase, the initial screening criteria were established. Only articles published in English were included, with no restrictions on publication date. Conference papers, industry reports, editorials, books, and book reviews were excluded to ensure the high quality and reliability of literature sources. As the focus of this study is on company-level business processes, the dataset on WoS was restricted to the subject areas of 'Management,' 'Business,' 'Operations Research Management Science,' 'Economics,' and 'Business Finance.' On Scopus, the dataset was restricted to 'Business, Management and Accounting, Economics, Econometrics and Finance,' and 'Decision Sciences.' For ProQuest, due to the absence of subject filters comparable to those on Scopus and WoS, only articles categorized as literature reviews and those related to supply chains and carbon were excluded at this stage to avoid omitting other relevant studies. The application of these filters yielded 879 documents.

In the third phase, deduplication was performed, resulting in a final dataset of 684 documents. In the second step, the titles and abstracts of these articles were reviewed, the full text was read when necessary, and literature not relevant to this study was excluded. This study only included literature that focuses on digitalization as the main research

context, analyzes it at the company level, and applies the following exclusion criteria:

- Documents that involve individual behaviors and actions as well as those focusing on areas beyond a single company's boundaries, such as supply chains, platforms, regional systems, hospitals/government/public sector, and macro-level financial systems, were excluded.
- Documents that solely focus on technological aspects were excluded.

These inclusion and exclusion criteria ensured the relevance and consistency of the selected literature within the scope of this study. Finally, 81 documents were obtained for bibliometric analysis. Fig. 1 depicts the search strategy and analysis performed in this study.

This study primarily utilized VOSviewer 1.6.20 software for data analysis. Using co-citation analysis, maps of journals and authors were created to better understand the knowledge structure and research networks within this field. Additionally, a keyword co-occurrence network was established to identify the main areas of focus on dynamic capabilities for digital transformation. The use of keyword networks facilitates a deeper understanding of the knowledge domain and provides clearer insights into research interests (Shrivastava and Mahajan, 2016).

To complement these efforts, this study employed content analysis to comprehensively examine the three dynamic capability dimensions of sensing, seizing, and transforming/reconfiguring, as discussed in the literature on digital transformations. This approach aimed to identify the specific dynamic capabilities required for successful digital transformations.

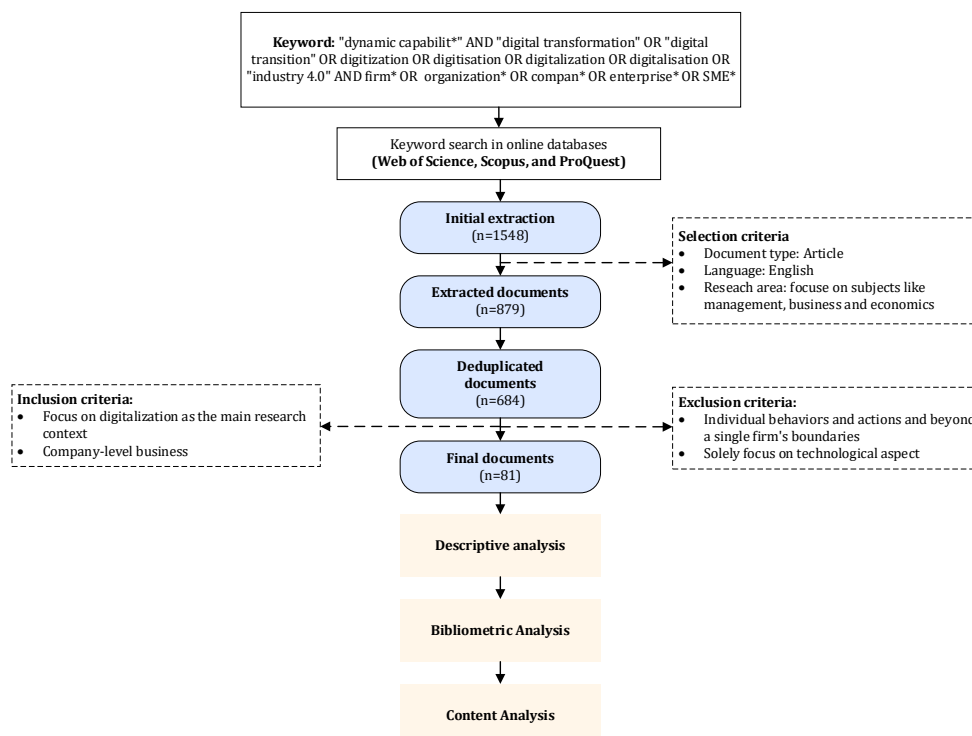


Fig. 1: Search strategy and analysis

4. Results and discussions

4.1. Descriptive analysis

Fig. 2 shows the annual publications of articles in the fields of digital transformation and dynamic capabilities. Research on the dynamic capabilities of company digital transformation began in 2015, but for unknown reasons, no articles were published in this research field from 2016 to 2017, and there was only one publication in 2018, which also shows that this research field is relatively new. Since 2019, the number of papers has exhibited a clear upward trend, reflecting the increasing attention and in-depth research of the academic community in this field.

The articles were published in 45 countries. Table 1 presents the countries with at least 5 publications and 10 citations. The United Kingdom

had 14 articles, 1749 citations, and the highest total link strength (TLS) of 10, indicating a high level of academic influence and connectivity. China also had 14 articles but lags significantly in citations (314) and TLS (1), suggesting weaker integration into the international academic network. Germany and Italy each published 12 articles in this field. The United States, despite publishing only 7 articles, achieved 779 citations, demonstrating high research quality or relevance. In contrast, Brazil's 7 articles garnered only 19 citations, highlighting potential challenges in research dissemination or collaboration. Although the number of related studies from other countries is limited, research from South Korea (2 articles) and South Africa (1 article) provides valuable perspectives. These studies show how companies in different economic and cultural contexts use dynamic capabilities for digital transformation.

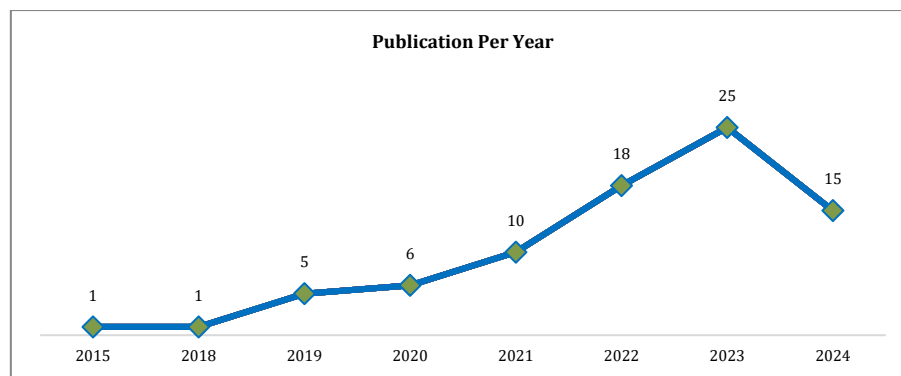


Fig. 2: Number of publications per year

Table 1: Publications per country

Journal	Articles	Citation	TLS
United Kingdom	14	1749	10
China	14	341	1
Germany	12	1603	8
Italy	12	776	7
United States	7	779	7
Brazil	7	19	3
Sweden	6	314	5
India	5	102	6
United Arab Emirates	5	31	1

Table 2 lists the journals that published two or more papers. Among these, the Journal of Business

Research had the largest number of publications, with six articles, highlighting its prominence and high visibility. Sustainability published five papers, ranking second in terms of the number of publications; however, the number of citations is relatively small. Interestingly, Technovation published two articles and received 246 citations, highlighting the potential high quality or significant impact of these specific publications. This journal's diversity indicates that this topic has attracted the interest of many disciplines.

Table 2: Journals with the most published articles

Journal	Articles	Citation
Journal of Business Research	6	758
Sustainability	5	60
Technological Forecasting and Social Change	4	56
Industrial Marketing Management	3	188
IEEE Transactions on Engineering Management	3	13
Technovation	2	246
European Journal of Information Systems	2	157
Production Planning and Control	2	104
Managerial and Decision Economics	2	85
European Journal of Innovation Management	2	42
European Business Review	2	17
International Journal of Innovation and Technology Management	2	13
Journal of Open Innovation: Technology, Market, and Complexity	2	10

The ten most cited articles (Table 3) are all empirical studies, highlighting the field's strong emphasis on evidence-based research. This trend reflects a critical alignment between theoretical

frameworks and real-world applications, highlighting the relevance of dynamic capabilities across various industries and organizational settings.

The most cited article was authored by [Warner and Wäger \(2019\)](#). In this article, the authors analyzed sectors such as automotive, industrial, banking, telecoms, energy, and media publishing. This study proposed a process model showing how companies build dynamic capabilities for digital transformation. The nine micro foundations it identified offer a clear framework to help companies design their digital transformation strategies.

The second most-cited paper, authored by [Karimi and Walter \(2015\)](#), elucidated how first-order dynamic capabilities assist enterprises in reconfiguring their resource base to counter digital disruptions. It identified the factors that create first-order dynamic capabilities from three perspectives: resources, processes, and values. Additionally, the study validated the mediating role of digital platform capabilities in the relationship between dynamic capabilities and response performance. The authors also highlighted the need for further research to determine whether the relationship between dynamic and digital platform capabilities varies across different contexts. The third most-cited paper was authored by [Matarazzo et al. \(2021\)](#). This study focused on a multi-case study of six Italian manufacturing SMEs, examined the role of dynamic capabilities in companies' digital transformation, and

identified key dynamic capabilities. The study demonstrated that digital transformation can utilize dynamic capabilities to create customer value in SMEs, where sensing supports the initiation of digital transformation and learning facilitates its design. This provides SME managers with practical references on how to initiate and design digital transformation.

The paper by [Soluk and Kammerlander \(2021\)](#), ranked fourth in citations, explained the impact of dynamic capabilities in the digital transformation process. They identified three stages of digital transformation: process digitalization, product and service digitalization, and business model digitalization. They also highlighted that digital transformation doesn't end after these stages, and new steps may follow. This digital transformation stage model provides valuable reference for enterprises to identify transformation paths and next steps.

In brief, these influential articles demonstrated the pivotal role of dynamic capabilities in enabling companies to navigate digital transformation. They underscored the necessity of context-specific empirical research to advance theoretical frameworks and inform strategic decision-making in dynamic, digitally disrupted environments.

Table 3: Articles with the most citations

Rank	Reference	Journal	Citations
1	Warner and Wäger (2019)	Long Range Planning	1144
2	Karimi and Walter (2015)	Journal of Management Information Systems	523
3	Matarazzo et al. (2021)	Journal of Business Research	458
4	Soluk and Kammerlander (2021)	European Journal of Information Systems	156
5	Sousa-Zomer et al. (2020)	International Journal of Operations and Production Management	154
6	Ghosh et al. (2022)	Technovation	131
7	Coreynen et al. (2020)	Industrial Marketing Management	117
8	Chirumalla (2021)	Technovation	115
9	Felsberger et al. (2022)	Production Planning and Control	104
10	North et al. (2020)	Journal of Enterprise Information Management	100

Of these 81 studies, 77 empirical studies were conducted in different sectors. [Fig. 3](#) illustrates the most frequently studied sectors. Manufacturing was the most-studied industry, with 30 papers mentioning it (approximately 39.0%). This significant focus on manufacturing indicates its critical role in digital transformation and technological adoption, especially concerning Industry 4.0 and automation. This also confirms the findings of [Remane et al. \(2017\)](#), who identified manufacturing as the core of digital transformation. The service sector, discussed in 13 articles,

highlights ongoing digitalization efforts aimed at enhancing customer experience and operational efficiency. The food and beverages sector, examined in nine articles, underscores the industry's move towards digital solutions for production optimization and consumer engagement.

In summary, research on different industries highlights the breadth of digital transformation research, indicating that the academic community generally recognizes that digital transformation is a common challenge and opportunity faced by all industries.

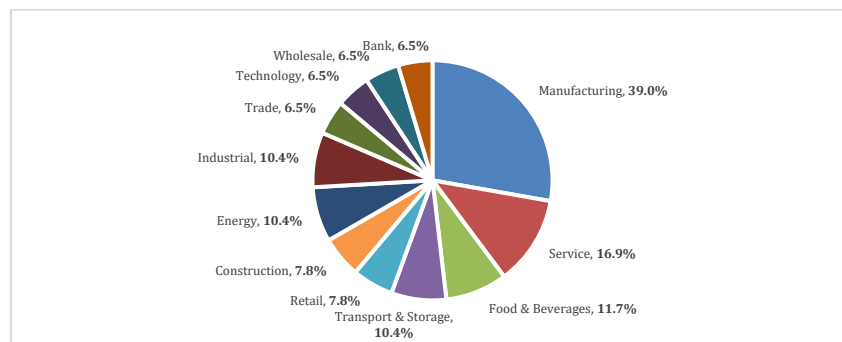


Fig. 3: Most frequently researched sectors

4.2. Bibliometric analysis

Fig. 4 illustrates the co-citation relationships among the journals generated by VOSviewer. This revealed the connections between the co-cited references within the selected 81 articles. Journal articles co-cited more frequently are likely to represent similar academic fields that exhibit strong co-citation relationships within each cluster, forming the basis of different subfields (Braam et al., 1991). The core works of a field serve as a reliable indicator of the influence of journals within the academic community (Batistič et al., 2017) and promote interdisciplinary research (Trujillo and Long, 2018). In Fig. 4, the nodes represent the cited journals, the size of the nodes indicates the number of times a journal is cited, and lines between the nodes represent co-citation relationships, with the thickness of the lines indicating the strength of co-citation. To ensure clearer results, this study set a threshold of 25 citations per source, retaining 30 journals. Strategic Management Journal (275 citations), Journal of Business Research (223 citations), and Long-Range Planning (136 citations)

are the top three most-cited journals. The analysis identified three clusters of journals, which can be categorized as business, strategic management, and technology applications. The visualization highlights strong co-citation relationships across interdisciplinary fields. Co-citation analysis based on authors generated a network of co-authorship and author co-citations to identify key contributors in the field (Fig. 5). These results unequivocally highlight the foundational role of Teece, who has been cited 267 times, establishing him as the central author in this domain. Since 1997, Teece et al. (1997) have published papers advancing the dynamic theory annually, spanning various countries (e.g., the United Kingdom, China, New Zealand, and India) and fields (e.g., manufacturing, technology, and education). Teece (2018) further simplified the dynamic capabilities framework, linking it with strategy to enhance defensive business models and guide organizational digital transformation. Recent studies by Teece (2018) have emphasized dynamic capabilities in corporate digital transformation, particularly in the digital economy era.

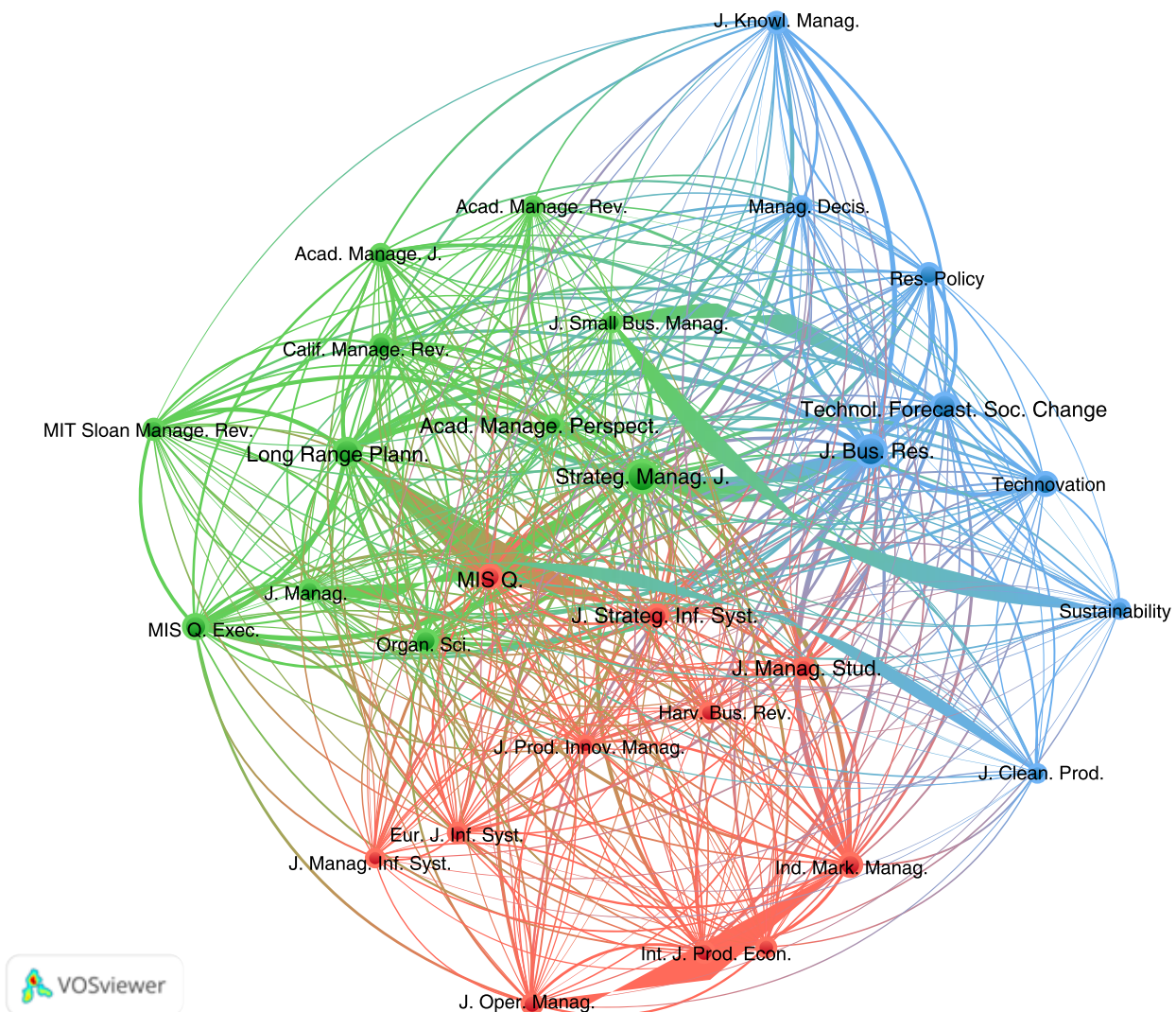


Fig. 4: Visualization of journal co-citation relationships

Other prominent authors identified in the co-citation network include Helfat, Eisenhardt, Hess, and Pisano, who rank among the top five cited authors. Helfat and Raubitschek (2018) focused on the role of dynamic capabilities in digital multi-sided platform ecosystems, emphasizing their importance for platform leaders in responding to and defending against innovation-driven competition. Specifically, they highlighted innovation capabilities and environmental sensing capabilities for identifying emerging opportunities and threats. Dynamic

capabilities also enable companies to adapt to or shape their external environments (Helfat, 2022).

These findings show that the co-citation network reflects the development of key authors' works and highlights the changing focus of dynamic capabilities research. It particularly emphasizes how this research is now addressing modern challenges, such as digital transformation and digital platform ecosystem management. The emergence of other influential scholars highlights the expanding scope of dynamic capabilities in the digital economy.

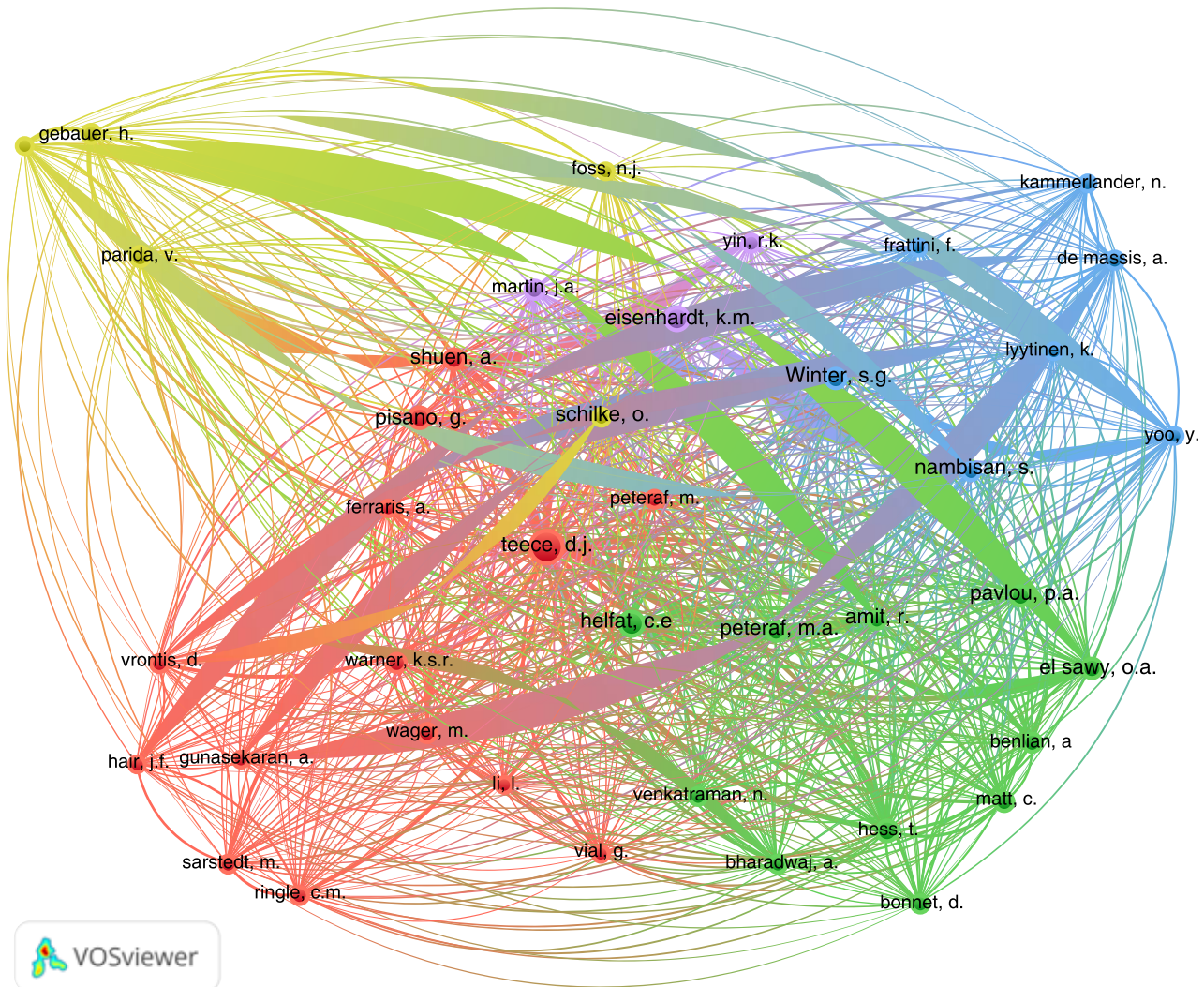


Fig. 5: Visualization of author co-citation relationships

4.3. Keyword analysis in dynamic capabilities for digital transformation

To ensure comprehensiveness, this study considered both author and journal index keywords for network visualization. Using VOSviewer, keyword co-occurrence from scientific metrics was extracted to analyze the focal points of previous research. In co-occurrence analysis, the size of a node indicates the number of documents contained in the node, and the line between two nodes indicates the link between two words, indicating the co-occurrence of keywords. The thicker the line, the higher the frequency of keyword co-occurrence.

To optimize map presentation, this study focused on keywords appearing in at least three publications, resulting in a final set of 32 keywords. At the center of the map lies 'dynamic capabilities' — unsurprisingly, given their strong linkages with other keywords, appearing 60 times with a TLS value of 179 (Fig. 6). Following closely is 'digital transformation,' appearing 44 times with a TLS value of 138. Other keywords with higher co-occurrence frequencies were enterprise resource management (18), digitalization (15), SMEs (14), and Industry 4.0 (13). These terms best represent the research framework.

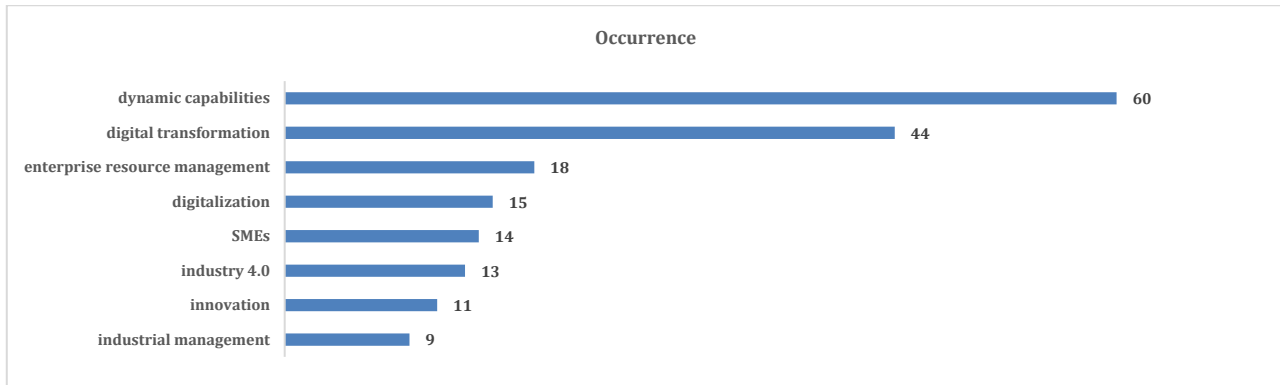


Fig. 6: Co-occurrence of the most often-used keywords

As shown in Fig. 7, these keywords were categorized into six clusters. Each cluster emphasizes distinct aspects of the field, reflecting the diversity and interconnectivity of the research topics.

1. Red Cluster (7 co-occurring keywords): entitled 'dynamic capabilities and digital transformation'

This cluster emphasizes the key role of dynamic capabilities in enabling digital transformation. Key themes include business model innovation, digital technology, and digital innovation, highlighting how companies, particularly SMEs, leverage these elements to navigate technological and market changes. The cluster also explores the integration of sustainability and strategic adaptation as part of digital transformation efforts. The focus on dynamic capabilities underlines their significance in sensing opportunities, seizing them, and transforming organizations for digital transformation.

2. Green Cluster (7 co-occurring keywords): entitled 'competition and industrial adaptation'

This cluster delves into the challenges posed by competitive environments, with an emphasis on the manufacturing industry. It highlights technological innovation and dynamic scheduling as critical factors that enhance performance and adaptability. The focus on competition and commerce underscores the role of market pressures in driving digital transformation. This cluster also considers how manufacturing companies leverage dynamic capabilities to innovate and sustain their competitiveness in rapidly changing environments.

3. Dark Blue (6 co-occurring keywords): entitled 'strategy and performance in Industry 4.0'

This cluster explores the interplay between digital strategies and firm performance within the context of Industry 4.0. It underscores the importance of organizational capabilities in aligning digital transformation efforts with strategic goals. Through case studies, the cluster highlights how manufacturing companies use dynamic capabilities

to adopt new technologies and improve processes for digital transformation.

4. Yellow Cluster (5 co-occurring keywords): entitled 'knowledge and micro foundations'

This cluster examines the micro foundations (e.g., second-order capabilities) of dynamic capabilities in digital transformation. It shows how these foundations support the development of dynamic capabilities. Multiple case studies provide practical insights into this process. Strategic management plays a key role in guiding decisions and allocating resources, requiring flexible strategies to adapt to rapidly changing digital environments. Knowledge is essential for continuous learning and innovation, helping companies sustain and improve their digital transformation efforts.

5. Purple Cluster (4 co-occurring keywords): entitled 'innovation and technological development'

This cluster emphasizes the enabling role of digital platforms and technological development in fostering innovation. It explores the process of digitization and its contribution to digital transformation, highlighting how companies leverage emerging technologies to innovate and adapt. The focus on innovation and digitization aligns with dynamic capabilities, particularly in integrating new technologies into organizational practices.

6. Light Blue (3 co-occurring keywords): entitled 'enterprise resource management and opportunity seizing'

This cluster focuses on the integration of enterprise resource management and industrial management in digital transformation. The keyword "seizing" reflects a specific dimension of dynamic capabilities, emphasizing how companies capture opportunities and align resources to achieve transformation goals. The connection with industrial management highlights the operational and strategic adjustments required to sustain competitive advantages in a digitalized environment.

Keyword analysis and cluster categorization provide a detailed map of the research landscape, revealing distinct yet interconnected thematic areas that reflect the multifaceted nature of the field. The analysis shows how these dynamic capabilities are applied in various industries to address market and technological changes. Furthermore, the interconnectedness among clusters illustrates the interdisciplinary nature of the research, emphasizing the convergence of strategic management,

innovation, and digital technology. Despite the progress, gaps remain in exploring the cultural and human aspects of capability development, suggesting future research directions such as the role of leadership, organizational culture, and cross-industry comparisons. This structured analysis not only identifies key research hotspots but also provides actionable insights, offering a comprehensive overview of the evolving discourse on dynamic capabilities for digital transformation.

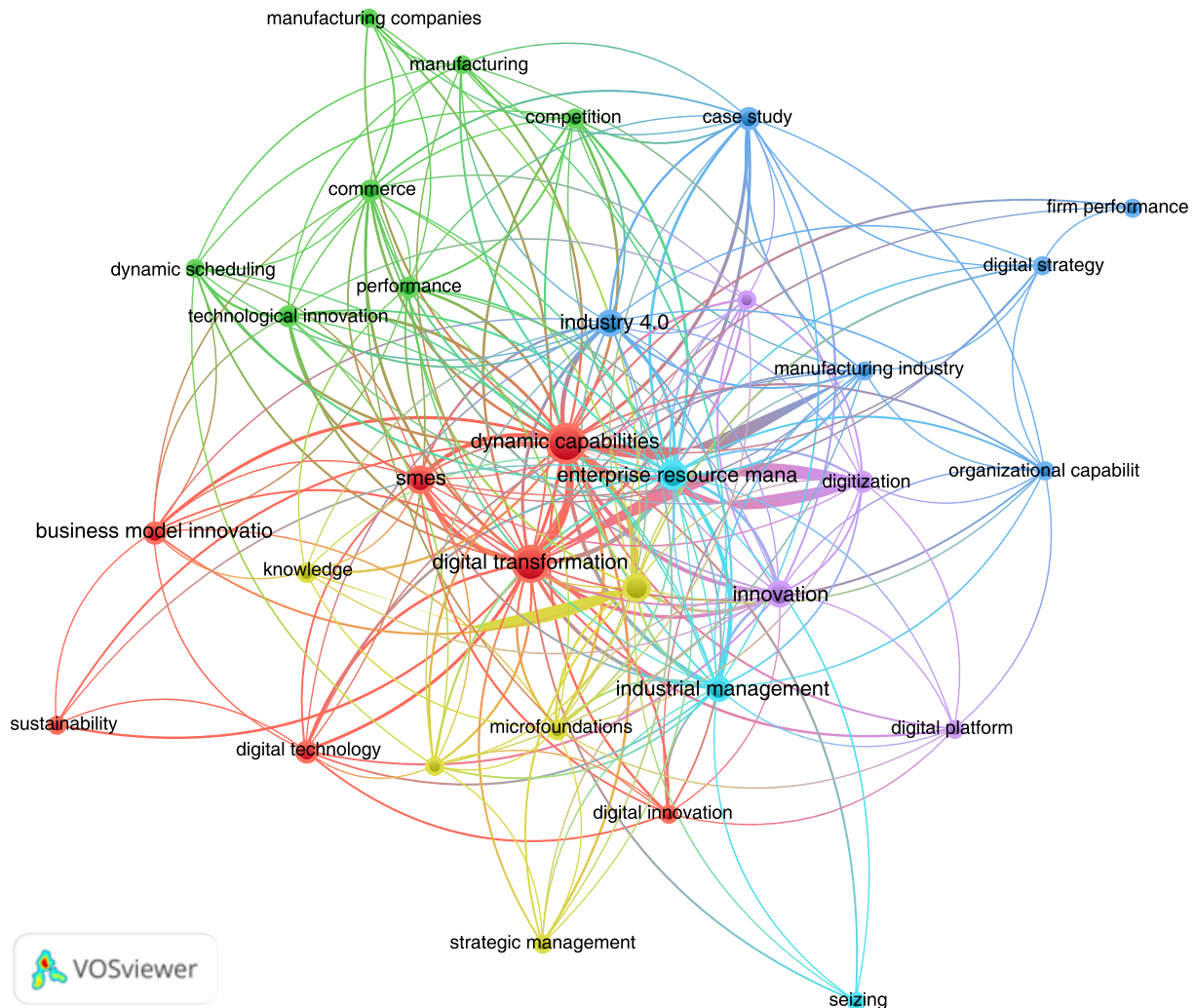


Fig. 7: Network visualization of co-occurrence of keywords

4.4. Content analysis

Merely conducting a bibliometric analysis may not comprehensively evaluate the effectiveness of individual journals. Following a descriptive bibliometric analysis of all publications, this study also conducted a content analysis. The objective of the bibliometric analysis was to examine the databases, whereas content analysis aimed to identify specific dynamic capabilities necessary for digital transformation.

This study included articles that explicitly proposed second-order capabilities or sub-capabilities in content analysis. By reading the full text, we finally screened 12 articles and classified the capabilities discussed in these articles. The results show that successful companies demonstrate strong

dynamic capabilities during the digital transformation process, which provides empirical support for current digital practices.

In these articles, the first type of dynamic capabilities for digital transformation was found to be sensing capabilities. Sensing is not limited to technological opportunities but also includes other environmental changes or internal decisions (Pavlou and El Sawy, 2011; Yeow et al., 2018). Scholars emphasize the importance of sensing because organizations must navigate uncertainty to guide and gain insights into new opportunities (Ghosh et al., 2022; Matarazzo et al., 2021; Warner and Wäger, 2019). These capabilities are not evenly distributed among companies, primarily relying on the organization's knowledge and learning ability,

particularly in understanding user needs related to both existing and new solutions (Teece, 2007).

The second is seizing capabilities, which means that when an organization identifies new technological or market opportunities during digital transformation, it needs to mobilize resources to respond (Feroz et al., 2023). Yeow et al. (2018) state that seizing involves a combination of actions such as designing, selecting among options, and committing. However, owing to inertia, businesses may not always seize opportunities promptly (Teece, 2007). Research confirms that seizing capabilities help companies maintain and enhance agility, thereby improving their ability to capture emerging trends (AlNuaimi et al., 2022; Warner and Wäger, 2019). The third involves the transforming/reconfiguring capabilities of the company, involving 'asset alignment, co-alignment, realignment, and redeployment' (Teece, 2007). Transforming capabilities refer to a company's ability to adjust rapidly and respond to new circumstances during the transformation process.

Sensing and seizing capabilities help in identifying and capitalizing opportunities; however, to execute a digital strategy, companies need to transform their capabilities to effectively implement a digital strategy and fully leverage the benefits of strategic change (Feroz et al., 2023; Saarikko et al., 2020). Companies can achieve success and sustain growth in digital transformation by leveraging transformation capabilities such as cultural transformation and redesigning organizational structures to adapt to ever-changing environments (Saeedikiya et al., 2024; Warner and Wäger, 2019).

In conclusion, most scholars have developed dynamic capabilities for digital transformation based on Teece (2007) (sensing, seizing, and transforming/reconfiguring). They have further identified and built specific second-order capabilities under each of these three types to address various challenges in digital transformation. Table 4 summarizes the dynamic capabilities necessary for digital transformation in the literature.

Table 4: Summary of literature on three dimensions of dynamic capabilities for digital transformation

Dynamic capability dimension	Sub-dimensions/second-order capabilities	Reference
Sensing	Digital scouting/scanning	Warner and Wäger (2019), Witschel et al. (2019), Soluk and Kammerlander (2021), Matarazzo et al. (2021), Ghosh et al. (2022), and de Paula Pereira et al. (2024)
	Digital scenario planning	Warner and Wäger (2019), Chirumalla (2021), and de Paula Pereira et al. (2024)
	Digital mindset crafting	Warner and Wäger (2019) and de Paula Pereira et al. (2024)
	Cross-industrial digital sensing	Ellström et al. (2021), Witschel et al. (2019), and Ghosh et al. (2022)
	Inside-out digital infrastructure sensing	Ellström et al. (2021) and Witschel et al. (2019)
	History and requirement-driven sensing	Chirumalla (2021)
	Proactive-driven sensing	Chirumalla (2021)
	Data-driven sensing	Chirumalla (2021), Saeedikiya et al. (2024), and Brewis et al. (2023)
	Organizational Learning	Matarazzo et al. (2021) and Saeedikiya et al. (2024)
	Rapid prototyping	Warner and Wäger (2019), Witschel et al. (2019), Ghosh et al. (2022), and de Paula Pereira et al. (2024)
Seizing	Balancing digital portfolios	Warner and Wäger (2019) and de Paula Pereira et al. (2024)
	Strategic agility	Warner and Wäger (2019), Chirumalla (2021), Herold et al. (2023), Feroz et al. (2023), Saeedikiya et al. (2024), and de Paula Pereira et al. (2024)
	Determine company boundaries	Witschel et al. (2019) and Ellström et al. (2021)
	Flexible root cause discovery	Chirumalla (2021)
	Opportunity assessment process	Chirumalla (2021)
	Management support	Chirumalla (2021)
	Reorganising routines	Witschel et al. (2019) and Soluk and Kammerlander (2021)
	Effective strategic decision-making	Warner and Wäger (2019), Soluk and Kammerlander (2021), Brewis et al. (2023), and Saeedikiya et al. (2024)
	Ability of employees to learn quickly	Soluk and Kammerlander (2021) and Khurana et al. (2022)
	Hire new human resources	Matarazzo et al. (2021) and Khurana et al. (2022)
Transforming/reconfiguring	Navigating innovation ecosystems	Warner and Wäger (2019), Khurana et al. (2022), and de Paula Pereira et al. (2024)
	Redesigning internal structures	Warner and Wäger (2019), Witschel et al. (2019), Chirumalla (2021), Matarazzo et al. (2021), Ghosh et al. (2022), and de Paula Pereira et al. (2024)
	Improving digital maturity	Warner and Wäger (2019), Witschel et al. (2019), Chirumalla (2021), Khurana et al. (2022), and de Paula Pereira et al. (2024)
	Development of teamwork at the inter-functional level	Witschel et al. (2019), Matarazzo et al. (2021), Chirumalla (2021), and Brewis et al. (2023)
	Decompose digital transformation into specified projects	Ellström et al. (2021)
	Create a unified digital infrastructure	Ellström et al. (2021) and Khurana et al. (2022)
	Business model transformation	Witschel et al. (2019) and Ghosh et al. (2022)
	Cultural transformation	Warner and Wäger (2019), Ghosh et al. (2022), Feroz et al. (2023), and Saeedikiya et al. (2024)
	Information push mechanism	Witschel et al. (2019) and Chirumalla (2021)
	Strategic partnerships	Warner and Wäger (2019), Soluk and Kammerlander (2021), Witschel et al. (2019), and Feroz et al. (2023)
	Brand management	Soluk and Kammerlander (2021)
	Digital strategic prioritization	Feroz et al. (2023) and Saeedikiya et al. (2024)
	Renew the firm continuously	Warner and Wäger (2019), Soluk and Kammerlander (2021), Feroz et al. (2023), and Saeedikiya et al. (2024)

5. Conclusions

This is the first study to conduct a quantitative and qualitative synthesis of the publications in the field of dynamic capabilities for digital transformation using bibliometric techniques and

content analysis. As such, its theoretical contribution is clear and can provide valuable insights for scholars aiming to deepen future research in this area. The study identifies core themes and research trends, offering practical guidance for advancing research in this field.

The results indicate that research on dynamic capabilities for digital transformation primarily adheres to a positivist paradigm, drawing empirical insights from various preliminary studies conducted in industries such as manufacturing, services, and food and beverages. Additionally, most studies rely on single-organization case studies, which somewhat limits the generalizability of the findings. The global research landscape remains uneven, with some regions (e.g., South Africa) still in the early stages of exploration. Future research should explore the integration of dynamic capabilities across different national and industrial contexts.

Additionally, the content analysis synthesis fragmented empirical research findings on dynamic capabilities for digital transformation, elucidating their specific aspects in the dimensions of sensing, seizing, and transforming/reconfiguring. The dynamic capabilities identified in the literature are further divided into 33 second-order capabilities. While these capabilities are widely recognized as essential, their application and integration across different transformation stages remain underexplored. Scholars note that dynamic capabilities may evolve at different stages of the digital transformation process, indicating a need for more research focused on dynamic capabilities from the perspective of the transformation process.

From a practical perspective, this study offers strategic insights for managers. It highlights the critical role of dynamic capabilities in the digital transformation process. These findings can guide managers in developing the capabilities necessary to enhance their organizations' adaptability and competitiveness in an increasingly digitalized market. Specifically, managers can leverage these insights to design actionable strategies for sensing emerging trends, seizing new opportunities, and implementing transformative changes.

Furthermore, the success of digital strategies requires ongoing investments in employee training, cultural development, and knowledge management to ensure the coordinated development of capabilities and optimal resource allocation. Policymakers can support these efforts by providing incentives for digital capability development, such as subsidies for training programs, investments in digital infrastructure, and promoting cross-industry collaboration to foster knowledge sharing and innovation.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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