

Digital transformation in SMEs: global maps and trends of research

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Abstract

Purpose – This paper reviews the literature on digital transformation in SMEs. The general purpose of the paper is to provide an overview of the evolution of digital transformation research in SMEs globally and propose possible future research directions to advance digital transformation research in SMEs.

Design/methodology/approach – This study used a systematic review of the literature by conducting bibliometric analysis and content analysis. The research protocol included 51 articles collected in the Scopus database in the bibliometric analysis. The Scopus database was searched using Publish or Perish, while Excel and Mendeley assistance were used for quantitative investigation of the sample and bibliographic management. A bibliometric analysis was conducted by combining two software applications, Biblioshiny R Studio and VOSviewer.

Findings – Digital transformation (DT) research on SMEs has increased significantly especially after 2015. Using bibliometric analysis and science mapping, seven main research themes were found, namely digital technologies, dynamic capability, digitalization, small and medium enterprises, big data, manufacturing sector and innovation. Seven future DT research trends were also found, namely digital technology adoption, dynamic capability, adaptive leadership, digital literacy, sustainable innovation, managerial readiness and external support.

Originality/value – Compared to existing reviews, we adopt a broader approach and one that does not focus on specific aspects of DT, but adopts an integrated and holistic approach that provides a comprehensive overview of the DT literature in SMEs. In addition to quantitative analysis through bibliometrics, this study also integrated content analysis to determine future research opportunities and directions.

Research limitations – This paper is based on imported bibliographic data from Scopus. The findings of bibliometric analysis may be affected by the use of certain databases. Therefore, the results depend on the selected databases which may lead to different results. Although the literature review procedure was applied, it is possible that there were missed articles related to the topic discussed. The use of different indicators and depiction methods will also lead to different results. Therefore, future researchers should optimize these aspects.

Keywords Digital transformation, SMEs, Systematic literature review, Bibliometric analysis

Paper type Literature review

1. Introduction

The SME sector (small and medium enterprises) is the backbone of the economies of many countries around the world, providing income and job creation for the population (Cueto, Frisnedi, Collera, Batac, & Agaton, 2022). Therefore, the success of SMEs has a direct impact on the sustainable development of a country (Arzubiaga, De Massis, Maseda, & Iturralde, 2023; Naicker & Nsengimana, 2022).



The rapid changes in digitalization and the current business environment have encouraged SME players to carry out digital transformation. In recent years, digital transformation (DT) has emerged as an important phenomenon. Once only seen as a trend, digital transformation has now become an essential component of modern business strategy and plays a critical role in the creation, resilience, success and sustainability of SMEs (Ta & Lin, 2023). Digital transformation has become a necessity for businesses that want to remain viable and competitive in the digital marketplace (Guo et al., 2023; Jafari-Sadeghi, Mahdiraji, Alam, & Mazzoleni, 2023; Martínez-Peláez et al., 2023; Ojochide & Oluwaseyi, 2024). Using digital technologies, business owners can create sustainable business models, minimize costs, reduce adverse environmental impacts and promote social welfare (Marino-Romero, Palos-Sanchez, & Velicia-Martin, 2022; Xu, Hou, & Zhang, 2022).

SMEs need to reposition themselves to carry out digital transformation in order to adapt to businesses in the digital economy era. However, the barriers faced by SMEs are greater than those faced by large companies in adopting DT. SMEs experience greater barriers than large enterprises to digital transformation due to financial, labor and technological limitations to adopt digital infrastructure and adequate staff training (Clemente-Almendros, Nicoara-Popescu, & Pastor-Sanz, 2024). Digital technologies such as Industry 4.0 require specific technical skills, yet SMEs generally lack the in-house expertise to manage such complexities (Hansen, Christiansen, & Lassen, 2024). SMEs are more vulnerable to market fluctuations and regulatory constraints. In developing countries, the lack of a supportive digital ecosystem is an additional challenge (Sukrat & Leeraphong, 2024).

Several studies reveal that the barriers to DT adoption in SMEs also stem from organizational aspects and their vulnerability in an increasingly competitive business environment (Brink & Packmohr, 2023; Egala, Amoah, Bashiru Jibril, Opoku, & Bruce, 2024; Troise, Corvello, Ghobadian, & O'Regan, 2022). SMEs face constraints in adjusting operations and allocating resources optimally (Lei, Tang, Zhao, & Chen, 2024), and have low technology adoption capabilities (Indrawati, Caska, & Suarman, 2020).

Research on DT has begun to develop globally. Digital transformation requires a combination of various complementary resources (Zhang, Xu, & Ma, 2022). However, there is still a gap in research that specifically addresses DT in SMEs. Previous studies have mostly discussed DT in large companies, such as manufacturing companies (Bednářová, Tesařová, & Šimberová, 2023; Nicolás-Agustín, Jiménez-Jiménez, & Maeso-Fernandez, 2022), the hospitality industry (Jayawardena, Ahmad, Valeri, & Jaharadak, 2023; Nikopoulou, Kourouthanassis, Chasapi, Pateli, & Mylonas, 2023) and banks (Shehadeh, Alshurafat, & Arabiat, 2024). There is still not much research on the success of DT in SMEs. The research that has developed only focuses on certain aspects, such as: organizational strategic planning (Rojas-García, Elias-Giordano, Quiroz-Flores, & Nallusamy, 2024), marketing strategies to support digital transformation (Meyer & Peter, 2024), the dynamics of digital change (Escoz Barragan, Hassan, Meisner, & Bzhalava, 2024), technology availability (Hansen et al., 2024), technology availability (Hansen et al., 2024), managerial practices (Kala Kamdjoug, 2024), strategic management (Tomáš, 2023), digital capabilities (Rupeika-Apoga, Petrovska, & Bule, 2022a); the role of social structures and human resources (Lang, Behl, Phuong, Gaur, & Dzung, 2023). This suggests an important gap in the literature on the determinants of successful digital transformation in SMEs.

To address the existing literature gap, this paper is organized to review the literature on DT in SMEs, given that SMEs not only play an important role in economic growth (Batrancea et al., 2022; Brodny & Tutak, 2022; Indrawati, Caska, Hermita, Sumarno, & Syahza, 2023), but also many aspects that differ between SMEs and large firms. Therefore,

this systematic review of the literature seeks to answer the following three research questions (RQs):

RQ1. What factors are most often discussed regarding the success of digital transformation in SMEs?

RQ2. What is the research map of digital transformation in SMEs?

RQ3. What are the future research trends of digital transformation in SMEs?

The overall aim of this study is to provide an overview of the evolution of DT research in SMEs globally and propose possible future research directions to advance DT research in SMEs. Compared to existing reviews, we adopt a broader approach and one that does not focus on specific aspects of DT, but adopts an integrated and holistic approach that provides a comprehensive overview of the DT literature in SMEs.

This paper provides a significant contribution to the existing literature on DT in SMEs. First, this paper will discover the most frequently discussed factors related to the success of DT in SMEs. Second, based on the systematization of co-occurrence analysis and content analysis, this paper will describe the current research framework for DT research in SMEs. Thirdly, based on the developed framework from the literature on DT in SMEs, we suggest a comprehensive agenda for future research that can be utilized by academics to advance knowledge on DT in SMEs.

The rest of the paper is organized as follows: The second section presents a review of previous literature. The third discusses the methodology consisting of data collection and analysis. The fourth and fifth sections present the main findings and future research agenda. The sixth section concludes by summarizing the results, discussing the implications and limitations of the study and proposing future research directions.

2. Literature review

Digital transformation refers to the adoption of modern digital technologies such as mobile devices, artificial intelligence, cloud computing, block chains and the Internet of Things to improve business operations and create added value for companies (Gill et al., 2019). According to Verhoef et al. (2021), DT is the process by which companies utilize digital technology to create and develop new business models, optimize customer interactions and fundamentally change company operations. This perspective is supported by studies (Mai, Nguyen, Ton, & Ahmed, 2024; Hermann et al., 2024; Rupeika-Apoga, Bule, & Petrovska, 2022b) that show how DT encourages companies to leverage technology to create new opportunities, adapt to market needs and improve global competitiveness. The integration of digital technology into business strategy is critical to creating new sustainable business models (Bresciani, Ferraris, Romano, & Santoro, 2021; Mai et al., 2024; Hermann et al., 2024).

DT is different from simple digitization that simply converts information or processes to digital formats to improve operational efficiency. DT involves fundamental changes enabling innovation and the achievement of a company's competitive advantage in the digital age. Key elements of DT include digital technology adoption, business model change, customer experience improvement, process automation, organizational culture transformation, data-driven decision-making and external collaboration, which significantly improve a company's business performance (Lungu & Georgescu, 2024).

In the context of SMEs, digital transformation is often seen as a strategic move to improve efficiency, market reach and innovation capacity (Judijanto, Suwandana, & Paramita, 2024). However, it is difficult for SMEs to achieve success in implementing DT, because adopting

digital technology requires skilled labor, low stakeholder support, lack of willingness of managers to implement DT and difficulty in aligning digital tools with DT vision (Kő, Mitev Ariel, Kovács, Fehér, & Szabó, 2022; Proksch, Rosin, Stubner, & Pinkwart, 2024). Implementing digital technology will help SMEs create new products, reach more customers and perform better. By shifting to digital technology, SMEs will become more competitive (Musyaffi et al., 2024).

This research utilizes bibliometric analysis to identify trends, gaps and key theme relationships in the DT literature on SMEs. This method has proven effective for understanding research directions, including the challenges and opportunities of DT adoption by SMEs (Skare, de Obesso, & Ribeiro-Navarrete, 2023; Akpan, Udoh, & Adebisi, 2022). The results reveal gaps in the literature, particularly the lack of in-depth studies on the success factors of DT implementation, which is the focus of this research.

Bibliometric analysis strengthens the literature review by providing a comprehensive database, identifying important research and ensuring the use of relevant sources. In addition to enriching the theoretical study, this approach also validates the research contribution in understanding the key elements of DT success while emphasizing the importance of DT as a strategy to face the challenges of the digital era.

3. Methodology

This study employs a Systematic Literature Review (SLR) methodology, encompassing data collection, bibliometric analysis and content analysis, with each step detailed as follows:

3.1 Data collection

The research used the Scopus database to gather information, as it presents a collection of publications that are double-blind and have gone through an in-depth peer-reviewed process, and are published in journals with a high level of accuracy (Groff et al., 2020). In addition, Scopus has strong features in terms of citation analysis and the availability of complete metadata, such as author, institution, keywords and abstract information (Pranckutė, 2021).

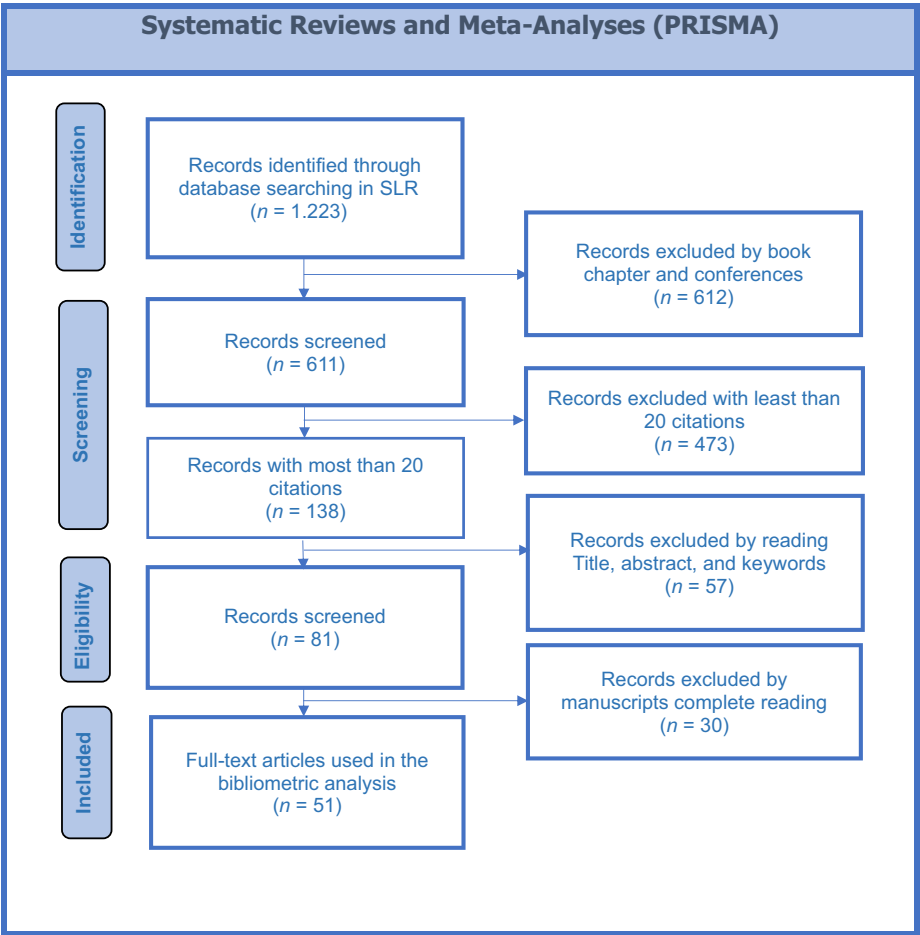
The research was carried out by applying specific criteria to the titles, abstracts and keywords to ensure comprehensive identification of relevant literature. The selection of keywords was designed to capture literature that reflects technology, entrepreneurship and business strategy, aligning with the cross-disciplinary nature of this research topic and supporting the research objectives. The search process was conducted on the Scopus database with the following combination of terms (“Digital” AND “transformation” OR “Digital Transformation”) AND (“SMEs” OR “Small and Medium Enterprises” OR “Small Mid-sized Enterprise”).

This search strategy was designed to ensure comprehensive coverage and high relevance. First, the terms “Digital” and “Transformation” were used as the main elements in the search formula to capture literature focusing on digital technology-based change processes, which are at the core of this research. These terms ensured that only literature relevant to digital transformation was included. Furthermore, the terms “SMEs,” “Small and Medium Enterprises,” and “Small Mid-sized Enterprise” were added to broaden the range of the search and cover the various terms globally used to describe SMEs. The addition of these terms ensured that the research comprehensively captured literature directly related to DT implementation in SMEs.

As the main search formula to ensure the relevance and completeness of the data, we established methodological stages to systematically and completely collect, analyze and understand the data, following the guidelines of previous research frameworks (Ramos Cordeiro, Lermen, Mello, Ferraris, & Valaskova, 2024), which used the

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) presented in [Figure 1](#).

The screening process refers to the document selection stage to ensure only articles relevant to the research topic are considered. In this paper, the initial search process resulted in 1,223 documents published between 2015 and August 19, 2024, covering various document types such as journal articles, book chapters, conference papers, reviews, books, editorials and data papers. The first step in screening is to eliminate all types of documents with only scientific journal articles, leaving 611 journal articles. This was followed by a screening process based on title, abstract and keywords to identify relevant articles, reducing the number of articles to 138. Subsequent screening, using VOSviewer, articles relevant to the research topic were further screened, resulting in 81 articles that met the eligibility



Source: Authors' own work

Figure 1. PRISMA protocol used

criteria. At the final stage of selection, 51 articles met the criteria. This process involved a series of procedures to clean and store the data systematically. Next, the processed data was analyzed in depth using the Biblioshiny analysis tool in R Studio and VOSviewer.

3.2 Bibliometric analysis

Bibliometric analysis is used to analyze global progress in digital transformation research on SMEs, suggesting frameworks and directions for future studies. Bibliometric analysis can be used to analyze research results in a certain time span. Bibliometric analysis is one method that can be used to analyze publications in a particular field (Zhai et al., 2023). Bibliometric analysis uses qualitative and qualitative indices such as publication year, country, citation and use of shared keywords (Marino-Romero, Palos-Sánchez, & Velicia-Martín, 2024). VOSviewer software was used as a bibliometric analysis tool for documents published in the Scopus database (Shirish, Srivastava, & Panteli, 2023). The Scopus database was searched using Publish or Perish, while Excel and Mendeley were used for quantitative investigation of the sample and bibliographic management.

In the bibliometric analysis phase, a comprehensive analysis of the 51 selected articles was conducted using a combination of the Biblioshiny program in R Studio and VOSviewer. This combination supports thorough scientific mapping, enriching the analysis and interpretation of research results, as proposed by Cobo, López-Herrera, Herrera-Viedma, and Herrera (2011). Biblioshiny in R Studio was chosen because of its advantages over other tools such as SciMAT, Citan, VOSviewer and so on (Moral-Muñoz, Herrera-Viedma, Santisteban-Espejo, & Cobo, 2020). This bibliometric analysis aims to map and evaluate existing research results. The articles were downloaded in BibTeX format from the Scopus database and then processed visually through the Bibliometrix Biblioshiny online platform to produce graphs, tables, spreadsheets and other visual features.

3.3 Content analysis

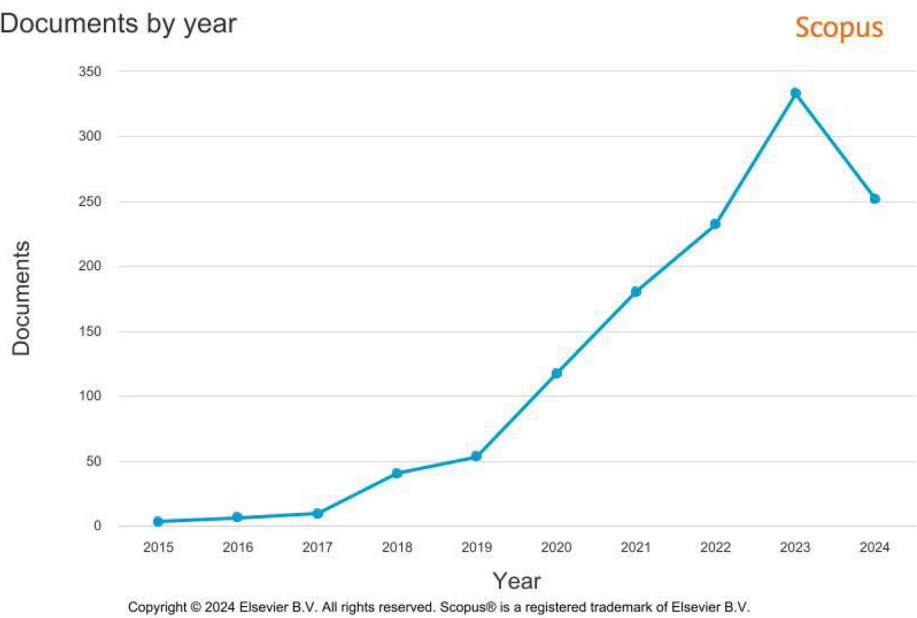
The content analysis phase followed the steps of previous research (Ghobakhloo & Iranmanesh, 2021; Ramos Cordeiro et al., 2024) by conducting a qualitative content analysis of 51 journal articles selected from the bibliometric analysis results. This analysis aimed to describe the current DT research framework on SMEs. Using a sample of 51 articles, the method employed open coding, categorization and abstraction techniques to find relevant data and gather appropriate information for further analysis. This abstraction process ultimately facilitated collaboration between authors to explore each community.

4. Results

4.1 Evolution of DT Research in SMEs

This research process identified 1,223 documents related to digital transformation (DT) research in SMEs, as shown in Figure 2. It can be seen that research related to DT in SMEs has increased significantly from 2015 to 2024, with the peak of publications occurring in 2023. This reflects the high attention of researchers to digital transformation, especially in recent years. Between 2015 and 2024, 1,223 documents have been published in various research fields.

Table 1 presents the ten most influential articles based on the number of citations in this theme. All articles show significant numbers based on this criterion, with Matarazzo, Penco, Profumo, and Quaglia (2021) standing out as the top one receiving 502 global citations, showing its significant impact, both in terms of total citations and average citations per year, signaling its relevance in this research area.



Source: Authors' own work

Figure 2. Number of published articles

Table 1. Most impactful articles

Articles	Total citations	Articles	Average citation per year
Matarazzo et al. (2021)	502	Matarazzo et al. (2021)	125.5
Priyono et al. (2020)	332	Priyono et al. (2020)	66.4
Bouwman et al. (2019)	324	Stentoft et al. (2021)	58.5
Stentoft et al. (2021)	234	Bouwman et al. (2019)	54.0
Klein et al. (2021)	199	Klein et al. (2021)	49.8
Garzoni et al. (2020)	194	Del Giudice et al. (2021)	45.0
Del Giudice et al. (2021)	180	Omrani et al. (2024)	43.0
Soluk et al. (2021)	166	Soluk et al. (2021)	41.5
Zangiacomi et al. (2020)	165	Garzoni et al. (2020)	38.8
Ghobakhloo et al. (2021)	152	Ghobakhloo et al. (2021)	38.0

Source: Authors' own work

Table 2 displays the top ten influential journals based on the number of articles published and total citations. Our results show that the Journal of Business Research and Sustainability (Switzerland) is the most productive journal with five articles published. It is one of the leading journals in the field of business and management research, followed by Production Planning and Control, Journal of Open Innovation and Competitiveness Review are also important platforms for research in this area, albeit with fewer article contributions by publishing two articles each.

Table 2. Most impactful journals

Journals	No. of articles	Journals	Total citations
<i>Journal of Business Research</i>	5	<i>Journal of Business Research</i>	718
<i>Production Planning and Control</i>	2	<i>Production Planning and Control</i>	399
<i>Sustainability (Switzerland)</i>	5	<i>Journal of Open Innovation: Technology, Market, and Complexity</i>	355
<i>Journal of Open Innovation: Technology, Market, and Complexity</i>	2	<i>Sustainability (Switzerland)</i>	241
<i>Competitiveness Review</i>	2	<i>Competitiveness Review</i>	174
<i>Journal of Knowledge Management</i>	2	<i>Journal of Knowledge Management</i>	171
<i>Journal of Strategy and Management</i>	2	<i>Journal of Strategy and Management</i>	147
<i>Journal of Small Business and Enterprise Development</i>	2	<i>Journal of Small Business and Enterprise Development</i>	95
<i>Business: Theory and Practice</i>	1	<i>Business: Theory and Practice</i>	45
<i>Bulletin of Electrical Engineering and Informatics</i>	1	<i>Bulletin of Electrical Engineering and Informatics</i>	21

Source: Authors' own work

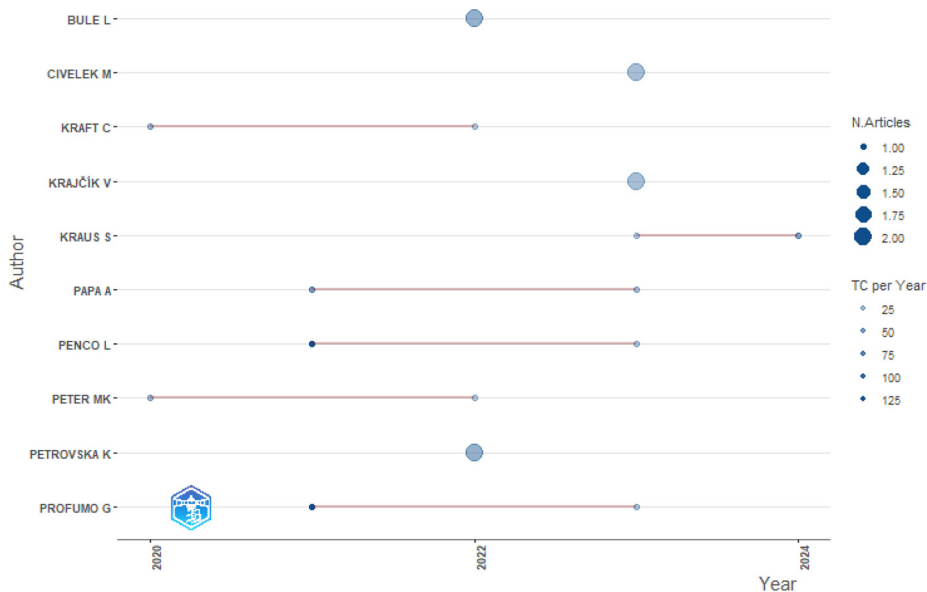
Figure 3 shows the production of top authors over time. Authors such as Kraus S, Civelek M and Krajčák V show high research activity in 2023, with significant contributions to the topic of DT in SMEs. This indicates that they produce quality publications and have ongoing engagement in developing the literature in this area. Most authors reach their productivity peak in 2023, which marks an intensive period of research on DT in SMEs. The name Kraus S also appears in 2024 publications, hinting at the potential for further contributions to this research. For example, Kraus et al. (2022) highlighted a holistic approach to digital transformation, including the integration of technology with management, culture and corporate resources. This research emphasizes that the success of DT in SMEs often depends on their ability to recognize market changes and adapt their strategies accordingly (Civelek, Krajčák, & Ključnikov, 2023).

To support the DT process, SMEs can adopt strategies such as partnering with technology companies, seeking external funding and implementing practical training programs. The contributions of leading authors over the past few years, as shown in Figure 3, provide important insights into the success factors of DT in SMEs.

Figure 4 highlights the contributions of institutions in this field. Several universities, such as Dhofar University, ESCP Business School, Free University of Bozen-Bolzano, Pan-European University, Sapienza University of Rome, University of Applied Sciences And Arts Northwestern Switzerland FHNW, University of Johannesburg, University of Latvia, University of Macerata and University of Oulu, contributed two studies each. The significant contributions of these institutions reflect the important role of higher education in supporting research in DT in SMEs.

Figure 5 displays the ten countries with the highest number of publications related to DT in SMEs. Italy ranks first with 30 scientific contributions, demonstrating the country's dominance in research in this area. The high scientific production of these countries reflects the importance of DT in SMEs in the context of the global economy and innovation.

The ability of SMEs to quickly adapt to technological and market changes is critical in dealing with today's business dynamics. This dynamic capability involves flexibility in allocating resources as well as the ability to adjust business strategies according to new technological developments (Civelek, Krajčák, & Ključnikov, 2023; Ghobakhloo & Iranmanesh, 2021;



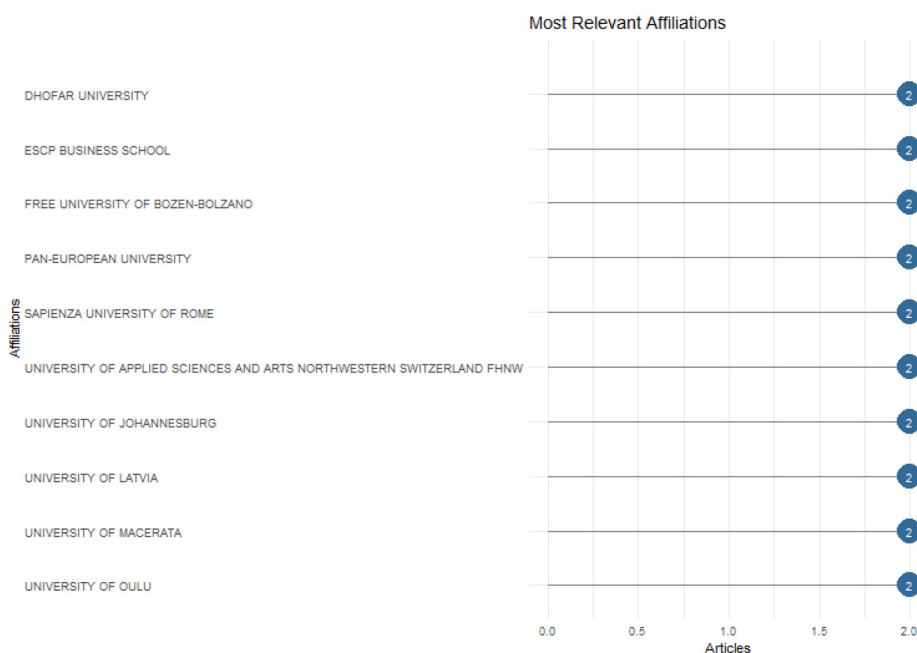
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Figure 3. Top authors' production over time

Omriani, Rejeb, Maalaoui, Dabic, & Kraus, 2024). SMEs that are able to respond to environmental changes and capitalize on market opportunities through the adoption of digital technologies are more likely to succeed in digital transformation (Civelek, Krajčık, & Ključnikov, 2023; Matarazzo et al., 2021; Soluk & Kammerlander, 2021). The digital readiness and competence of employees and leaders are crucial in supporting this process, where low digital literacy can be a major obstacle to the progress of digital transformation (Ghobakhloo & Iranmanesh, 2021; Krajčık, Novotný, Civelek, & Zvolánková, 2023; Rupeika-Apoga et al., 2022b). Therefore, developing digital skills among staff and leaders of SMEs is crucial to ensure success in digital transformation.

Innovation in business models, such as the transition from traditional to digital approaches, is also an important aspect in supporting the success of digital transformation. This includes the integration of technology in business operations and the development of sustainable digital strategies (Kraus et al., 2022; Peter, Kraft, & Lindeque, 2020). In addition, adaptability in transforming traditional business models to digital enables SMEs to respond to challenges, including those arising from the COVID-19 pandemic (Bouwman et al., 2019; Garzoni, De Turi, Secundo, & Del Vecchio, 2020; Priyono, Moin, & Putri, 2020). Advanced technologies, such as Industry 4.0, also improve operational efficiency and drive product and service innovation (Del Giudice et al., 2021; Peter et al., 2020; Zangiacomi, Pessot, Fornasiero, Bertetti, & Sacco, 2020). Therefore, a well-planned DT strategy, followed by technology integration across all aspects of the business and consistent execution, is critical to success (Kraus et al., 2022; Peter et al., 2020).

Collaboration with external partners, such as technology companies and digital service providers, allows SMEs to gain easier access to the technology and training needed. These partnerships, including with experienced IT companies or universities, can accelerate the



Source: Authors' own work

Figure 4. Affiliations with the highest scientific production on the topic

digitalization process (Civelek et al., 2023; Penco, Profumo, Serravalle, & Viassone, 2023). On the other hand, government policies that support digital transformation, such as regulations that facilitate technology adoption and access to funding, are significant enablers for SMEs (Kraus et al., 2022; Peter et al., 2020). Support from the government, conducive policies and adequate digital infrastructure play an important role in the success of TD, although challenges such as limited resources remain an obstacle (Omrani et al., 2024; Stentoft, Adsbøll Wickstrøm, Philipsen, & Haug, 2021). The COVID-19 pandemic has also accelerated the adoption of digital technologies, with entrepreneurship and innovation playing a central role in driving the transformation process (Klein & Todesco, 2021; Penco, Profumo, Serravalle, & Viassone, 2023).

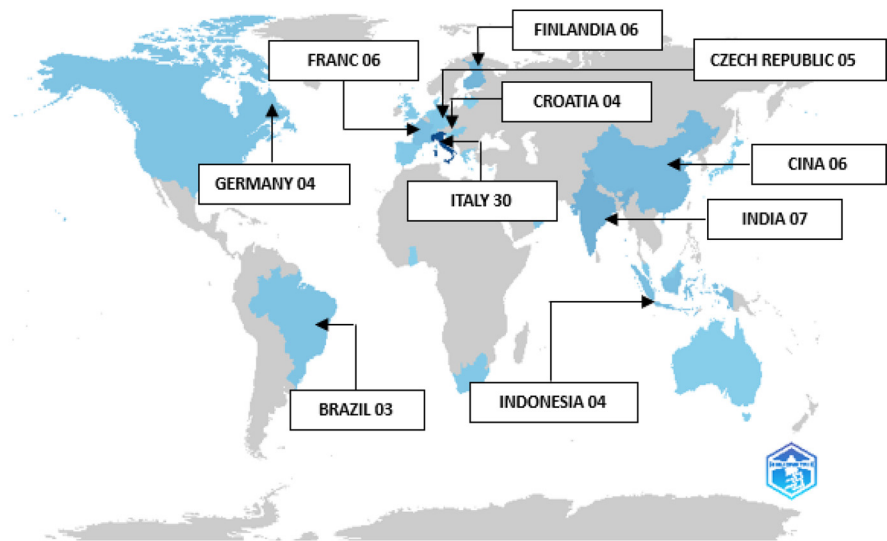
Other factors contributing to DT's success are organizational culture and leadership that support innovation and adaptation to technology. Visionary leaders who are able to drive change are often the main drivers in the digital transformation process in SMEs (Kraus et al., 2022; Penco, Profumo, Serravalle, & Viassone, 2023).

Factors such as dynamic capabilities, digital literacy, business model innovation, strategic partnerships, government support and organizational culture are the main elements that influence the success of digital transformation in SMEs. Thus, determining the determinants of DT success in SMEs in this study can produce maps and trends that are more targeted, relevant and contributive to the future of digital transformation in SMEs.

4.2 Co-occurrence network analysis

The co-occurrence analysis resulted in the formation of seven cluster groups covering 26 keywords shown in Figure 6. Table 3 describes the keywords by cluster, including the

Country Scientific Production



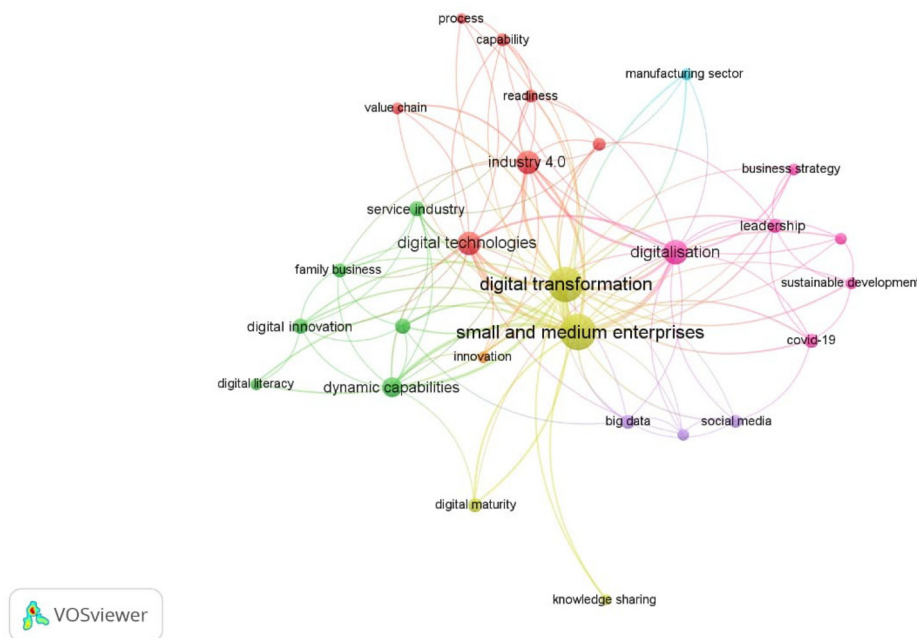
Source: Authors' own work

Figure 5. Country collaboration map

number of occurrences and their total link strength. Figure 6 shows that the co-occurrence analysis indicates key terms that are more widely discussed in the literature (larger nodes in the figure), namely Red cluster-"Digital technologies", Green cluster-"Dynamic capabilities", Pink cluster-"Digitalization", Yellow cluster-"Small and medium enterprises", Purple cluster-"Big data", Blue cluster-"Manufacturing sector" and Orange cluster-"Innovation". Table 3 illustrates the keywords by cluster, highlighting the number of occurrences and their total link strength.

4.2.1 Red cluster-"digital technologies". This cluster emphasizes the importance of using digital technologies and implementing Industry 4.0. The concept of Industry 4.0 involves automation and data exchange through advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI) and big data analysis. Digital technologies play an important role in accelerating the digitization process, ultimately improving companies' capabilities in the value chain. The buzzwords digital technologies and Industry 4.0 often appear together, emphasizing the importance of digital technology and automation in driving transformation in SMEs. This suggests that adopting modern technologies is an important foundation in the digital transformation process of SMEs.

4.2.2 Green cluster-"dynamic capabilities". This cluster centers on the dynamic capabilities and digital innovation of SMEs to adapt to technological change. The focus is on digital literacy, technology adoption and the role of family businesses and service industries in dealing with digital transformation. This cluster highlights the dynamic capabilities required by businesses, particularly family businesses and service industries, to adopt digital innovation and develop digital literacy. The keywords dynamic capability and digital innovation highlight the importance of adaptability and innovation in ensuring DT's success.



Source: Authors' own work

Figure 6. Co-word occurrence analysis: network map

Companies that are able to adapt quickly to technological change have a greater chance of succeeding.

4.2.3 Pink cluster-"digitalization". This cluster emphasizes digital transformation in the context of the challenges of the COVID-19 pandemic, which is forcing many businesses to adapt and redefine their business strategies. Adaptive leadership is essential in the face of these sudden changes. The study also emphasizes the importance of sustainability and business performance in executing digital transformation effectively and sustainably, especially during times of crisis. The keyword leadership in the pink cluster suggests that strong and adaptive leadership, especially during the COVID-19 pandemic, plays a critical role in determining the direction of a successful business strategy in the face of digitalization.

4.2.4 Yellow cluster-"small and medium enterprises". This cluster emphasizes the importance of digital transformation for SMEs and the digital maturity required to survive in the digital age. Knowledge sharing is also an important element to accelerate SMEs' adaptation to digital transformation. This cluster focuses on digitalization in small and medium enterprises (SMEs). SMEs must share knowledge and build digital literacy to compete in the digital economy. Digital transformation in SMEs requires a deep understanding of how digital technologies can improve competitiveness and operational effectiveness. The co-occurrence of the keywords digital maturity and small and medium enterprises shows that SMEs that achieve digital maturity are more prepared and able to effectively utilize digital technologies to improve competitiveness.

Table 3. Co-word occurrence clusters

Clusters	Occurrences	Total link strength	Main research topics
<i>Red cluster (n = 7)</i>			Digital technologies
Digital technologies	9	31	
Industry 4.0	9	28	
Capability	2	7	
Mixed method	2	7	
Process	2	4	
Readiness	2	7	
Value chain	2	6	
<i>Green cluster (n = 6)</i>			Dynamic capability
Dynamic capability	8	20	
Digital innovation	2	10	
Digital literacy	2	5	
Family business	2	8	
Service industry	2	11	
Technology adoption	2	11	
<i>Pink cluster (n = 6)</i>			Digitalisation
Digitalisation	12	38	
Covid-19	3	8	
Leadership	3	9	
Business strategy	2	5	
Performance	2	6	
Sustainable development	2	6	
<i>Yellow cluster (n = 4)</i>			Small and medium enterprises
Small and medium enterprises	36	90	
Digital transformation	34	83	
Digital maturity	3	8	
Knowledge sharing	2	4	
<i>Purple cluster (n = 3)</i>			Big data
Big data	2	8	
Business model innovation	2	6	
Social media	2	7	
<i>Blue cluster (n = 1)</i>			Manufacturing sector
Manufacturing sector	2	6	
<i>Orange cluster (n = 1)</i>			Innovation
Innovation	2	6	
Source: Authors' own work			

4.2.5 *Purple cluster-“big data”*. This cluster focuses on the use of big data and innovation in business models driven by social media. This is important in helping SMEs improve their competitiveness through better data analysis and more innovative approaches to the market. This cluster illustrates how business model innovation is influenced by the use of big data and social media. The utilization of big data allows companies to make more accurate decisions, while social media aids in customer interaction and digital marketing. Business model innovation is often driven by the ability to leverage big data and social technologies to gain competitive advantage. The co-occurrence of the keywords *big data* and

business model innovation emphasizes that the ability of companies to leverage big data for business model innovation, as well as the use of social media, is key in creating competitive advantage.

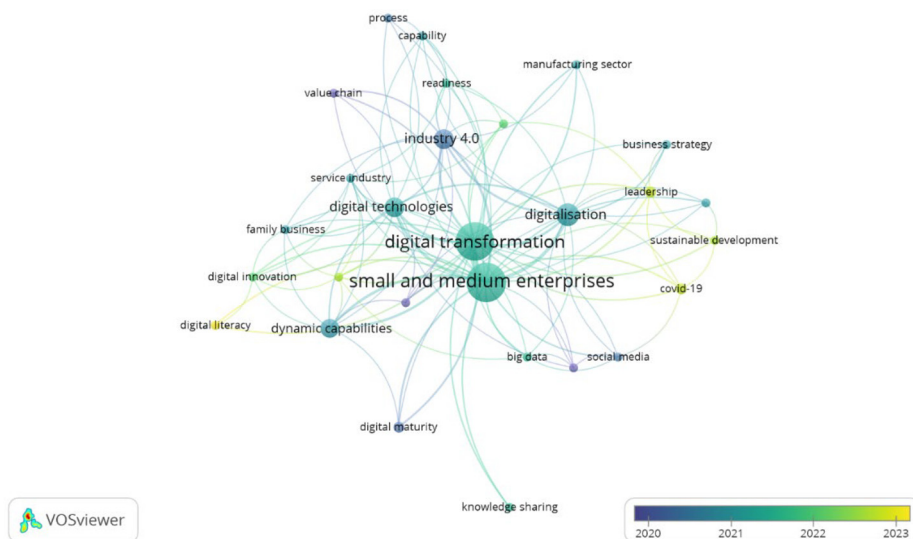
4.2.6 Blue cluster-“manufacturing sector”. This cluster specifically examines the manufacturing sector in the context of digital transformation. The focus is on how the sector adopts digital technologies to improve productivity and efficiency.

4.2.7 Orange cluster-“innovation”. This cluster focuses on innovation as a key factor in driving digital transformation. Innovation is considered a key driver in the development of successful digital strategies in SMEs. The last cluster emphasizes the importance of innovation in the context of digitalization. Innovation is a key factor for companies to adapt quickly to technological changes and market competition.

Keyword co-occurrence analysis can reveal important factors that influence the success of DT in SMEs. The clusters generated from this analysis provide a comprehensive picture of the various aspects that determine the success of DT in SMEs.

4.3 Co-occurrence analysis considering a time frame

The analysis over time is presented in [Figure 7](#), where the color of the nodes provides additional information. *Nodes* with yellow color indicate keywords with more recent research. Terms with darker colors (from purple to green) represent topics that have been published from 2020 to 2022. Meanwhile, the terms in yellow indicate recent publications that reflect current research trends. While DT's approach to SMEs has consolidated in the early years of the analysis, more recent research highlights topics such as leadership, sustainable development, covid-19, technology adoption and digital literacy.



Source: Authors' own work

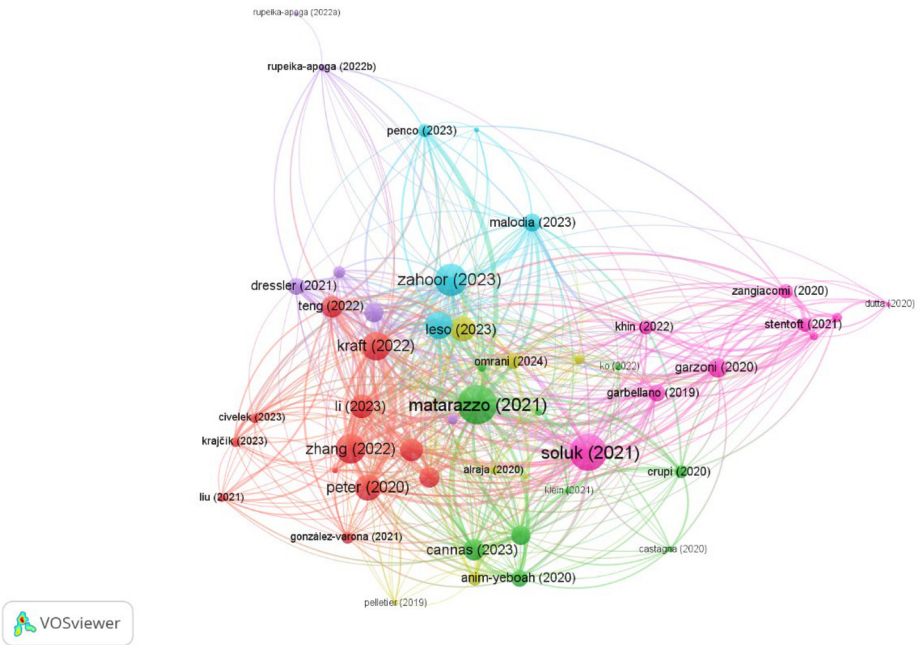
Figure 7. Co-occurrence analysis considering a time frame

4.4 Bibliographic coupling of document analysis: network map

The results of literature screening from the Scopus database analyzed by *Bibliographic coupling* of articles show groups of articles that have the same references grouped together resulting in six cluster groups covering 51 articles. The clusters formed may indicate research that has similar topics or approaches. Analyzing these clusters can help identify recurring themes and methodologies that are considered effective in the success of DT in SMEs. [Figure 8](#) shows the co-citation network map with six clusters and 583 *links* formed from VOSviewer.

The content analysis of each article included in the article allowed the identification of the main themes that form the intellectual structure of this research stream as follows:

4.4.1 Red cluster. The red cluster discusses how SMEs can utilize digital technology to succeed in the digital era. The success of SMEs in digital transformation largely depends on their ability to adapt to changes in the business environment and technology ([Peter et al., 2020](#)). The application of digital technology can improve operational efficiency and create added value for customers, which supports business success and competitiveness ([Teng, Wu, & Yang, 2022](#)). The importance of adaptation, technology integration and organizational culture in achieving DT success in SMEs ([Zhang et al., 2022](#)). An organizational culture that supports innovation, adequate technological capabilities, and human resource skills are important elements that determine the success of digital transformation. Overall, the main focus of this cluster is on identifying the strategic, managerial, technological and organizational capability factors that support successful



Source: Authors' own work

Figure 8. Bibliographic coupling of document analysis: network map

digital transformation in SMEs, taking into account the diverse contexts and challenges faced during the digitization process (Ben Slimane, Coeurderoy, & Mhenni, 2022; Civelek et al., 2022; Civelek et al., 2023; González-Varona, López-Paredes, Poza, & Acebes, 2021; Kraft, Lindeque, & Peter, 2022; Krajčík, 2023; Li, Yang, Jin, & Wang, 2023; Liu, Ni, Karlsson, & Gong, 2021; Peter et al., 2020; Riera & Iijima, 2019; Teng et al., 2022; Zhang et al., 2022; Zoppelletto, Orlandi, Zardini, Rossignoli, & Kraus, 2023).

4.4.2 Green cluster. Green clusters emphasize the significance of dynamic capabilities, a culture of innovation and the application of technology as the main factors that influence the success of DT in SMEs. For this reason, SMEs need to develop the ability to adapt and respond to changes in the market and customer needs (Matarazzo et al., 2021). SMEs that effectively integrate digital technologies into their business models can enhance customer value and strengthen their competitiveness. The success of DT largely depends on SMEs' ability to adapt to new technologies and adjust their business processes to meet market demands (Cannas, 2023). On the other hand, the adoption of smart technologies and the ability of SMEs to adapt to rapid changes in the business environment are crucial. Thus, support for innovation and development of technological capabilities are key determinants of DT success (Del Giudice et al., 2021). Overall, research in this cluster explores various aspects of digital transformation in SMEs, with a focus on dynamic capabilities, digital innovation, technological adaptation and crisis coping strategies (Anim-Yeboah, Boateng, Odoom, & Kolog, 2020; Cannas, 2023; Castagna et al., 2020; Crupi et al., 2020; Del Giudice et al., 2021; Kääriäinen et al., 2020; Klein & Todesco, 2021; Kő et al., 2022; Lányi, Hornyák, & Kruzsliz, 2021; Matarazzo et al., 2021).

4.4.3 Pink cluster. The success of digital transformation in SMEs is strongly influenced by several key factors, including dynamic capabilities, strong leadership, investment in technology and skills development. The ability to adapt and innovate is a vital element in achieving such success (Soluk & Kammerlander, 2021). In addition, factors such as visionary leadership, technology investment and employee upskilling also act as key drivers that prepare SMEs for the digital transformation process (Khin & Hung Kee, 2022). However, success in digital transformation does not only depend on how well technology is adopted; the interaction between business strategy, organizational structure, operational processes and corporate culture is also crucial in supporting the achievement of digital goals (Garzoni et al., 2020). The combination of all these factors forms a solid foundation for achieving a successful digital transformation. Overall, this research provides deep insights into how SMEs can face challenges and capitalize on opportunities in adopting digital technology and facing Industry 4.0. The main focus of this research is on the technological readiness, organizational capabilities and managerial strategies required to ensure success in digital transformation (Dutta, Kumar, Sindhwani, & Singh, 2020; Garbellano & Da Veiga, 2019; Garzoni et al., 2020; Ghobakhloo & Iranmanesh, 2021; Khin & Hung Kee, 2022; Nwaiwu, Duduci, Chromjakova, & Otekhile, 2020; Soluk & Kammerlander, 2021; Stentoft et al., 2021; Zangiacomini et al., 2020).

4.4.4 Yellow cluster. The success of digital transformation in SMEs is influenced by a number of factors, such as a supportive organizational culture, flexible structure, effective leadership and technological and human resource readiness. An organizational culture that encourages innovation and collaboration plays an important role in facilitating change, while a flexible structure allows SMEs to respond quickly to market changes. In addition, visionary and transformative leadership contributes greatly to motivating employees and directing the entire digital transformation effort within the organization (Leso, Cortimiglia, & Ghezzi, 2023). The importance of adopting appropriate technologies and developing organizational capabilities to support innovation is also a major concern. Digital readiness, employee skills

and management support are factors that greatly affect the success of the digital transformation process (Omrani et al., 2024). Thus, technological readiness and human resource competencies are considered crucial determinants of successful digitization (Okfalisa, Anggraini, Nawanir, Saktioto, & Wong, 2021). Overall, this cluster emphasizes the importance of organizational readiness, support from the ecosystem and an adaptive culture in driving digital transformation in SMEs (Alraja, Hussein, & Ahmed, 2021; Leso et al., 2023; Nair, Chellasamy, & Singh, 2019; North, Aramburu, & Lorenzo, 2020; Okfalisa et al., 2021; Omrani et al., 2024; Pelletier & Cloutier, 2019).

4.4.5 Purple cluster. The success of digital transformation in SMEs is influenced by several key factors, including the adoption of technologies that match organizational capacity, the ability to adapt to digital business models and a commitment to sustainability and innovation. Flexibility and the ability to adapt to changing situations are vital elements in the implementation of effective digital transformation (Priyono et al., 2020). The use of appropriate technology can improve operational efficiency and optimize processes, which further supports the success of digital transformation. Readiness to adopt new technologies and staff involvement in their use are also important aspects in achieving DT success (Dressler & Paunovic, 2021). The integration of sustainability principles in the digital transformation process is crucial, as sustainable strategies are able to support long-term competitiveness. In addition, the ability to adapt to market changes and consumer needs is a determining factor in achieving DT success (Savastano, Zentner, Spremić, & Cucari, 2022). Overall, this cluster emphasizes how business model innovation, public support and proper technology adoption can strengthen the position of SMEs in facing changes and challenges in the digital era, especially in crisis situations such as the COVID-19 pandemic (Bouwman et al., 2019; Dressler & Paunovic, 2021; Priyono et al., 2020; Rupeika-Apoga et al., 2022a, 2022b; Savastano et al., 2022).

4.4.6 Blue cluster. The success of digital transformation in SMEs is influenced by various factors, including crisis resilience, digital literacy, managerial attributes and belief in digital capabilities. Effective leadership and strategic design also play an important role in this process. All these elements support each other and contribute to SMEs' ability to face challenges in the digital age (Khurana, Dutta, & Singh Ghura, 2022; Malodia, Mishra, Fait, Papa, & Dezi, 2023; Zahoor, Zopiatas, Adomako, & Lamprinakos, 2023). This cluster explores how internal and external factors influence the process and outcomes of digital transformation in SMEs, as well as how they build resilience through the adoption of digital technologies during times of crisis (Khurana et al., 2022). Such resilience includes the ability to adapt, innovate and leverage existing resources to remain competitive. In addition, managerial understanding and ability to manage digital technology greatly influence the success of the transformation. SMEs led by managers with good managerial skills and high digital literacy tend to be more successful in adopting new technologies and implementing effective digital strategies (Zahoor et al., 2023). Strong leadership and the ability of individuals to utilize digital technology are also important factors in achieving success in digital transformation. Leadership that provides clear direction and supports the development of digital skills for employees can increase the chances of success of the digitization process (Kaftan, Kandalov, Molodtsov, Sherstobitova, & Strielkowski, 2023; Ragazou, Passas, & Sklavos, 2022; Versiani, Abade, de Carvalho, & De Muyllder, 2024). Overall, the research in this cluster highlights aspects of resilience, digital literacy and entrepreneurial orientation as drivers of SMEs' digital transformation amid the crisis. This research provides insights into how SMEs can develop dynamic capabilities and effective strategies to survive and grow in uncertain situations.

5. Future research agenda

Bibliometric map analysis enables the identification of gaps in existing research and the prediction of future research trends. This opens up opportunities to determine research directions that are still rarely explored. Based on the network map analysis of shared word occurrence and bibliographic coupling, [Table 4](#) presents a future research agenda to advance research in the field of digital transformation in SMEs. Based on [Table 4](#), it can be explained as follows:

5.1 Adoption of digital technology

The adoption of digital technologies (IoT, AI, Big Data and automation) acts as a key foundation in the digital transformation of SMEs. These technologies affect the value chain, enabling SMEs to improve operational efficiency and connectivity with the market ([Ghobakhloo & Iranmanesh, 2021](#); [Priyono et al., 2020](#)). The readiness of companies to adopt technology is an important key in ensuring the smooth process of digitalization.

5.2 Dynamic capability

Dynamic capabilities are an organization's ability to adapt, develop innovations and create value for customers amid technological change. It includes the ability to innovate on business models and products ([Cannas, 2023](#); [Matarazzo et al., 2021](#)). SMEs that adapt quickly to technological changes have a greater chance of succeeding in digital transformation.

5.3 Adaptive leadership

Leadership that is adaptive and responsive to technological change plays a critical role in the successful digital transformation of SMEs. Effective leadership is needed to create a culture of innovation, direct business strategy and manage human resources during crisis and rapid change ([Clemente-Almendros et al., 2024](#); [Del Giudice et al., 2021](#); [Khin & Hung Kee, 2022](#)).

5.4 Digital literacy

Digital literacy is an important prerequisite for the success of SMEs in utilizing digital technology. The higher the digital literacy, the greater the digital maturity achieved by SMEs, which allows them to utilize technology to improve competitiveness ([Matarazzo et al., 2021](#); [Priyono et al., 2020](#); [Zahoor et al., 2023](#)).

5.5 Continuous innovation

Continuous innovation in business models and operational processes is necessary to maintain the relevance of SMEs in a changing market. The use of Big Data and social media for innovation is a key factor in creating competitive advantage ([Soluk & Kammerlander, 2021](#)). In addition, the manufacturing sector is also utilizing digital technology for product innovation to improve competitiveness ([Klein & Todesco, 2021](#); [Ghobakhloo & Iranmanesh, 2021](#)).

5.6 Managerial readiness

Managerial readiness involves the ability of managers to lead digital transformation, develop people skills and make data-driven decisions. This readiness ensures that the transformation process can be executed effectively, especially with the right technology and skills support ([Cannas, 2023](#); [Matarazzo et al., 2021](#)).

Table 4. Future research agenda

Research domains	Future research agenda
Digital technology adoption	• How can SMEs identify and adopt digital technologies that are most relevant to their needs? • What are the main barriers SMEs face in the digital technology adoption process, and what are the strategies to overcome them? • How can digital technologies such as AI, IoT and big data be effectively applied in MSME operations? • Are there significant differences in digital technology adoption patterns between SMEs in different sectors? • To what extent does the digital readiness of technology infrastructure in SMEs affect the success of digital transformation?
Dynamic capability	• How do SMEs' dynamic capabilities affect their adaptation and response to technological and market changes? • How can SMEs enhance their dynamic capabilities to maintain a competitive advantage in the digital age? • What is the role of organizational learning in building dynamic capabilities in SMEs during the digital transformation process? • How do dynamic capabilities interact with external factors such as government policies in supporting technology adoption? • How do dynamic capabilities mediate the relationship between technological change and SME business performance?
Adaptive leadership	• How can adaptive leadership characteristics facilitate effective digital transformation in SMEs? • How much influence does adaptive leadership have in overcoming resistance to change in SME organizations? • What is the role of adaptive leadership in building a culture of innovation and collaboration during the digitalization process of SMEs? • How can SME leaders develop the necessary leadership skills to support continuous technological change? • How can SME leaders drive management and employee commitment to digital technology implementation?
Digital literacy	• To what extent does the digital literacy of employees and management affect the effectiveness of digital technology adoption in SMEs? • How can SMEs develop digital literacy across the organization to support successful digital transformation? • What is the relationship between digital literacy and the innovation capabilities and competitiveness of SMEs in the digital era? • How can digital literacy be integrated into SME human resource development strategies? • Does managerial digital literacy play a more significant role than employee digital literacy in the success of digital transformation?

(continued)

Table 4. Continued

Research domains	Future research agenda
Sustainable innovation	• How can SMEs integrate sustainable innovation into their digital business strategy? • What are the key factors that drive continuous innovation in SMEs during the digital transformation process? • How can sustainable innovation improve the competitiveness and resilience of SMEs in the global market? • What is the role of digital technology in driving product and service innovation in SMEs? • How can SMEs create innovative and sustainable business models in the face of ever-evolving technological changes?
Managerial readiness	• To what extent is SME managerial readiness in influencing the success of digital transformation? • What is the role of managerial training in enhancing management readiness to adopt and manage digital technologies? • How can management develop strategies to improve technology readiness and digital culture in SMEs? • What factors influence the readiness of SME management in facing the challenges of digital transformation? • How does SME managerial readiness interact with technological and human resource readiness in facilitating the digitalization process?
External support	• How can government policies be more effective in supporting the digital transformation of SMEs? • What is the role of fiscal policy, incentives and regulations in encouraging the adoption of digital technologies by SMEs? • How can collaboration between government, academia and industry improve the digital capabilities of SMEs? • How can external policies help SMEs overcome financial and technical barriers in the digitalization process? • To what extent can government policies related to digital education and training facilitate the development of skills needed for the digital transformation of SMEs?

Source: Authors' own work

5.7 External support

External support, especially from the government and regulatory policies, plays an important role in facilitating the adoption of digital technologies by SMEs. Incentives, supportive regulations and collaboration with stakeholders help create an ecosystem that enables successful digital transformation (Peter et al., 2020; Zhang et al., 2022).

6. Conclusion and implications

DT research on SMEs has increased significantly, especially after 2015. Using bibliometric analysis and science mapping, seven main research themes were found: digital technologies, dynamic capability, digitalization, small and medium enterprises, big data, manufacturing

sector and innovation. Seven future DT research trends were also found: digital technology adoption, dynamic capability, adaptive leadership, digital literacy, sustainable innovation, managerial readiness and external support.

Digital transformation of SMEs has economic impacts and can affect people's quality of life and public attitudes. The findings from this paper support the notion that digitalization has the potential to bring about positive changes in various aspects of people's lives, and this is an area worthy of further research.

6.1 Policy implication

In terms of policy, since SMEs are the most fundamental sector in the economy, it is recommended that policymakers (government) should prioritize continuous digital education and training to upskill SMEs. The need for digital literacy, continuous innovation and dynamic capabilities suggests that SMEs need to invest in training and skills development for employees as well as business owners. In addition, incentives such as training subsidies or tax deductions for technology investments could be implemented. Providing adequate digital infrastructure, especially in remote areas, is also important to create a conducive ecosystem. These actions will help SMEs adapt to technology, and improve competitiveness, productivity and innovation, while promoting equity and national economic growth.

6.2 Managerial implication

Regarding managerial implications, this study emphasizes the importance of collaboration between SMEs and the government and private sector to improve SMEs' digital capabilities. Collaboration between SMEs, the government and the private sector is essential to support SMEs' digital transformation. Through this collaboration, SMEs can obtain financial support, such as incentives or low-interest loans, as well as access to the necessary technology and infrastructure. In addition, adaptive managerial and leadership training can improve SMEs' ability to manage digital change. External assistance and mentoring also help SMEs overcome technical challenges. By creating an inclusive digital ecosystem, this collaboration strengthens SME competitiveness and accelerates technology adoption, ultimately driving more sustainable economic growth.

6.3 Theoretical implications

This study has important implications for theory, providing an up-to-date literature review on digital transformation in SMEs. The bibliometric and content analysis conducted represents an in-depth, comprehensive and integrated review of existing research, highlighting trends in the literature on DT in SMEs. The comprehensive agenda for future research developed can be utilized by academics to advance knowledge on DT in SMEs.

This paper identifies key research trends through bibliometric analysis and creates a comprehensive future research agenda. The findings enrich existing theories by proposing new themes such as digital technology adoption and dynamic capabilities, which are important for understanding how SMEs adapt to technological change. The agenda opens up opportunities for academics to deepen knowledge of DT in SMEs and develop relevant theories and models to support digital transformation in the future.

6.4 Limitations and future research direction

This research is based on imported bibliographic data from Scopus. The findings of bibliometric analysis can be influenced by using specific databases (Mongeon & Paul-Hus, 2016). Therefore, the results depend on the database chosen, which may lead to different

results. Although the literature review procedure was applied, it is possible that there were missed articles related to the topic. In addition, the purpose and nature of the screening process used for the articles had a certain selection bias. For example, the WoS and Scopus database analysis does not consider sources other than academic journals, conference proceedings, notes and commercial or informational journals. Limited access to these documents means that some important papers will be missed. The use of different indicators and depiction methods will also lead to different results.

The results of bibliometric analysis are strongly influenced by the database used, where each database has a different scope and focus, which in turn can affect the findings and interpretation of research results. For this reason, future researchers should optimize these aspects. Future researchers are advised to use more databases or reference sources to minimize the risk of missing important works, combine multiple databases to obtain more representative results and apply various analysis methods to increase the validity and accuracy of the findings.

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