

FACTORS LEADING SMES TO IMPLEMENT A DIGITAL TRANSFORMATION STRATEGY AND TO INCREASE THEIR DIGITAL MATURITY

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Abstract

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Digital transformation has become a critical priority for small and medium enterprises (SMEs), especially after the pandemic crisis. Despite progress in upgrading their digital maturity, many SMEs still encounter significant challenges in designing and implementing effective digital transformation strategies. This study investigates the factors that shape SMEs' digital transformation journeys and their digital maturity. A total of 81 academic papers were collected from three databases (ScienceDirect, EBSCO, Scopus) and analyzed using latent dirichlet allocation (LDA) after appropriate text cleaning and preprocessing. The analysis revealed nine key topics influencing SMEs: dynamic and digital capabilities, emerging tech adoption, strategic transformation intensity, digital processes implemented, extrovert opportunities, performance and capabilities, management's transition to agile structures, digital vision and orientation, and human resources and digital maturity. These topics highlight the technological, organizational, and resource-related complexity of digital transformation for SMEs. The study contributes to existing research by offering a structured view of the digital transformation landscape in the SME ecosystem and proposes a roadmap to help firms navigate this complexity and enhance their performance and efficiency in the digital era.

Keywords: Digital Transformation, SMEs, Systematic Literature Review, Content Analysis, Grounded Theory

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1. INTRODUCTION

The fourth industrial revolution (Industry 4.0) has affected the business ecosystem by reshaping totally or merely business sectors (e.g., music industry, hospitality and television broadcasting sector), by integrating digital applications and technologies into almost every economic activity and by altering the global “doing business” mentality (Hai et al., 2021; Kozarkiewicz, 2020). Such a digital orientated transformation is not only about adopting digital technologies, but moreover it involves the development of digital business models, reshaping business structures, cultivating digital strategies, expanding their products/services usefulness to both physical and e-customers (Kane et al., 2015; Schallmo et al., 2017).

Even though digital transformation involves several business aspects, its core remains the adoption and use in practice of various digital technologies. Such technologies may involve mobile devices, cloud services, blockchain systems, big data analytics, automations and robotics, artificial intelligence, augmented and virtual reality technologies, Internet of Things, online applications and various software programs, all aiming to improve business performance and enable major business improvements (Warner & Wäger, 2019). When combined with appropriate business logics, such technologies support product and service development, enable the prediction of consumer behaviour, and facilitate the planning and achievement of desired business outcomes (Industrial Internet Consortium, 2015).

The transition towards a more digital oriented approach offers new possibilities, but at the same time, it is a significant challenge since it requires organizational changes and increases complexity regarding customers, competitors, suppliers and every other business ecosystem (Kraus et al., 2021; Lakemond et al., 2020). These challenges are even more significant for small and medium enterprises (SMEs) since addressing them requires scarce or expensive resources to achieve digital networking, information processing capability and processes for effective knowledge management (Li et al., 2021; Omrani et al., 2024; Manesh et al., 2021). Moreover, SMEs are frequently reluctant to advance their digital transformation due to the absence of effective business models and difficulties in applying digital business models (Filotto et al., 2021). Overcoming all these issues may involve a series of demanding transformations, including new operations and structures, alternative resource allocation methods (Reis et al., 2018) and the cultivation of a new digital culture (Appio et al., 2021).

At the same time, digital transformation and Industry 4.0 cannot be neglected since they have been associated with several business benefits. Existing research and empirical studies link digital transformation with effective decision-making through rapid data extraction, cost reductions in products and services, creation of added value for customers, internal process efficiency, innovative thinking and cultivation of an appropriate culture and gaining competitive advantage (Corso et al., 2018; Wolpert & Roth, 2020; Saini, 2018; Appio et al., 2021; Gebayew et al., 2018; Cahyadi, 2020). There

are also cases where digitally oriented firms not only can achieve one or more of the above — mentioned outcomes but also reshape entire markets. Well-known examples come from the television broadcasting sector and film industry, and how Netflix reshaped them, from the hospitality and tourism industry and how Booking and Airbnb changed them, the music industry with Spotify and of course the retail market with Amazon and Alibaba.

Entrepreneurs and professionals across sectors recognize the need to innovate to remain competitive. Additionally, consumer behavior has evolved, with digital channels playing an important role in their preferences, their culture and their choices as well. Social media, forums and online reviews, online stores and search engines, have developed a new generation of customers seeking more information before purchase and providing more feedback after consuming (Lamberton & Stephen, 2016; Verhoef et al., 2022). These consumers have an increased desire for product customization, access to products/services directly from their source and are more willing to share reviews formatting the consuming opinion to a global audience (Beckers et al., 2018).

To support the new business goals and such customers' needs, a digitally oriented vision is required, alongside an innovative employees' mindset and a more flexible organizational design (Niemand et al., 2021; Kammerlander et al., 2018; Kretschmer & Khashabi, 2020). Moreover, existing academic research emphasizes the importance of an effective fit between the implementation of digital technologies with organizational mindfulness and digital growth strategies (Li et al., 2021; Verhoef et al., 2021).

From an SMEs perspective, many studies have highlighted their heightened vulnerability to external shocks due to limited financial, human and technological resources, a phenomenon often described as the liability of smallness (Cucculelli & Peruzzi, 2020; Eggers, 2020). This vulnerability makes SMEs more cautious in investing in innovative projects with uncertain outcomes and in activities that increase financial leverage, while they often lack dedicated information technology (IT) departments and specialised digital expertise (Lee et al., 2015; Thorgren & Williams, 2020; Fenton et al., 2019). Moreover, the integration of digital technologies and information systems has enhanced the flexibility of SMEs, facilitating better communication between customers and providers and optimizing the flow of goods and services (Gkika et al., 2025, Kargas, Gkika, Komisopoulos, et al., 2025). On the other hand, it should be taken into account that SMEs are more sensitive in recognizing and reacting fast when a crisis occurs.

Recent crises, such as climate-related disruptions and the COVID-19 pandemic, have further intensified the importance of a “green and digital agenda” for SMEs, acting as a technological accelerator and prompting substantial changes in business models and operations (Cowling et al., 2020; Ratten, 2020; Brown et al., 2020). In this context, digital transformation shifted from a technologically oriented aspect to a more human-centered approach, with emphasis on both tangible

and intangible business assets (Baur & Wee, 2015; Kargas et al., 2022).

Despite the growing body of research on digital transformation in SMEs, several important gaps remain, especially when it comes to non-technological aspects (Liang et al., 2021; Chen et al., 2021; El-Haddadeh et al., 2021). First, many studies focus on specific technologies, sectors or national contexts, or examine isolated dimensions such as technological, organizational or environmental factors, without offering an integrated and empirically grounded map of the main determinants that either accelerate or hinder SMEs' digital transformation and their progression in terms of digital maturity. Second, existing systematic reviews typically rely on manual coding or qualitative synthesis, which may overlook latent thematic structures within the expanding academic discourse on SMEs and digital transformation.

The present study addresses these gaps by combining a systematic literature review with a text-mining approach based on latent dirichlet allocation (LDA) to analyze a corpus of 81 academic articles on SMEs and digital transformation. This dual approach enables the identification of underlying thematic patterns that cut across individual studies and the aggregation of these patterns into nine higher-order topics that capture the complexity and multidimensional nature of SMEs' digital transformation processes.

Accordingly, the study pursues the following research questions:

RQ1: Which key factors, as reflected in academic literature, act as enablers or barriers to the digital transformation of SMEs?

RQ2: How can these factors be systematically grouped into coherent themes that inform both the understanding and the measurement of SMEs' digital maturity?

By answering these questions, the paper contributes a structured, topic-based framework that synthesizes dispersed evidence and offers a conceptual roadmap for future theoretical development and empirical assessment of SMEs' digital transformation.

The structure of this paper is as follows. Section 2 reviews the relevant literature. Section 3 analyses the methodology that has been used to conduct empirical research, and Section 4 proposes the main findings. Section 5 discusses the results, while in the final Section 6, main conclusion, limitations and future research agenda are presented.

2. LITERATURE REVIEW

Building on the above discussion, this section reviews the existing body of research on digital transformation in SMEs, with a particular focus on the factors that shape their digitalization and digital maturity. Digital transformation has been widely recognized as a key driver of structural change in the business ecosystem, reshaping value creation, business models and competitive dynamics across sectors (Rahmani et al., 2024; Tavana et al., 2022). Digital transformation in SMEs is not limited to the adoption of specific technologies (Kargas, Gkika, Lymperiou, et al., 2025) but involves deeper changes in organisational structures, processes,

culture and strategic orientation (Kane et al., 2015; Schallmo et al., 2017; Kargas, Gkika, & Sepetis, 2024). Existing research links digital transformation to improved decision-making, cost reduction, process efficiency, innovation and competitive advantage, while also highlighting that digitally oriented firms can fundamentally disrupt traditional markets (Corso et al., 2018; Saini, 2018; Wolpert & Roth, 2020; Gebayew et al., 2018; Cahyadi, 2020; Kostakis & Kargas, 2021).

The relationship between digital transformation and technology adoption has been examined through multiple theoretical lenses, including models such as the technology acceptance model, the theory of planned behaviour and the unified theory of acceptance and use of technology, which highlights perceived usefulness, ease of use and social influence (Ajzen, 1991; Davis et al., 1989; Venkatesh et al., 2003). Beyond individual adoption factors, organisational-level studies identify a wide range of technological, organisational and environmental determinants that shape SMEs' digital transformation, such as industry characteristics, customer expectations, competitive pressures, supply-chain integration and the fit between digital technologies and organisational identity (Kammerlander et al., 2018; Li et al., 2021; Verhoef et al., 2021; Caputo et al., 2016).

A growing body of research focuses on internal organisational factors, including employees' digital capabilities, innovation-oriented business models, leadership support for digital transformation and data-driven decision-making processes (Scuotto et al., 2021; Bouwman et al., 2019; Alraja et al., 2021; Kilimis et al., 2019). These studies consistently show that digital transformation success depends not only on the availability of technologies, but also on the alignment between digital initiatives, organisational culture, leadership values and the firm's strategic growth trajectory (Isensee et al., 2020; Kargas & Aretos, 2023; Troise et al., 2022). Another important stream of literature addresses organisational readiness and digital maturity, typically distinguishing between assets, capabilities and commitment to innovation as key dimensions (Nguyen et al., 2019). Readiness is further shaped by external factors such as customers, suppliers and ecosystem partners, whose own digital maturity and expectations can either accelerate or hinder the firm's progress (Kraus et al., 2021; Caputo et al., 2016).

Recent systematic reviews and empirical studies have proposed various taxonomies and frameworks capturing the determinants of digital transformation in SMEs, often identifying dozens or even hundreds of factors across technological, organisational, environmental and human-related domains (Brozzi et al., 2021; Han & Trimi, 2022; Ghobakhloo et al., 2022; Liang et al., 2021; Chen et al., 2021; El-Haddadeh et al., 2021). Some contributions develop multi-dimensional models of SME digital transformation, covering aspects such as technology adoption, organisational capabilities, skills, innovation, strategy, management practices and processes, while others highlight critical enablers including digital infrastructure, leadership, government support, digital marketing and collaborative networks (Meier et al., 2025;

Shao et al., 2024; Sagala et al., 2024; Ta et al., 2023; Bilal et al., 2025; Kahveci, 2025).

One notable example is the work of Dörr et al. (2023), who identified 354 distinct factors shaping SME digital transformation and, using the Gioia method, synthesised them into three broad categories and seventeen subcategories. Their taxonomy illustrates both the richness and the fragmentation of the field, as different studies tend to focus on specific subsets of factors, using diverse terminologies and classification schemes. Overall, the literature highlights a wide spectrum of determinants of SME digital transformation, but these factors are often examined in isolation, through heterogeneous frameworks and without a unified, empirically grounded map of how they cluster into higher-order themes. Existing reviews predominantly rely on manual coding and qualitative synthesis, which may overlook latent topic structures and co-occurrence patterns within the growing academic discourse on SMEs and digital transformation (Dörr et al., 2023; Liang et al., 2021). This fragmentation underscores the need for a systematic and data-driven synthesis that can consolidate dispersed evidence into a coherent, topic-based framework that also speaks to digital maturity.

The research on SMEs and their digital transformation procedure is an ongoing issue. A series of recent research works emphasize the most significant aspects of the issue. Romero and Mammadov (2025) examine the key determinants that influence SMEs' digital transformation journeys. Wang and Zhang (2025) provide evidence that the concept of digital drive fully mediates the link between digital adoption and innovation performance. Chirumalla et al. (2025) undertake a systematic exploration of the determinants that underpin successful digital transformation in manufacturing SMEs. Kahveci (2025), in his study, investigates the critical success factors underpinning digital transformation in SMEs. Bilal et al. (2025) investigated how technological, organisational, and environmental factors shape digital transformation and innovation performance in SMEs operating within developing economies.

Meier et al. (2025), in their study conducted in Spain, conceptualize digital transformation in SMEs through nine interconnected dimensions: technology adoption, organisational capabilities, knowledge and skills, product and service innovation, business model innovation, strategic orientation, organisational maturity, management practices, entrepreneurship, and business processes. In parallel, Shao et al. (2024), investigating SMEs in China, identify a set of critical enablers for successful digital transformation. Their results emphasize that robust digital infrastructure, technological innovation capacity, access to skilled digital talent, and market competitive pressures function collectively as key drivers that facilitate digital advancement.

Subsequent studies have aimed to identify the fundamental success factors that SMEs should prioritise to effectively navigate digital transformation. Sagala et al. (2024) propose eight key dimensions: SMEs' inherent limitations, organisational learning, alignment of IT systems, leadership, digital marketing initiatives, collaborative practices, competitive environment, and overarching

digitalization process or framework. Moreover, additional research has emphasised five critical elements that shape SMEs' decisions to engage in digital transformation: enhancing customer experience, ensuring technological compatibility, leveraging government support, securing organisational backing, and managing human resources effectively. Collectively, these insights underscore the importance of both internal organisational readiness and external enabling conditions in facilitating successful digital transformation efforts (Ta et al., 2023).

Overall, the literature highlights a wide range of technological, organisational, environmental and human-related factors, but these determinants are often examined in isolation, through diverse frameworks and taxonomies. This fragmented evidence underscores the need for a systematic and data-driven synthesis that can consolidate the main themes underlying SMEs' digital transformation and digital maturity.

3. MATERIALS AND METHODS

To address the research questions, this study combines a systematic literature review with quantitative text-mining and topic modelling techniques. The review follows established guidelines for conducting the systematic literature reviews in management and business research, structured around three main phases: planning, conducting the review and reporting the results. The text-mining component builds on the final corpus of selected articles and applies LDA to identify latent thematic structures related to SMEs' digital transformation.

During the planning phase, the authors refined the review question, delineated the conceptual scope (digital transformation and digital maturity in SMEs) and defined explicit inclusion and exclusion criteria. Only peer-reviewed journal articles written in English, focusing on SMEs and explicitly addressing digital transformation or closely related concepts (e.g., digitalization, Industry 4.0 in SMEs) were considered. Conference papers, book chapters, monographs, reports and non-English publications were excluded to ensure a consistent level of scientific quality and comparability of findings. The review targeted the post-COVID period in order to capture recent developments in SME digital transformation. Building on earlier systematic literature reviews that cover the period up to 2019 (Isensee et al., 2020), the time window was set from 2020 to 2024. This design allows the present study to complement existing reviews rather than duplicating them. As far as the research process is concerned, it included: 1) titles, abstracts and keywords for "digital transformation" and "SMEs"; 2) all content for "enablers" or "obstacles".

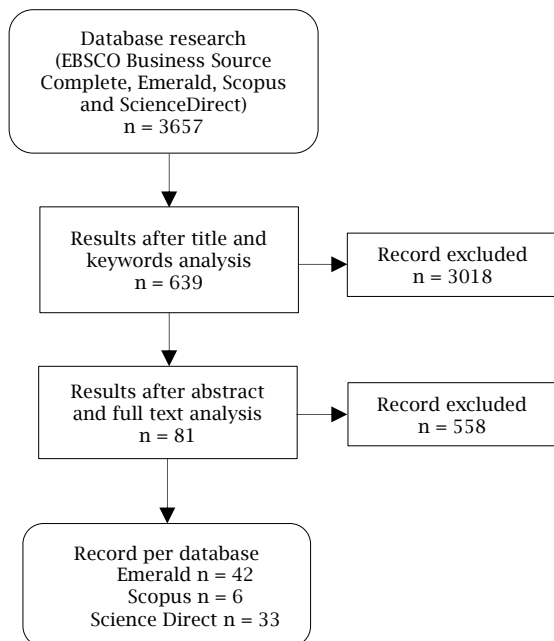
In line with prior systematic literature reviews in business and management, four major bibliographic databases with strong coverage of the SME and digital transformation literature were selected: EBSCO Business Source Complete, Emerald, Scopus and ScienceDirect. The search strategy was intentionally focused but transparent, aiming to balance conceptual precision with adequate coverage. To ensure that the pool of records explicitly addressed factors that enable or hinder

digital transformation, a secondary filter was applied at the full-text level, searching for the presence of at least one of the following terms within the body of the articles: enablers, obstacles, drivers, barriers, challenges or success factors. This two-step strategy avoided an overly broad initial query with all possible synonyms (which would have generated excessive noise, including studies on general SME success factors unrelated to digital transformation) while still capturing a wide range of formulations used by different authors. The overall process is represented in a PRISMA-style flow (Figure 1), comprising: 1) identification of records via database search; 2) removal of duplicates; 3) title and abstract screening; 4) full-text assessment for eligibility.

The screening procedure followed a multi-stage, multi-reviewer process to enhance transparency. In the first stage, all retrieved records were deduplicated and screened based on titles and abstracts. At this point, the reviewers kept a conservative stance: when there was uncertainty about the relevance of a paper, it was retained for full-text assessment. Each paper was independently assessed by at least two researchers, and disagreements were resolved through discussion; if needed, a third reviewer adjudicated. In the second stage, the full texts of the remaining articles were examined against the inclusion criteria. Papers were retained if they:

- 1) focused on SMEs or provided disaggregated insights for SMEs;
- 2) addressed digital transformation, digitalisation or Industry 4.0 in a way that went beyond purely technical descriptions
- 3) explicitly discussed determinants, enablers, barriers or outcomes related to digital transformation and digital maturity.

Figure 1. Research process



Source: Authors' elaboration.

The final sample consisted of 81 articles, and even though the exact replication of database search results may be affected by index updates and minor changes in search engines over time, search queries and eligibility criteria offer a high degree of procedural transparency. Non-substantive sections such as front matter, references and author biographies were removed to focus on the conceptual and empirical content. The text was then preprocessed using standard procedures: lowercasing, removal of numbers and punctuation, tokenization and deletion of common stop-words. To reduce dimensionality and group morphological variants of the same root, a Porter-type stemming algorithm was applied. In addition, the analysis was conducted at the level of bigrams, which are pairs of consecutive words, to preserve more contextual information than unigrams and better capture multi-word concepts relevant to digital transformation (e.g., “digital strategy”, “dynamic capabilities”). As part of quality control, the most frequent bigrams and their contexts were inspected by the authors to ensure that stemming and tokenization did not systematically distort meaning.

Frequency thresholds were then applied to filter out extremely rare bigrams that occurred below a minimum frequency and in fewer than a specified number of documents. These thresholds were chosen to strike a balance between retaining sufficient detail and avoiding an overly sparse term-document matrix that would hinder topic modelling. While the exact cut-off values are partly pragmatic, their impact is mitigated by subsequent expert validation of the topics. The core analytical step involved applying LDA to the preprocessed corpus to uncover latent themes related to SME digital transformation. LDA was implemented using a standard Gibbs sampling algorithm, with hyperparameters set to commonly used defaults and finetuned through iterative experimentation.

The selection of the number of topics (K) followed a two-step procedure combining quantitative and qualitative criteria. First, several candidate models were estimated with K ranging from 6 to 14 topics. For each model, standard coherence metrics and perplexity scores were examined to identify ranges where additional topics no longer produced substantial gains in model fit or interpretability. Second, the candidate solutions were reviewed by the research team, who evaluated if the resulting topics were coherent in terms of the top-ranked bigrams, could be meaningfully labelled in the SME digital transformation context, and did not exhibit excessive overlap.

The configuration with $K=9$ was selected because it offered the best compromise between statistical adequacy and substantive interpretability: models with fewer topics tended to merge conceptually distinct themes (e.g., technological capabilities and human resources), whereas models with more topics produced highly fragmented or redundant clusters. The final nine topics were then labelled and grouped into three higher-order dimensions by triangulating the LDA outputs with the broader literature and the domain expertise of the authors.

The next section describes in more detail the empirical results of the process followed.

4. RESULTS

4.1. Data collection

Following the methodological procedures outlined above, the results are presented in three steps: description of the corpus, key preprocessing outcomes, and the topics extracted through LDA. The research scope of the study was the identification of factors affecting the digital transformation of SMEs. Based on the scope, it was possible to further elaborate and define a few supplementary research questions, like:

What role do organizational culture and leadership play in the digital transformation of SMEs?

What are the primary barriers SMEs face in adopting digital transformation?

The multifaceted nature of digital transformation attracts a vast amount of research questions, and we decided to limit the scope by incorporating only those related to business studies. The formation of different research questions enabled our search strategy of academic sources on Scopus abstract databases, and various search strings were used. The main search strings were “digital transformation” and “SME” combined with a secondary term (e.g., “case study”, “business model”, “operations”, “customer retention”).

The next step was to screen collected papers and exclude duplicated documents, and view in more detail the title, abstract and keywords. Certain exclusion criteria were adopted to narrow down the results. For example, papers referring to digitization or to the simple adoption of new technologies were not included as part of implementing our research selection process. Moreover, papers published within the last five years were considered in the scope of the study. At the next step, the eligibility of the articles was examined based on full-text reading. Three different reviewers were involved in the process. We assigned to every reviewer a set of articles to justify whether to include the article in our study. In the case of disagreement, the third reviewer made the final decision.

Data collection resulted in a list of 81 different research papers from various high-quality journals (e.g., “*International Journal of Information Management*”, “*Business Process Management Journal*”, “*European Journal of Innovation Management*”, “*Technological Forecasting & Social Change*”). We considered the final list of papers a corpus describing several aspects of digital transformation for the SMEs, as discussed and studied by the academic community.

4.2. Text cleaning and transformation

A topic modeling approach was selected to extract factors from the corpus. In more detail, the LDA is a generative probabilistic model and has been applied in text analysis to identify topics (also called themes or aspects) within large sets of text data (Blei et al., 2003). It is an unsupervised machine learning technique and requires minimal, yet important, guidance by the researcher. We examined whether the discovered topics can be interpreted as factors that underline the documents. In LDA, topics are semantic structures of words as they are iteratively produced by the thorough examination of the documents.

An important step is the preparation and transformation of documents in a way that facilitates the analysis at the word level. In our case, it was challenging to identify the body of the article and remove non-related content. For example, the word “journal” would be among the most frequent because it was usually found at the header or footer of the document. Various preprocessing methods were applied, such as word tokenization, lowercase the tokens, keep the abbreviations, number removal, punctuation marks, stop words, URLs and in-text citations. In our work, we also selected to stem words, using Porter’s algorithm, and use bigrams (two adjacent words in text) as the unit of analysis. Table 1 shows the most frequent bigrams for two publishers (Emerald and Science Direct), the bigrams used after stemming, the original form(s) of a bigram and the frequency.

Table 1. Bigram frequency for different publishers (sub-corpora)

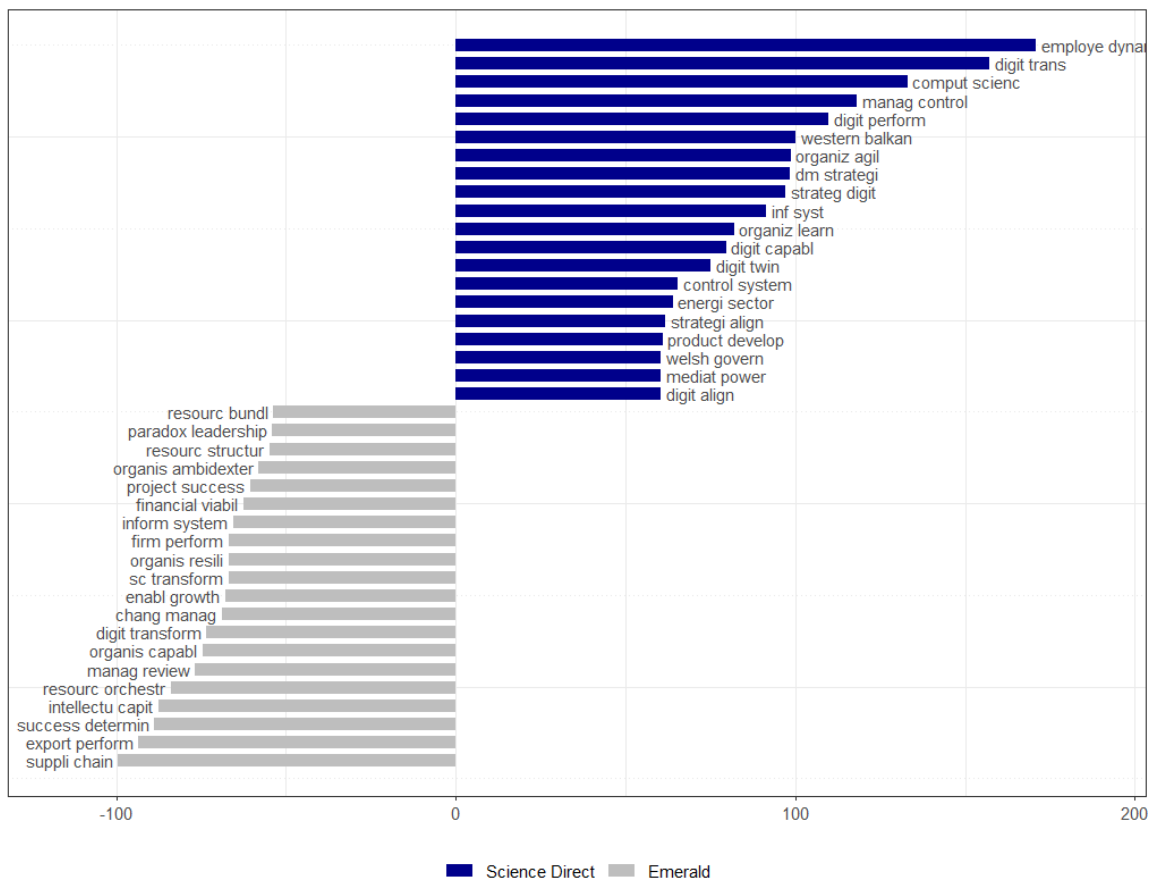
<i>Publisher</i>	<i>Bigram (stem)</i>	<i>Original form(s)</i>	<i>Bigram's frequency</i>
Emerald	digit transform	Digital transformation	2670
ScienceDirect	digit transform	Digital transformation	1485
Emerald	digit technologi	Digital technology, digital technologies, digital technological	746
ScienceDirect	digit technologi	Digital technology, digital technologies, digitized technologies	588
Emerald	dynam capabl	Dynamic capability, dynamic capabilities	460
Emerald	busi model	Business model, business models, business modelling	408
ScienceDirect	dynam capabl	Dynamic capability, dynamic capabilities	330
Emerald	inform system	Information system, information systems	281
ScienceDirect	busi model	Business model, business models, business modelling	279
ScienceDirect	digit capabl	Digital capabilities, digital capability	218

Source: Authors' elaboration.

The most frequent bigram was [digit transform], which corresponds to the “digital transformation” phrase, in both publishers, as expected. It is also interesting that all high-frequency bigrams like [digit technologi], [dynam capabl], and [busi model] are common across the publishers, indicating a strong association.

A complementary view to the identification of the most frequent terms is also provided by the recognition of differences between sub-corpora. The next figure illustrates the differences in the bigrams relative frequencies between the sub-corpora originated from Science Direct, having as a reference the sub-corpora of Emerald (Figure 2).

Figure 2. Keyness analysis



Source: Authors' elaboration.

Various approaches have been proposed to measure keyness between corpora, like the ratio metric and the odds ratio (Kilgarriff, 2009; Pojanapunya & Watson Todd, 2018). Figure 1 illustrates the frequency differences of bigrams (keys) between two sub-corpora, namely Science Direct (target) and Emerald (reference), using the log-likelihood ratio (G^2) as a metric. G^2 is widely used and is a ratio of the observed to the expected frequency, meaning that it is a statistical significance metric to highlight the magnitude of differences.

Our keyness analysis revealed some differences, and two main factors may possibly explain these differences. First, the journals' thematic focus varies: most selected journals from Emerald, such as *European Journal of Innovation Management* and *International Journal of Organizational Analysis*, emphasize organizational perspectives. In contrast, Science Direct journals, including *Journal of Business Research* and *Technological Forecasting and Social Change*, tend to address technology-driven topics, such as digital performance and digital strategy, within a firm's context. Second, different research types require the utilization of different linguistic styles. In our corpus, two key terms ("Western Balkan" and "Welsh Gover") appeared because of case studies with a regional focus. This suggests that some key terms may be influenced by specific linguistic or contextual features (Gabrielatos, 2018).

Keyness analysis was helpful because it revealed some characteristics of frequent bigrams and the role of abbreviations in our study. Keywords are linguistic markers which encode the essence or topical focus of a corpus. Therefore, it could potentially uncover a factor depending on how they connected to a document with other key terms. As a consequence, the frequency of a term within a (sub)corpus might not be enough to reveal a factor, and we suggest that a factor is a mixture of different key terms consistently found between different documents. From such a point of view, it is possible to incorporate topic modeling and further study thoroughly examine the relationship between keywords within a document/corpus and qualitatively assess the formation of different topics, to identify factors associated with the digital transformation of SMEs.

LDA analyze words and documents to identify common aspects (topics) with the assumption that one document might cover different topics, and one word could be used simultaneously across different topics. We examined using expert opinion different results based on the experimentation few variables. First, the number of topics (K) is determined by the research, and it is an important requirement of the LDA. Second, the number of bigrams we take into account. In this work, we exclude bigrams with low frequency (less than 0.001%). Third, how many different documents (> 3) include the bigram is another criterion we employed to avoid hapaxes. The results of LDA are presented in Table 2.

Table 2. Extracted topics

Topic number	Five top terms	Label	Description
Topic 1	Social media, inform system, transform process, product develop, digit strategi	Digital processes implemented	Suggest a focus on how businesses reshape processes by using digital tools and strategies
Topic 2	Technologi adopt, comput scienc, medium enterpris, digit twin, develop countri	Emerging tech adoption	Discuss technology adoption and relevant emerging tech trends
Topic 3	Manufactur SME, chang manag, project manag, success factor, project success	Success of management's transformation to agile	Highlight the effort to implement digital management and departmental agility within the SMEs
Topic 4	Busi perform, innov perform, competit advantag, organis capabl, firm perform	Performance and capabilities	Elaborate with the focus on business outcome
Topic 5	Digit tool, intellectu capit, digit divid, tool adopt, digit busi	Digital vision and digital orientation	Combination of various business elements as a result of an existing digital vision and/or an existing digital orientation
Topic 6	Dynam capabl, digit capabl, digit literacy, job satisfact, organiz learn	Dynamic and digital capabilities	Skills and capabilities related to digital transformation
Topic 7	Firm perform, export perform, firm digit, data analyt, intern busi	Extrovert opportunities	Improve external connections and opportunities, related to business external environment
Topic 8	Transform strategi, top manag, sme digit, digit strategi, digit innov	Strategic transformation intensity	Discuss the existence of a transformation strategy from the management's side
Topic 9	Human resourc, transform success, success determin, enabl factor, digit matur	Human resource and digital maturity	Highlight the role of human resources and maturity in digital evolution

Source: Authors' elaboration.

The nine extracted topics were easily comprehended by the experts, who were tasked with assigning a label to each topic and providing a brief description. Based on their interpretations, we found that the topics related to the digital transformation of SMEs closely resemble discussions pertinent to companies of all sizes. One possible explanation is that a corpus derived from academic authors may exhibit significant bias, as the creation of a body of knowledge is heavily influenced by prior academic sources. Consequently, this makes it challenging to identify factors that are exclusive to SMEs.

Digital transformation in SMEs has been extensively studied, yet most contributions examine isolated drivers or barriers rather than offering an integrated view of the broader ecosystem in which SMEs operate. While many of the elements captured in the nine topics identified by this study have been discussed separately in existing literature, the present work adds value by synthesizing them into a holistic map of the SME digital transformation landscape. The LDA analysis highlights not only the individual themes but also their articulation into three higher-order layers:

1) technological and dynamic capabilities (dynamic & digital capabilities, emerging tech adoption, digital processes implemented);

2) strategic and organizational orientation (strategic transformation intensity, management's transformation to agile, digital vision & digital orientation);

3) human capital and external interfaces (human resources & digital maturity, extrovert opportunities, performance & capabilities).

In this way, the study proposes a coherent three-layer conceptual structure for SME digital transformation, which can serve as a foundation for future theoretical modelling and empirical testing.

Taken together, these nine topics provide a structured view of how literature conceptualizes the drivers and barriers of SMEs' digital transformation. The next section discusses these

findings in relation to existing theoretical frameworks and outlines their implications for research and practice.

5. DISCUSSION

Building on this interpretation of the findings, the current section summarizes the main contributions of the study, outlines its limitations and proposes directions for future research on SMEs' digital transformation and digital maturity. Building on the nine topics revealed by the LDA analysis, this study proposes a conceptual framework in which SME digital transformation is structured around three core dimensions: technological readiness, strategic-organizational alignment, and human-relational capital. The technological dimension encompasses the development of digital and dynamic capabilities, the adoption of emerging technologies, and the integration of digital processes into day-to-day operations. The strategic-organizational dimension covers the intensity of strategic transformation initiatives, the transition of management towards more agile structures, and the presence of a clear digital vision and orientation that guide decision-making. Finally, the human and relational dimension reflects the role of human resources in building digital maturity, the exploitation of extrovert opportunities (such as internationalization and network participation), and the enhancement of performance outcomes. This three-dimensional structure moves beyond a simple listing of themes and offers a structured lens through which researchers and practitioners can analyze and design SME digital transformation initiatives. It can be used as a basis for developing measurable indicators and theory-driven models that explicitly link these dimensions to SME performance and resilience in the digital era.

Results enlighten that several business issues should be taken into account when it comes to digital transformation. Processes are an essential

characteristic of all firms, while nowadays these processes have been enriched by integrating social media, information systems, and digital methods, which all help businesses to transform into the digital age. As a consequence of implementing such digital processes, the whole business function is reconfigured, while product/service development is enhanced, and the overall efficiency is increased (Elsa et al., 2025; Ueasangkomsate, 2025).

Moreover, another important issue is the adoption of new technologies and how such an issue may affect the whole process of digital transformation. Cloud computing, artificial intelligence, augmented reality applications, mobile devices and other digital technologies play more and more an important role in the business processes of SMEs (Barragan et al., 2025; Hongyun et al., 2025). Their adoption enhances operational capacities, but moreover, it can provide a competitive edge even to a small business. Such an adoption usually requires, as a supplementary element, the adoption of agile practices. Agile management techniques enable SMEs to respond rapidly to market and customer requirements, thereby increasing the success rate of change procedures, including digital transformation (Hansen et al., 2025; Hongyun et al., 2025).

Additionally, digital transformation is related to businesses that aim to achieve business performance, innovation performance, and a sustainable competitive advantage (Kargas, Gkika, Komisopoulos, et al., 2024). Focusing on such results ensures that digital transformation efforts are aligned with business goals and objectives. Such a digital orientation should guide the whole change process, while the existence of a digital vision as well could help companies adopt digital tools, bridge the digital divide, and integrate intellectual capital into their business practices (Espina-Romero et al., 2025; Amin et al., 2025). Digital orientation, digital vision and the strategic transformation intensity are intercorrelated, creating a consistent business framework of how digital maturity can be achieved (Sagala et al., 2025; Sultan & Riyadh, 2025; Vladimirov & Harizanova, 2025).

At a human resource level, digital literacy and dynamic digital competencies are the required skills for developing a workforce capable of managing the complexities of the digital economy. Building a digitally literate and adaptable workforce is crucial for SMEs to unlock the full benefits of digital technologies. This involves not only spending on training and development but also fostering a culture of continuous learning and innovation (Hasan et al., 2025; Ueasangkomsate, 2025). Moreover, such a workforce can effectively react to technological changes to remain competitive. Strong interconnection with the external environment creates new opportunities. Extrovert orientation combined with digital technologies can facilitate SMEs to expand their market footprint, to develop international business activity and export performance. Finally, human resources contribute additionally to the cultivation of an appropriate digital culture capable of reinforcing successful drivers and enabling digital transformation in SMEs (Pira & Fleet, 2025; Held et al., 2025; Setiawan et al., 2025).

These results are broadly consistent with prior research that highlights the complex nature of SME digital transformation and the need to consider multiple domains simultaneously. Topics such as dynamic and digital capabilities, emerging tech adoption and digital processes implemented echo existing evidence on the importance of technology adoption, process integration and data-driven operations for improving performance and competitiveness (Bouwman et al., 2019; Rahmani et al., 2024). At the same time, the strong presence of themes linked to strategic transformation intensity, management's transition to agile structures and digital vision and orientation reinforces earlier findings about the critical role of leadership, strategy and organisational culture in enabling successful digital transformation (Isensee et al., 2020; Kargas & Aretos, 2023; Troise et al., 2022).

6. CONCLUSION

Compared with existing taxonomies that enumerate large numbers of drivers and barriers — sometimes hundreds of individual factors — this study contributes by empirically deriving a more compact, topic-based structure through LDA (Dörr et al., 2023). Rather than proposing yet another checklist of factors, the nine topics reveal how the literature implicitly groups the determinants of SME digital transformation into coherent thematic clusters, offering a parsimonious and interpretable representation of the digital transformation landscape. This synthesis complements previous work that has relied primarily on manual coding and qualitative aggregation, which may overlook latent topic structures and co-occurrence patterns in the academic discourse on SMEs and digital transformation (Liang et al., 2021).

From a theoretical perspective, the study extends current knowledge by organizing the identified topics into a three-layer conceptual framework for SME digital transformation. The technological dimension (dynamic and digital capabilities, emerging tech adoption, digital processes implemented) connects the literature on IT adoption and process digitalization with the specific constraints of SMEs (Venkatesh et al., 2003; Kammerlander et al., 2018). The strategic-organisational dimension (strategic transformation intensity, management's transition to agile structures, digital vision and orientation) integrates insights from research on strategy, leadership and organisational agility (Isensee et al., 2020; Kargas & Aretos, 2023). Finally, the human and relational dimension (human resources and digital maturity, extrovert opportunities, performance and capabilities) links digital transformation to human capital, networking and performance literature, highlighting the importance of skills, learning and external relationships (Scuotto et al., 2021; Gawel et al., 2023).

From a managerial standpoint, the topic-based framework provides SMEs with a structured roadmap for planning and monitoring their digital transformation. Instead of focusing exclusively on technology investments, SME owners and managers can use the three dimensions to assess their current position in terms of capabilities, strategic orientation and human resources, identify gaps —

such as the absence of a clear digital vision or insufficient agile structures — and prioritise interventions accordingly. Policymakers and support organisations can also draw on the identified topics to tailor financial instruments, advisory services and training programmes to the specific needs and maturity levels of SMEs, rather than promoting generic, one-size-fits-all digitalization initiatives.

This study is subject to several limitations that delineate the scope of its findings. First, the corpus consists of 81 academic articles, which may appear relatively small given the breadth of the digital transformation field. Even though this size results from the deliberate application of strict inclusion criteria, the findings should be interpreted as reflecting a focused segment of literature rather than the entire universe of studies on digital transformation in SMEs. Second, the geographical and disciplinary representativeness of the corpus is not statistically balanced. The selected articles mainly originate from management, business and information-systems journals, which emphasize certain perspectives, while empirical studies are unevenly distributed across countries and regions. Future research could construct larger and more explicitly stratified corpora (e.g., by country, region or industry) to examine how the salience of specific factors varies across different institutional and sectoral settings. Third, the methodological quality of the individual studies included in the corpus was not systematically assessed using a formal quality-appraisal tool. Consequently, the topics identified through LDA aggregate evidence from studies with potentially heterogeneous levels of methodological rigour, which calls for caution when generalizing the conclusions. Combining topic-modelling approaches with explicit quality-assessment procedures represents an important avenue for future systematic reviews.

Limitations also arise from the text-processing choices applied in the study. The use of Porter stemming and bigram analysis helps reduce dimensionality and reveal underlying patterns, but it may in some cases, distort the semantic nuances of specific concepts (e.g., multi-word terms being truncated or interpreted out of context). In addition, the frequency thresholds and filtering criteria adopted (minimum occurrence levels for bigrams, minimum number of documents in which they appear, etc.) have a partly empirical character and are not based on universally accepted “scientific” benchmark values, which should be taken into account when interpreting the results. Future research could explore alternative preprocessing techniques (e.g., lemmatization instead of stemming, the use of trigrams or contextual embeddings) and experiment with different threshold settings in order to assess the robustness of the findings and further reduce the risk of semantic distortion. Finally, the temporal scope of the literature covered in this study is largely centred on the post-COVID-19 period, during which the pandemic acted as a strong accelerator of SMEs’ digital transformation. This raises the question of whether the observed patterns are driven by crisis-related conditions or reflect more enduring dynamics that will persist in the medium term. In parallel, the meaning and perceived importance of digital transformation for SMEs is continuously reshaped as new technologies gain prominence. Future studies could, therefore, investigate the factors that influence the implementation of specific technologies, such as artificial intelligence, and explore how successive technological waves reconfigure the drivers and barriers of SMEs’ digital transformation and digital maturity.

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