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Understanding the Digital Transformation of SMEs: A Systematic Review from a Dynamic Capabilities Perspective Across Business, Technology, and Societal Domains

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ABSTRACT

The impact of digital technologies on various industries has been transformative, restructuring and disrupting existing business and operational models. Small and medium-sized enterprises (SMEs) are vital to the economies of countries worldwide, leading to increased interest in their Digital Transformation (DT) from both industry and academia. However, these disruptive changes extend beyond individual companies; they also have environmental and societal implications. Over the past two decades, research on the Digital Transformation of SMEs (SMEs' DT) has garnered significant attention, covering a wide range of topics in the literature. This paper aims to provide insights into the current state of research on SMEs' DT through a systematic literature review. An analysis of co-occurrence using VOSviewer software was conducted to visually represent the literature's node network. This approach emphasizes key research avenues in Digital Transformation (DT), highlighting technology as the main catalyst for these changes. The literature on SMEs' DT is qualitatively classified into five different clusters, focusing on business (readiness, process, and value chain), technological (AI, big data, cloud computing, blockchain), and societal impacts (Social Responsibility & Sustainability, Politics, Philosophy, Religion & Culture). Several research gaps have been identified in the literature, and they are proposed as future lines of inquiry. By addressing these gaps, valuable insights can be provided to both government and private sectors. These insights can help them adapt to disruptive changes in business and reduce negative impacts on society and the environment.

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1. Introduction

In the era of the digital economy, DT has become a key approach for firms to gain competitive advantages amid intense market competition. Companies across industries have undergone or are currently undergoing DT. According to the latest McKinsey research report, the success rate for DT in enterprises is only 20% (Oludapo et al, 2024).

Rupeyika-Apogha and Petrovska (2022) contend that Small and medium-sized enterprises (SMEs) are pivotal to any economy, representing over 99 percent of companies in the European Union (EU) and employing between 50 percent and 70 percent of the full-time workforce. With a gross value-added share of over 50 percent of the European economy, SMEs require research to sustain their economic significance amid ongoing technological developments. DT empowers SMEs to rethink their decision-making and apply technology in meaningful ways (Sagala & Őri, 2024).

However, SMEs lag behind larger firms in DT, negatively impacting performance. SMEs possess strengths that are harder for larger firms to emulate, including their rate of innovation and ability to evolve due to their flexibility and coherent culture (Rupeika-Apoga & Petrovska, 2022).

While the influx of academic studies on DT is welcome and provides clarity, they largely focus on large-firm contexts. The DT imperatives referred to by Verhoef et al. (2019) are often beyond the reach of resource-constrained SMEs. It has been observed by Parra-Sánchez & Talero-Sarmiento (2024) that the digital transformation of SMEs continues to be regarded as an under-researched phenomenon, a view that remains largely unchanged in subsequent studies. Furthermore, the seven major barriers that are encountered by SMEs during the process of digital transformation across various industries have been identified by Rupeyika-Apogha and Petrovska (2022), and these barriers have been described as including the lack of appropriate financing options, the presence of IT security issues, the insufficient digital skills of employees, the shortage of specialists in the external labor market, the internal resistance to change, the limited knowledge of managers, and the uncertainty regarding future digital standards Hu, Y. (2024).

Given the increasing importance of DT in SMEs and its effects on companies, academic and societies, this paper provides an overview of the current state of the art in SMEs' DT literature. An analysis of co-occurrence based on selected keywords was conducted to achieve this. The 54 most influential publications will be analyzed through a qualitative literature review examining DT in the context of digital business transformation. Technology here is considered a driver of SMES'DT, and is understood as having societal implications.

This paper is organized into several sections. The first section introduces the publication selection process—methodology, criteria, terms, and software used—and the results obtained from conducting the bibliometric co-occurrence analysis, which identifies five main clusters in the literature. In addition, this section highlights the growing interest in SMEs' DT and specifies the definitions surrounding this concept. The third section describes the five clusters found: A)Technology as a Driver-which included the research of AI, Cloud Computing, Big Data, Block Chain; B) Readiness of SMEs' DT—which is subdivided into two areas of research: Maturity Models (MMs) and Strategies; C)Business Processes Transformation—which is subdivided into three areas of research: Steps, Business Model(BM) and Focus Factors; D) Enterprise Value Chain Transformation; E) Societal Impacts—which is subdivided into three areas of research: Social Responsibility and Sustainability, Philosophy, Religion and Culture. Finally, the last section concludes and comments on the results, including the limitations and further research possibilities.

2. Foundations

2.1. Review Methodological Description

An overview of the current state of research on the digital transformation (DT) of small and medium-sized enterprises (SMEs) has been provided through a systematic literature review (e.g., Kraus et al., 2020), and it has been further complemented by a bibliometric co-occurrence analysis.

The literature analysis enhances our understanding of SMEs' DT by identifying key research avenues. Data for both analyses were collected from the online Web of Science (WOS) database, encompassing articles published or accepted for publication up to 2025 in journals related to business, management, economics, finance, and computer science. The search utilized the terms "Digital* Transformation*," "Digital* change*," and "SMEs*" in titles, abstracts, or keywords, resulting in a total of 827 articles.

For the co-occurrence analysis, VOSviewer software (Van Eck and Ludo Waltman, 2010) was employed to visually represent the network of information (Donthu et al. 2021). VOSviewer facilitates the interpretation of bibliometric maps derived from large datasets (Castillo-Vergara et al., 2018; Cobo et al., 2011; Jeong et al., 2016; Mas-Verdu et al., 2021).

In the network visualization, each item was depicted by its label and, by default, by a circle, and the size of both elements was determined by the item's weight, with items of greater weight being shown as larger. To avoid overlap, the display of certain item labels was omitted. The color assigned to each item was used to indicate the cluster to which it belonged. Links between items were visualized through lines, of which only the 1,000 strongest were presented, thereby highlighting the most substantial connections. The spatial proximity of two journals was used to represent the degree of their relatedness based on co-citation links, so that journals positioned closer together were interpreted as more closely related. The strongest co-citation relationships were illustrated through connecting lines, as has been explained by Van Eck and Waltman (2010). The original VOSviewer item cluster is divided into 8 groups.

The co-occurrence analysis organized the literature into eight clusters based on the specified keywords. Figure 1's bibliometric map illustrates the relationships between SMEs' DT, keywords, and the various clusters. Figure 2 shows the Chronological development of publications used for the literature review. The connecting lines between the nodes, along with their size, signify the strength and importance of these links (Donthu et al., 2021; López-Rubio et al., 2021). Notably, SMEs' DT is strongly associated with themes such as DT, technology, dynamic capabilities, management, and Industry 4.0.

2.2. Digital Transformation

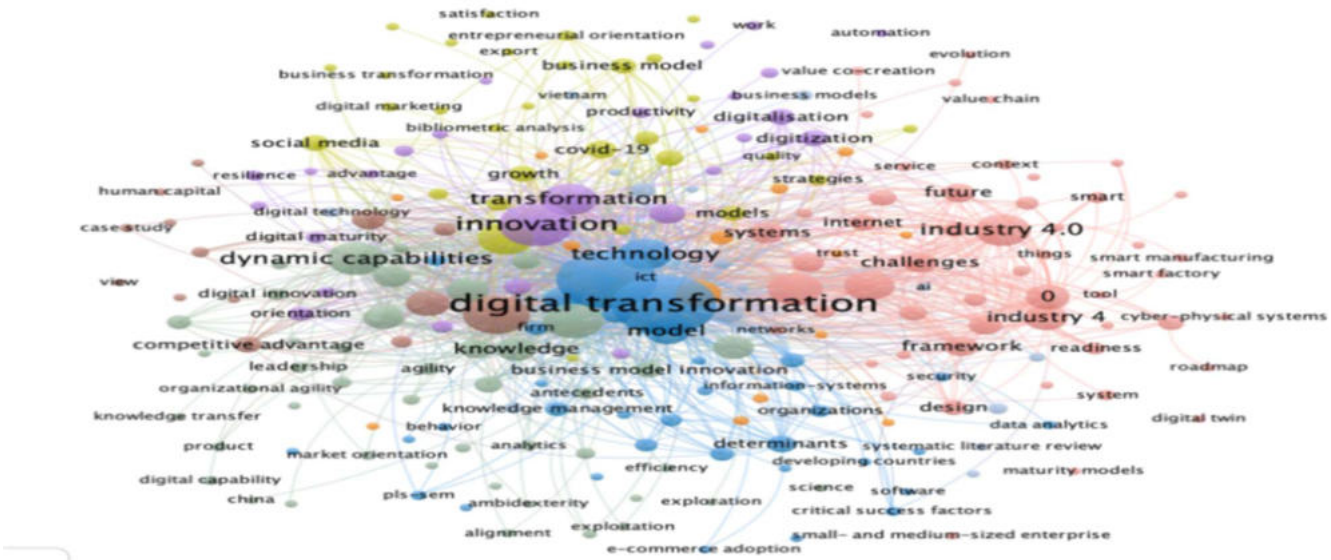

Fig. 1. Bibliometric map of SMEs DT (SMEs DT)

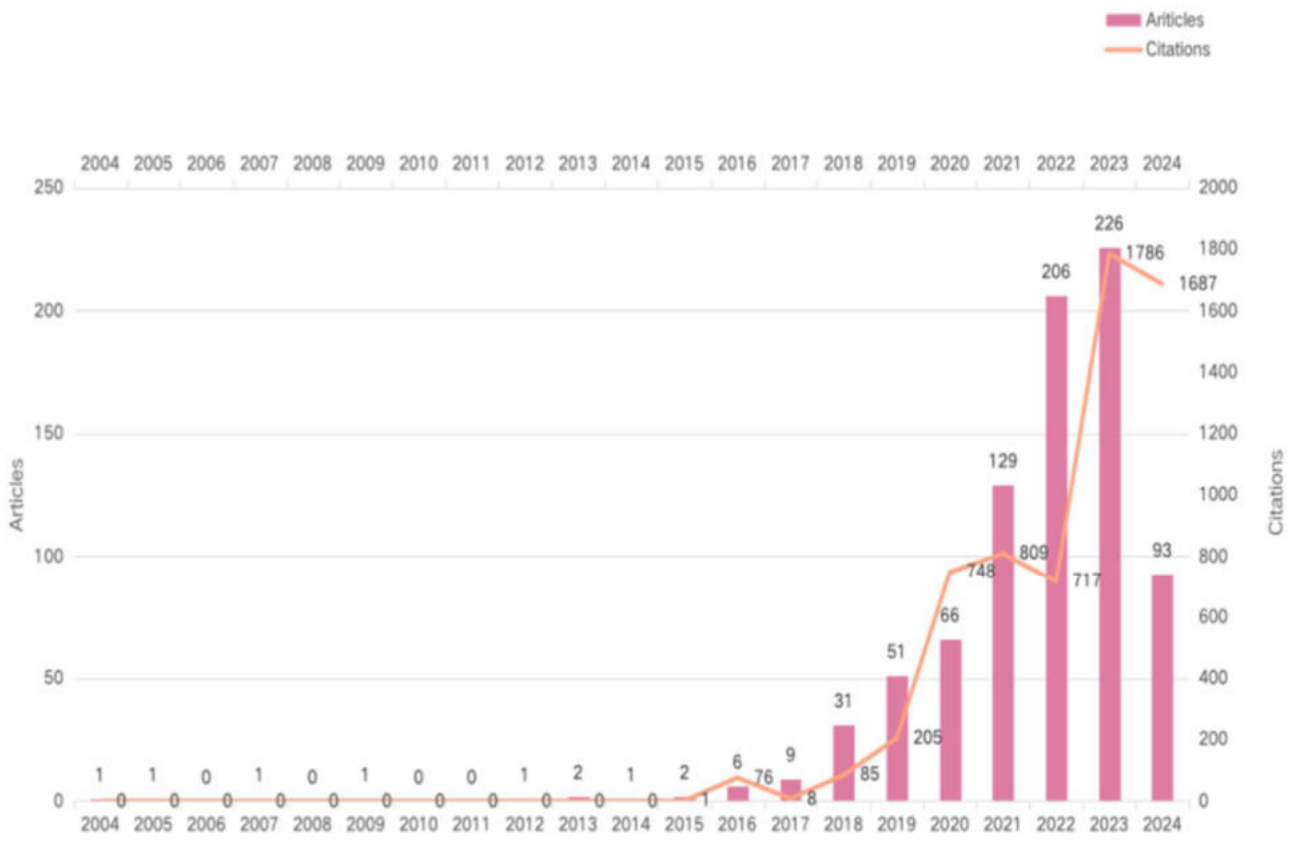

Fig.2. Chronological development of publications used for the literature review.

The DT concept must be differentiated from "digitization" and "digitalization". Digitalization involves applying digital technologies and integrating them with a firm's activities. Zhou (2022) posits that digitalization can be divided into internal and external categories. As Qin et al. (2024) and Salamah et al. (2023) note, internal digitalization primarily seeks to reduce costs and improve the efficiency of internal processes, whereas external digitalization emphasizes the use of digital technologies to strengthen interactions with stakeholders, including lead firms, customers, and suppliers.

DT is not merely about "digitization" or "transformation"; it is about "adaptation." The term "transformation" involves taking necessary actions when organizations face new technologies and should not be confused with simple change (Kane et al., 2017). DT reflects how technology alters business conditions and changes the expectations of customers, partners, and employees. This process

will not be complete in the near term (Verhoef et al., 2021). DT is widely seen as a driver of change in all contexts, especially in business, influencing all aspects of human life through technology use (Gong, C., & Ribiere, V 2021).

Systematically reviewing 134 well-received and published definitions on DT, Gong & Ribiere (2021) developed a unified definition: “A fundamental change process enabled by digital technologies that aims to bring radical improvement and innovation to an entity (e.g., an organization, a business network, an industry, or society) to create value for its stakeholders by strategically leveraging its key resources and capabilities.” In educational settings, this transformation crosses boundaries between different systems, demanding significant efforts from all stakeholders to consider new practices for working with and thinking about digital platforms, methods, strategies, and cultures (Henderson et al., 2017).

Adoption of digital technologies and innovations may occur “bottom-up” within an enterprise; strategic objectives such as DT and digital engineering require a coordinated application of multiple technologies and innovations to achieve results Vial, G. (2019). Consequently, there is a need for research that bridges the gap between current adoption research, which generally focuses on individual technologies or innovations, and adoption in the context of digital engineering and DT, which depends on the strategic application of a multitude of ever-changing digital innovations. Table 1 shows the developmental trajectory of the definitions of digital transformation.

Up to now, there is still no clear definition for digital transformation. This study holds that in the context of 2026 when artificial intelligence is deeply integrated into the economic and social systems, digital transformation no longer merely refers to the application of digital technologies or the reconfiguration of business processes. Instead, it is a continuous process driven by artificial intelligence, centered around adaptation and reconfiguration. This process is manifested as organizations operating in a highly uncertain and rapidly evolving technological environment, constantly sensing the structural changes triggered by intelligent technologies, seizing the value creation logic, and systematically reconfiguring resources, capabilities, and governance mechanisms, in order to achieve collaborative evolution at the organizational, industrial, and social levels.

Compared to the earlier forms of digitization and digitalization applications that focused on automation, efficiency improvement, or the adoption of a single technology, the digital transformation in 2026 places greater emphasis on the "intelligent - adaptive - co-evolution" paradigm. Artificial intelligence is not merely a tool or infrastructure; rather, it functions as a universal, generative, and self-learning technological system that deeply integrates into decision-making, knowledge production, organizational learning, and value distribution mechanisms, thereby fundamentally altering the business models, value chain structures, organizational boundaries, and interaction patterns between enterprises and their stakeholders.

Therefore, the digital transformation in this article in 2026 can be defined as: a dynamic adaptive process that is empowered by artificial intelligence, and spans across technical, organizational, institutional and social levels. Its core lies in achieving a fundamental update of the value creation logic through continuous capacity reshaping and system reconfiguration, and responding to the economic, social and ethical challenges brought about by technological changes.

Table 1. The developmental trajectory of the definitions of digital transformation.

Author(s)	Definitions
Martin (2008, p. 130)	**DT is the use of information and communication technology, not when trivial automation is performed, but in the case where fundamentally new capabilities are created in business, public government, and in the lives of people and society.**
Westerman et al. (2011, p. 5)	**DT is the use of technology to radically improve the performance or reach of enterprises.**
Fitzgerald et al. (2014, p. 2)	**DT is the use of new digital technologies such as social media, mobile technology, analytics, or embedded devices to enable major business improvements including enhanced customer experiences, streamlined operations, or new business models.**
Hinings et al. (2018, p. 53)	**Digital transformation has been understood as a phenomenon in which several digital innovations are combined and are perceived to exert effects that result in the emergence of novel actors and actor constellations, as well as new structures, practices, values, and beliefs, all of which are regarded as reshaping, threatening, replacing, or complementing the existing rules of the game within organizations, ecosystems, industries, or broader institutional fields.**
Gong & Ribiere (2021)	**DT is fundamental change process enabled by digital technologies that aim to bring radical improvement and innovation to an entity (e.g., an organization, a business network, an industry, or society) to create value for its stakeholders by strategically leveraging its key resources and capabilities.**
Zou et al. (2024)	**DT crosses boundaries between different systems, demanding significant efforts from all stakeholders to consider new practices of working with and thinking about digital platforms, methods, strategies, and cultures.**

2.3. Small and medium-sized enterprises (SMEs)

SMEs are essential to global economies, representing about 90% of firms in developing Asia and employing much of the workforce. Despite their economic significance, Rupeika-Apoga and Petrovska (2022) outlined seven key challenges hindering SMEs' digital transformation across industries. These include financial constraints, insufficient employee competencies, talent scarcity, weak managerial support, and resistance to change, along with concerns over IT security and evolving digital standards. In China, national digitalization initiatives, such as Special Action Plan for SME Digital Empowerment (2025–2027), aim to accelerate SME adoption of cloud and AI solutions. However, practical challenges persist, including financial constraints, inadequate technical expertise, and a narrow digital culture (The Asset, 2024). In fact, different countries define small and medium-sized enterprises (SMEs) differently. The table 2 below presents the definitions of SMEs in major countries.

Table 2. Definitions Policies for SMEs in some major countries.

	Type	Medium-sized		Small-size		Micro-sized	
Nation		Employees (EM)	Operating Income (OI)	EM	OI	EM	OI
China (million RMB)	Industrial Enterprises	300-1000	20-400	20-300	3-20	<20	<3
	Construction Industry	300-800	60-800	20-300	3-60	<20	<3
	Wholesale Trade	20-200	50-400	5-20	10-50	<5	<10
	Retail Trade	50-300	50-200	10-50	10-50	<10	<10
	Transportation Industry	300-1000	30-300	20-300	2-30	<20	<2
	Accommodation & Catering Industry	100-300	20-100	10-100	1-20	<10	<1
Europe (million Euro)		≤250	≤€50	≤50	≤€10	≤10	≤2
	Balance sheet total	≤€43		≤€10		≤€2	
United States (dollar million)	Manufacturing & Mining Industries	100-1,500	≤500$	<500			
	Wholesale Trade	100-1,500	≤500$	≤100			
	Retail and Service Industries	100-1,500	≤500$		7.5-38.5$		
	Construction Industries:	100-1,500	≤500$		15-36.5$		
	Agriculture	100-1,500	≤500$		0.75-5$		
	Other Sectors						
Malaysia (RM million)	Manufacturing	75-200	15-50RM	5-75	0.3-5RM	≤5	≤0.3RM
	Services and Other Sectors	30-75	3-20RM	5-30	0.3-5RM	≤5	≤0.3RM

3. Literature Review on SMEs' DT

3.1. Review Approach Descriptive

Pupakova, Lavrin & Zelko (2004) is considered the first peer-reviewed scientific article dealing with Business information and knowledge services for SMEs, and pointed out a practice case of how DT has been applied in the SMEs. For the next decade, SEMs' DT were not widely mentioned, but 10 years later, since 2018, articles on SMEs' DT have grown exponentially and are widely discussed and cited. From the perspective of time, the topic heat of SMEs' DT is surprisingly consistent with the epidemic time. This temporal coincidence suggests a potential accelerating role of the COVID-19 pandemic, which warrants further empirical investigation.

Verhoef et al. (2021) state that DT is inherently multidisciplinary, as it involves changes in strategy, organization, information technology, the supply chain, and marketing, and each phase of the DT has its corresponding resources, structure, growth strategy, metrics, and goals. A general consensus exists that DT requires a combination of multiple complementary resources.

The original VOSviewer item cluster is divided into 8 groups. But the original clusters have data overlap and cannot reflect the links among various items. After rational analysis of the observation of links and the research theme, the above 8 clusters are combined into 5 Clusters: A) Technology as a Driver; B) Readiness of SMEs DT; C) Business Processes Transformation; D) Enterprise Value Chain Transformation; E) Societal Impacts.

3.2. Review Theoretical Framework

This review is primarily grounded in Dynamic Capabilities Theory （DCT） , which emphasizes firms' abilities to sense digital opportunities and threats, seize them through strategic and organizational actions, and reconfigure internal and external resources to sustain competitiveness in rapidly changing environments (Teece, Pisano, & Shuen, 1997; Teece, 2007). This theoretical lens is particularly suitable for small and medium-sized enterprises (SMEs), as their limited resources and heightened exposure to environmental uncertainty necessitate continuous capability development and strategic renewal during digital transformation (Warner & Wäger, 2019).

As illustrated in Figure 3, Dynamic Capabilities Theory serves as the core integrative framework guiding the structure of this literature review. Digital technologies—such as artificial intelligence, cloud computing, big data, and blockchain—are conceptualized as exogenous drivers that trigger SMEs' dynamic capability development. Through the interrelated processes of sensing, seizing, and reconfiguring, SMEs respond to technological change by enhancing digital readiness, transforming business processes and business models, and reconfiguring enterprise value chains. These firm-level transformations further extend to broader societal impacts, including social responsibility and sustainability considerations, as well as institutional, cultural, and ethical dimensions.

By explicitly anchoring the review structure to the DCT framework, Figure 3 demonstrates how disparate research streams—ranging from digital maturity models and strategic orientations to technology-enabled value chain transformation and societal implications—can be synthesized within a coherent theoretical logic. This integrative perspective not only clarifies the mechanisms through which digital transformation unfolds in SMEs but also explains the heterogeneity of transformation outcomes across different technological and institutional contexts (Teece, 2018).

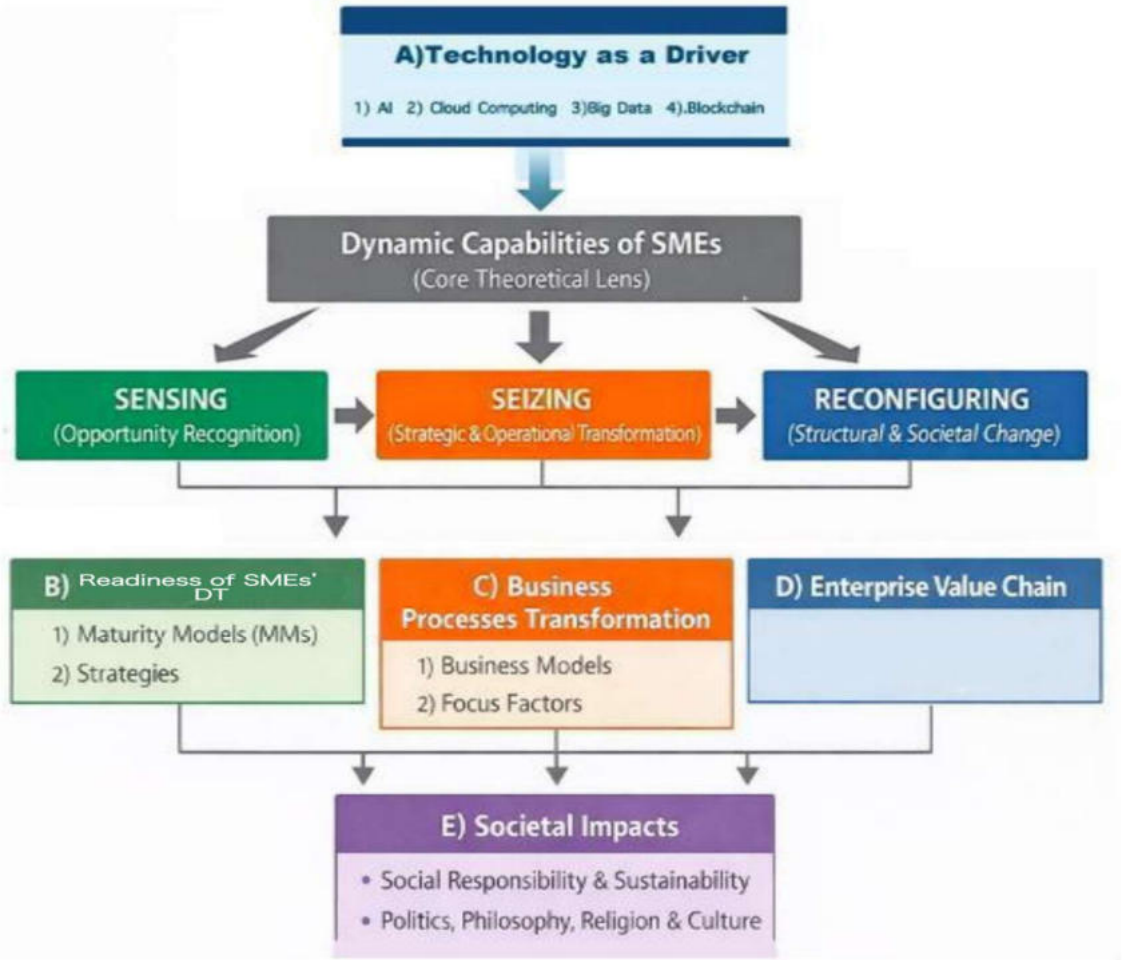

Fig.3. Theoretical Framework of SMEs' digital transformation grounded in Dynamic Capabilities Theory.

3.3. Technology as a Driver

Technology is widely recognized as a key driver of digital transformation (DT), offering organizations substantial advantages when integrated into strategic and operational processes (A. Shaji George et al., 2023). Omrani et al. (2024) examine the determinants of digital technology adoption among SMEs using the technology–organization–environment (TOE) framework. Their study identifies enabling factors across technological, organizational, and environmental contexts and hypothesizes their relationships with varying levels of digital technology adoption. Based on survey data from 15,346 SMEs across both European Union and non-European Union countries, the authors employ an ordered logit regression model to identify factors associated with higher levels of DT adoption. Despite the recognized benefits of emerging digital technologies—such as artificial intelligence, big data, cloud computing, and blockchain—many SMEs continue to face significant challenges in building adequate IT infrastructure, leaving them insufficiently prepared for comprehensive digital transformation.

AI: Dwivedi et al. (2023) suggest that ChatGPT, an AI-powered chatbot developed by OpenAI, has the potential to fundamentally transform human–technology interaction, with applications spanning customer service, entertainment, education, finance, and healthcare (Allouch et al., 2021). Existing studies indicate that AI-driven solutions such as ChatGPT are reshaping organizational operations by enhancing efficiency, improving customer satisfaction, and reducing operational costs across multiple sectors, including e-commerce, healthcare, finance, marketing, and software development (Arman & Lamiya, 2023; George, Hovan George, & Gabrio Martin, 2023).

Despite these benefits, concerns remain regarding the reliability and maturity of AI models, as well as ethical and legal challenges related to privacy, data protection, and algorithmic bias (George et al., 2023; Rheu et al., 2021). Accordingly, scholars emphasize the importance of establishing ethical guidelines and regulatory compliance mechanisms to ensure responsible deployment of ChatGPT in business contexts (Dwivedi et al., 2023).

Current research on ChatGPT remains limited in scope, focusing on a restricted set of industries and short-term outcomes (George et al., 2023). Future studies are encouraged to examine its long-term implications for organizational performance and economic systems, extend empirical analysis to additional business domains, and further explore governance, regulatory, and ethical issues associated with corporate adoption (Dwivedi et al., 2023; Rheu et al., 2021). Moreover, research may investigate how training and educational initiatives can equip firms with the capabilities required to effectively implement and manage ChatGPT-based AI systems (Arman & Lamiya, 2023).

Cloud Computing: Cloud computing technologies provide flexibility and scalability at such a high level that makes them a prerequisite for all DT strategies. Nevertheless, multiple challenges emerge, mainly related to architectural intricacy and potential security threats. According to Lambropoulos, Mitropoulos, and Douligeris (2021), the fundamental features of cloud computing, existing security weaknesses, and possible risk factors are examined in detail. In contrast to conventional

computing settings, the end-to-end management of cloud services typically engages a greater number of stakeholders. This group comprises both the user and the cloud vendor, which expands the operational separation and increases the likelihood that malicious entities could obtain confidential data or carry out security breaches (National Security Agency, 2020). Furthermore, users of cloud-hosted services tend to rely heavily on the provider's technological infrastructure, protection systems, and service availability, typically lacking direct authority or oversight over these elements (Subashini & Kavitha, 2011).

Big Data: Kostakis and Kargas (2021) analyze the existing literature to identify the main components of big-data management according to researchers and the business community. Mikalef, Papadopoulos, Krogstie & Pappas (2018) notes that big data, a technology that is gaining increasing attention, is a driving force in company goals to transform and gain a competitive advantage (Wamba-Sabié, Akter, Edwards, Chopin & Gnanzou, 2015). This work employs a technological, organizational, and environmental (TOE) framework to examine BD adoption drivers in the SME sector (Maroufkhani et al., 2020). Moreover, security has been found to negatively affect BD adoption in this study. According to Priyadarshinee et al. (2017), security is a top concern for business owners regarding data-related technologies. SMEs often outsource BD, but the risk of losing confidential data and information leakage to rivals may hinder their adoption. Therefore, BD service providers need to build SMEs' confidence and trust in their services. Trust is generally established through the service provider's reputation or clients' prior experiences (Choudhury, V.; Sabherwal, R. 2003). This suggestion for building trustworthiness was supported by Bush, Tiwana, and Tsuji (2008), who emphasized the importance of providers communicating their reputation for security and positive referrals from previous clients. Kim and Ko (2010) recommended that a service provider's good reputation could be reinforced through social media marketing. Finally, the significant relationship found between government regulations and BD adoption in this study is consistent with prior research (Alshirah et al. 2021). Specifically, Lutfi (2020) argued that SMEs CEOs' recognition of government support and incentives plays a key role in IT innovation adoption, leading to prompt adoption. Government regulatory support and financial incentives can address the lack of financial and technical skills for BD adoption among firms. In fact, government regulations facilitate adoption decisions for SMEs with insufficient resources. Lastly, future studies may utilize this framework and include additional factors such as provider support, organizational culture, and peer influence, or verify whether BD use scores are not significantly related to control variables such as firm size, age, and sector.

Xu et al. (2024) note that the roles of big data capability and organizational agility in digital transformation (DT) are not fully clarified, partly due to the limits of cross-sectional data. Although their study examines these two mediators, it does not explore how other factors may interact with them. They recommend future research to investigate how big data capability and organizational agility relate to variables such as corporate culture, innovation climate, employee skills, and technology acceptance. It is also important to understand how these mediator function across managerial levels and strategy implementation to improve firms' innovation strategies and performance.

Blockchain: Many businesses seek to reassure consumers that their online data will be treated confidentially or that they have full control over it (Liyanaarachchi et al., 2019). Blockchain is a decentralized, distributed digital ledger technology that records transactions across multiple systems, ensuring transparency, security, and immutability (Cozzio et al., 2023). Despite its design for transparent information transmission, consumers generally perceive blockchain-provided information as less credible (Mazzù et al., 2023). Existing literature has predominantly, focused on the technical aspects of blockchain, overlooking the dynamic nature of privacy behavior (Schlatt et al., 2023). Singapore's PDPA reflects a business-friendly approach to balancing commercial needs and data privacy. Parviainen et al. (2022) propose a Blockchain-based framework that stabilizes consensus mechanisms, strengthens governance, and offers accessible services for current business needs. This framework supports digital transformation (DT), particularly for resource-constrained SMEs, by enabling them to integrate Blockchain into their business models and focus on core operations.

Future research could examine how advanced Blockchain systems influence corporate reputation, competitive differentiation, and internal efficiency. Additional opportunities include exploring cross-departmental integration, developing codes of conduct, offering education and financial incentives, and establishing global policy frameworks that address the broader regulatory challenges of Blockchain and cryptocurrencies.

3.4. Readiness of SMEs' DT

The increasing digitalization of business and society has prompted organizations to transform for sustainability. Adapting to technological developments affecting strategies, business processes, and organizational structures has become essential. This effort is accompanied by monitoring and evaluation to ensure alignment with the DT maturity level standard (Haryanti, Rakhmawati & Subriadi, 2024).

Zhang, Xu & Ma (2022) argued that the DT (DT) of enterprises requires not only technology use but also the reshaping of the company's vision, strategy, organizational structure, processes, capabilities, and culture to adapt to the changing digital business environment (Gurbaxani, V & Dunkle, D, 2019). The purpose of digital transformation (DT) has been understood as the creation of value, which is conceived as being achieved through a variety of outcomes, including enhancements in operational efficiency, improvements in customer experience, the strengthening and renewal of business models, the attainment of strategic differentiation and competitive advantage, and the development of more effective relationships with stakeholders.

Maturity Models (MMs). DT is considered to require guidance from a comprehensive and integrated perspective. Maturity models (MMs) are viewed as tools that support organizations by offering step-by-step directions for improvement. DT maturity models (DT-MMs) are used to evaluate an organization's existing DT capabilities and maturity (Gökalp & Demirörs, 2022; Teichert, 2019; Aras et al., 2023). They are also applied to identify performance gaps and to develop structured, objective, and standardized improvement plans. The main functions of DT-MMs are described as assessing DT activities, helping organizations determine their current maturity stage, revealing opportunities for progressing to higher maturity stages, and enabling comparison with other organizations assessed using the same models (Verhoef et al., 2021; Vial, 2019). To design a measurement model that satisfies the evaluation requirements of the DT domain, the SPICE framework and the ISO/IEC 33000xx family of standards are employed. In this approach, the process dimension is defined to include 26 DT processes. These processes are arranged into four categories: strategic governance, digital process transformation, workforce management, and information and technology management. The capability dimension, which is adapted from SPICE, is structured around six capability levels and six maturity levels (Gökalp, E., & Martinez, V. 2021).

This study develops an evaluation framework and approach, and it employs cross-case analysis to implement the maturity models in mechanical and chemical enterprises. A key limitation of the research lies in its restricted external validity, which results from the small number of cases examined. To improve the robustness and broader applicability of the findings, additional case studies from diverse industries, national contexts, and levels of digital transformation adoption are required (Teichert, 2019; Re & Jäkel, 2024).

The DT – Self-Assessment Model (DT-SAMM) is structured around seven dimensions and 21 sub-dimensions that support effective digital transformation. Smart District 4.0 is designed to promote the digitalization of small and medium-sized enterprises (SMEs) in Apulia. The initiative focuses on the Agri-Food, Clothing, Footwear, and Mechanics-Mechatronics sectors. One challenge identified in this context is the need for a tailored dashboard or a set of key performance indicators to evaluate SMEs' progress in their digital transformation efforts (Haryanti, Rakhmawati, & Subriadi, 2024). Garzoni et al. (2020) propose a four-stage framework to guide SMEs in adopting digital technologies. The stages include digital awareness, digital inquiry, digital collaboration, and digital transformation. In their study, relevant variables are specified for each stage. Future research is encouraged to incorporate additional case studies and to design a self-assessment tool that enables employees or organizations to evaluate their digital transformation maturity and identify areas requiring further development.

Strategies: a substantial body of research on business processes has been devoted to the role of organizational strategies. Merely experimenting with or deploying digital technologies is not regarded as sufficient for achieving transformation; instead, organizations are expected to articulate coherent digital strategies (Sebastian et al., 2017). Several scholars have further contended that digital transformation necessitates the alignment of a firm's strategic orientation with a digital business strategy that synthesizes both business and IT strategic domains (Bharadwaj et al., 2013; Matt et al., 2015).

Matarazzo et al. (2021) emphasized that dynamic capabilities stimulate digital transformation, underscoring the importance of sensing and learning capacities as key initiators of this process. Zhang (2022) incorporate dynamic capabilities into the evolutionary trajectory of the enterprise ecological niche. Konopik et al. (2022) observe that dynamic capabilities are understood to be grounded in organizational capabilities (Eisenhardt & Martin, 2000; Teece et al., 1997; Winter, 2003), and moreover, they are not considered to arise solely from formalized learning processes (Nayak, Chia, & Canales, 2020). Wilden et al. (2013) indicated that dynamic capabilities influence performance through specific organizational capabilities. The connection between dynamic and organizational capabilities is reflected in hierarchical typologies developed by various scholars, with abstract dynamic capabilities at the top and a broader set of organizational capabilities at the bottom (Ambrosini et al., 2009; Collis, 1994; Danneels, 2002; Winter, 2003). Schilke et al. outline that dynamic capabilities consist of a set of organizational capabilities "that can effect change in the firm's existing resource bases (and the associated support system such as the firm's organizational and governance structure), its ecosystem and external environment, as well as its strategy" (Zahra et al., 2006). Rupeika-Apoga, R. et al. (2022) propose a conceptual framework of organizational capabilities for DT consisting of seven themes related to (1) Strategy and Ecosystem, (2) Innovation Thinking, (3) DT Technologies, (4) Data, (5) Operations, (6) Organizational Design, and (7) DT Leadership. This framework integrates Teece's (2007, 2014, 2018) dynamic capability theory to differentiate phases of the DT process.

Organizations benefit from this structured approach, as it helps them create a capability development roadmap for different actors and align processes, structures, and systems to the new digital reality. Since the necessary organizational capabilities vary throughout the transformation process, it is recommended that organizations engage in a digital maturity assessment (Klötzer & Pflaum, 2017; Remane et al., 2017). With the results from the digital maturity assessment, organizations can identify current gaps and gain insights into their phase in the transformation process and what organizational capabilities are underrepresented or missing.

Zhang, Gao, and Zhang (2022) analyze the challenges Chinese SMEs face in digital transformation and offer a theoretical basis for developing innovation strategies. Gökalp and Demirörs (2022) focus on SMEs and examine three drivers of organizational agility—digital technology capability, relational capability, and innovation capability. They show that these capabilities enhance agility, which in turn improves financial performance and both product and process innovation. Their results highlight that agility is crucial for SME success and that digital technologies play a central role.

Oludapo, S., Carroll, N. et al. (2024) suggest that the effective deployment of digital technologies enables MSMEs to automate operational processes, decrease operating expenses, and enhance productivity and innovation. Their work concludes that digital transformation encompasses not merely the adoption of technology but also the reconfiguration of work processes and organizational mindsets to generate sustainable value for SMEs. The article, furthermore, introduces a framework intended to strengthen technology management practices within SMEs.

Dynamic capabilities can be strengthened through innovation and organizational change. Strong organizational capabilities—such as operational, marketing, research and development, human resources, financial management, information technology, customer service, strategic management, and leadership capabilities—provide a stable foundation for fostering these dynamic capabilities. Future research could explore how dynamic capabilities enhance organizational capabilities, focusing on the role of three specific elements of dynamic capability in this process. Additionally, it could examine how dynamic capabilities influence organizational performance by affecting organizational capabilities and the impact index of transformed organizational capabilities within the context of DT. Furthermore, it would be valuable to investigate how newly emerged regulatory variables play a role in this dynamic.

3.5. Business Processes Transformation

Numerous studies indicate that advanced digital technologies significantly transform innovation activities and production processes (Müller et al., 2018; Frank et al., 2019; Nambisan et al., 2019). Industry 4.0—conceptualized as an outcome of "transformation information technology" (Lucas et al., 2013, p. 372)—is understood to entail profound modifications in business processes (Venkatraman, 1994), operational routines (Chen et al., 2014), and organizational capabilities (Tan et al., 2015).

Smart District 4.0 is designed to advance the digital transformation of SMEs by applying a structured methodology that introduces different degrees of involvement and influence on firms' business models, strategic orientation, and organizational structures. Garzoni et al. (2020) outline four progressive levels in this framework: (1) Digital awareness, (2) Digital inquiry, (3) Digital collaboration, and (4) Digital transformation, which represents the most advanced stage. Only a small proportion of

SMEs reach this highest level, yet their commitment to digitization is considered crucial for achieving the project's broader objectives.

Romero, I., & Mammadov, H. (2025) emphasize critical steps for effective business models in logistics, including (1) business model innovation, (2) DT, (3) Quality 4.0, (4) human resources management practices, and (5) Logistics 4.0. The study provides a framework for practical and theoretical contributions. For logistics companies, it indicates that investing solely in Industry 4.0 technologies is insufficient; they must first identify internal and external obstacles before making significant investments to leverage these technologies fully.

Lyngdorf, Jiang, and Du (2024) systematically review 13 studies on frameworks for digital transformation (DT) in engineering education. They identify key features such as framework types, DT drivers, and digital learning tools, and outline expected outcomes at micro, mezzo, and macro levels. The study also offers recommendations for students, educators, institutions, and future research. Its main limitations include reliance on only five databases and the exclusion of non-English and non–peer-reviewed sources, such as institutional reports and strategy papers.

Business Model: Today's frenetic pace of technological innovation has created a business environment more complex and ambiguous than ever before. These developments significantly prevent traditional business models from maintaining their competitive advantage, as flexibility and speed come to the fore in new markets, which, in turn, require new forms of organizing value creation (Hacklin, Björkdahl, & Wallin, 2018). Thus, although technological innovation itself is critical to meeting the demands of today's markets, it must be accompanied by a sound innovative business model structure to enable businesses to compete successfully. Therefore, in the era of DT, the competitive advantage of businesses depends on more than just the technology itself, but also on how it is "transformed" into business models (Teece, 2010). DT is based on how companies innovate their business models. New digitally transformed companies enter the market with innovative business models, while incumbents still rely on their existing business model. As the market and customers change, incumbents need to develop new skills and innovate the business model they apply (Chesbrough, 2010). Therefore, company digitalization encourages changes in sociocultural (i.e., attitudes, beliefs, and behaviors) and technical aspects (i.e., material elements like processes and goods) (Doz & Kosonen, 2010).

Typically, a business model can be seen as a system of directing resources, including social ones, through interdependent activities focused on value creation and the delivery and capture of value (Dymitrowski & Mielcarek, 2022). The enterprise value architecture and the tools that support the development of value propositions are considered the first dimension of value creation. They usually pertain to how resources and processes are set up. The second most important element of a business strategy is delivering value to the customer, as expressed through utility, emotional value, and social value. The third dimension examines how an organizational strategy generates income and profits for the company by converting the value supplied to customers (Teece, D. J., 2010).

There is no single standard business model (BM) for digital transformation because companies face different production conditions (Tortorella & Saurin, 2022). The only common element is the importance of vertical processes in the value chain, including integrated planning, automated and digitized processes, real-time quality control, end-to-end process structuring, personalized online procedures, customer-focused ordering systems, and maintaining core online-oriented technologies. Conner (1992) views organizational transformation as a complex, ongoing process requiring fundamental changes in structures, systems, and values. Andriole (2017) argues that not all companies or business models require DT, and shifting to a more innovative model may not always be more profitable. Another line of research examines who should lead and guide DT efforts.

Another stream of research centers around enterprise architecture (EA). Existing frameworks of EA must be adapted to appropriately cope with DT. Masuda et al. (2018) discuss adaptive EA and how it aligns with the IT strategy in DT. As a result of new trends in IT—such as cloud computing, mobile IT, or digital IT—EA is necessary when facing technical challenges. Van Veldhoven, Z., & Vissers, G. (2021) describe enterprise architecture as a discipline driving change within organizations. EA and DT affect each other; hence, a successful implementation of EA creates a strong input for DT. Instead of separating design-time and run-time of a process in workflow management, EA follows the concepts of templates that can be adjusted by end users at run time. EA enables DT, and as a consequence, organizations are better prepared to introduce DT into their strategies, easily reducing overlapping work processes.

Focus Factors: Zhang, Xu, & Ma (2022) stated that due to limited resources and capabilities, the digitalization process of small and medium-sized enterprises (SMEs) is relatively slow, making it critical to ascertain the key factors and paths affecting the success of DT for SMEs to optimize resource allocation.

Studies on the driving or success factors, mechanisms, paths, and impacts of DT are gradually increasing. However, most studies are practical introductions and descriptive summaries of the DT phenomenon. For example, Cichosz et al. (2020) use case study methods to refine the success factors for DT, and Osmundsen et al. (2018) summarize the driving and success factors for enterprise DT through a literature review. Due to the lack of large-sample empirical research, it is difficult to verify the universality of relevant factors; their internal mechanisms are unclear, and the relationship between these factors is rarely discussed. Therefore, based on these research gaps, this study raises the following objectives: (1) To identify the critical factors of successful DT in SMEs from a holistic perspective. (2) To explore the interaction mechanism of technological, organizational, and environmental factors on the success of DT. (3) To examine the moderating effect of employee skills.

Zhang, Xu, and Ma (2022) empirically analyze how seven key resources—across technology, organization, and environment—shape digital transformation (DT). Their findings show: (1) IT infrastructure and IT management do not directly drive DT but influence it through organizational capabilities such as digital strategy and top management, indicating that technology is essential but insufficient on its own. (2) Digital strategy and top management support are confirmed as critical determinants of DT success. (3) Employee skills strengthen the positive effects of digital strategy and top management on DT. (4) Government support and partnerships complement each other by enhancing digital strategy and managerial capabilities, thereby promoting DT. The uniqueness of the regional scenario and the limited sample size imply that the study results must be further verified, which can be regarded as a limitation. Future research can consider using larger samples over a wider range to improve the generalizability of the conclusions.

Additionally, the study did not verify the impacts and relationships of many more factors (Werth et al., 2020). This study explores the impact relationships among six critical factors, thus reducing the complexity of DT. Future research should include

additional factors in their model. For example, technological innovation, dynamic capabilities, corporate cultures and structures, and industrial vitality could be reviewed. Finally, this study does not conduct an in-depth analysis by industry (Zhang, Xu & Ma, 2022). Nadeem and Wong et al. (2024) state that strong leadership behaviors are needed for the digitization projects that Industry 4.0 supports. It is emphasized that it is unnecessary for SMEs to use all the resources and capabilities of Industry 4.0 but rather to focus on identifying and prioritizing the main skills and resources needed to effectively exploit its benefits. In this regard, SMEs can develop these key resources and capabilities both internally (through process and product innovation focused on digital technologies, human resource management practices, and top management commitment) and externally (through recruiting skilled workers and networks of creative collaboration). The DT process calls for strong support from the top management team (TMT) because DT must not only be implemented but also secured and communicated. The complexity of DT projects can challenge executives (Andriole, 2017). Accordingly, Kohli and Johnson (2011) address DT in the latecomer oil and gas industry, showing the importance of chief information officers' (CIOs') and chief executive officers' (CEOs') leadership in digitization efforts. In contrast to the retail or banking industry, the oil and gas industry is considered a latecomer in digitization and DT progress and, therefore, is under pressure to react agilely to price and demand volatility. According to Singh and Hess (2017), the technical competencies of CIOs are required to be continually renewed as they oversee customer-facing IT systems, broaden their spheres of influence, and potentially transition into the role of chief digital officer. Hansen et al. (2011) highlight that leadership must be capable of swiftly adjusting to digital transformation and show that the participatory process model can be utilized to align DT initiatives with leadership responsibilities.

Major barriers to business digitization are understood to involve ineffective change management, insufficient digital culture and strategic direction, as well as the additional constraints encountered in developing economies with challenging socioeconomic conditions. Zhen et al. (2021) note that an organization's digital culture and its technological capabilities are fundamental determinants of its preparedness to adopt new business models.

3.6. Enterprise Value Chain Transformation

Reinartz, Wiegand & Imschloss (2019) stated that owing to the multiple forces of technology evolution, DT, consumers' evolving needs, and demographic changes (Grewal et al., 2017), this once-predominant structure seems to be eroding rapidly. New apps, services, platforms, data, and devices "have become a crowded play-ground for all kinds of companies that want to tap emerging chances" (Zott & Amit, 2017, p. 19). From this perspective, scholarly attention has delved into the diffusion of digital technologies that are focused on value propositions and customer relationships. Digitalization and specific technologies are innovating in particular SMEs, operating in high-tech and digital industries as well as traditional ones (Warner & W¨ager, 2019). The diffusion of platforms, such as Alibaba, Amazon.com, and eBay. com, has modified the process of value delivery (the "place") and the relationship with customers of SMEs (Li et al., 2020; Ramaswamy & Ozcan, 2018; Perren & Kozinets, 2018). Social media, with the increasing relevance of mobile devices, have radically created new ways of interacting (Taiminen & Karjaluoto, 2015) and are considered by SMEs as the most important means of communication and value creation within the business model. Social media enhances and transforms customer value propositions and organizes innovative delivery operations (Berman, 2012; Swani, Milne, & Brown, 2013). Augmented reality (AR) transforms how individuals interact with physical environments (Poushneh & Vasquez-Parraga, 2017). The diffusion of platforms, such as Alibaba, Amazon.com, and eBay. com, has modified the process of value delivery (the "place") and the relationship with customers of SMEs (Li et al., 2018; Ramaswamy & Ozcan, 2018; Perren & Kozinets, 2018). Social media, with the increasing relevance of mobile devices, have radically created new ways of interacting (Taiminen & Karjaluoto, 2015) and are considered by SMEs as the mostimportant means of communication and value creation within the business model. Social media enhances and transforms customer value propositions and organizes innovative delivery operations (Berman, 2012; Swani, Milne, & Brown, 2013). Augmented reality (AR) transforms how individuals interact with physical environments (Poushneh & Vasquez-Parraga, 2017). Nowadays, the web provides space for creating and sharing knowledge that can be accessed easily by new marketing channels through smartphones and tablets, paving the way for value co-creation through customer engagement processes (Brodie, 2011; Jaakkola & Alexander, 2014).

Zott & Amit (2017) stated that the enterprise value architecture and the tools that support the development of value propositions are considered to be the first dimension of value creation. They usually have to do with how resources and processes are set up (Tsarouhas & Papaevangelou 2024). The second most important element of a business strategy is giving value to the customer, as expressed through utility, emotional value, and social value. The third dimension examines how an organizational strategy generates income and profits for the company by converting the value supplied to customers (Mielcarek, P. & Dymitrowski, A. 2022). It should be noted at this point that Industry 4.0 aims to innovate primarily because doing so enables the production, delivery, and acquisition of distinctive value and competitive advantage. Innovations aim to benefit both consumers (new goods, new customer service techniques, etc.) and businesses (environmental protection, new technology, new value chains, greater productivity, etc.).

As a result of these combined changes, the competition for occupying the interface toward the customer is rekindled more than ever. Hence, the value chain has begun to move away from the traditional linear structure (manufacturer→ retailer→ consumer) toward a structure that allows each group of constituents to engage directly with the final consumer. Recent years, DT has revolutionized the way companies conduct business, create relationships with consumers, suppliers, and other stakeholders (Bresciani, Ferraris, & Del Giudice, 2018; Scuotto, Arrigo, Candelo, & Nicotra, 2019), and foster business model innovation and customer value creation. DT is the way in which "a firm employs digital technologies, to develop a new digital business model that helps to create and appropriate more value for the firm" (Verhoef et al., 2019, p.1). However, to the best of our knowledge, understanding how SMEs, operating in traditional industries, utilize digitalization to shape the process of customer value creation requires more in-depth investigation.

3.7. Social Impact

Social Responsibility & Sustainability: Costa Melo et al. (2023) pointed out that SMEs are responsible for 90% of all businesses and 50% of employment globally, mostly female workers. Measuring SMEs' performance under DT through methods that encompass sustainability is essential for reducing poverty and gender inequality (United Nations Sustainable Development Goals). Italy, China, and Finland have the most publications on this theme. Nine practical research directions are identified,

including applying big data, regional prioritization, and cross-temporal investigations.etc.

Currently, government policy support for environmental, social, and governance (ESG), which balance environmental protection, social responsibility, and corporate governance goals, has also significantly increased (Xie, Hanafiah, Yang, Abdul Hamid, & Juhdi, 2025). Enterprise ESG, as an important indicator of sustainable development, represents the level of sustainable development practices in environmental, social, and corporate governance (Dunn, N. A., et al., 2019), significantly impacting the green and sustainable development of the economy and society. To effectively improve ESG performance, scholars have conducted in-depth studies on traditional factors such as national policies, enterprise scale, enterprise strategy (Rajesh et al., 2022), and R&D investment. However, there are generally few studies on how digital factors, such as enterprise DT, affect ESG performance (Mu et al., 2023; Hu et al., 2023), and most are in the initial stages. Yang & Han (2024) find that enterprise DT has a significant inverted U-shaped impact on environmental, social, and governance (ESG) performance. Moderate DT can improve ESG performance, whereas excessive DT can create organizational conflicts and increase costs, which is detrimental to ESG performance. Digital transformation (DT) brings both benefits and drawbacks (Trittin-Ulbrich et al., 2021). Ahmad, Wu, and Ahmed (2024) show that DT-enabled corporate social responsibility (CSR) can support social and environmental well-being, helping SMEs advance sustainable development goals. Their findings highlight the need for SMEs, policymakers, and society to promote digital CSR practices and cultivate a digital culture to enhance sustainability.

The study examines how CSR-driven DT affects the sustainable competitive performance of SMEs in Pakistan, but its generalizability is limited. Future research should include more diverse samples across different regions to gain a broader understanding of how CSR-based DT influences SME supply chain performance. Enterprise DT requires significant resource investment, has a high opportunity cost, and carries a risk of failure that may negatively impact economic and social development. It can also present adaptability challenges, potentially disrupting existing organizational structures and harming enterprise development. In conclusion, rational DT allows enterprises to break away from traditional structures, alter strategic perceptions, achieve deeper reinvention and re-engineering, and empower existing business operations with DT (Mariani et al., 2023).

The effect of DT on enterprises is not linear (Nadkarni and Prügl, 2021). Furthermore, evidence suggests that DT can adversely affect sustainability performance (Wang and Guo, 2023). DT can result in marginal revenue falling below marginal cost, harming ESG performance and sustainable development. Thus, it is crucial to discuss the nonlinear relationship between enterprise DT and ESG performance and explore how DT affects ESG performance. This will guide reasonable and orderly DT and promote sustainable development. Current research tends to focus on the linear impact of DT on ESG performance, often overlooking its multiple effects. The text analysis of enterprise annual reports using Python can measure the overall DT level of the enterprise, but it lacks measurements of specific dimensions. Current studies on the appropriateness of DT are mainly based on the overall level of the enterprise. Future research should focus on measuring DT in more specific dimensions and identifying the optimal DT interval for individual enterprises (Ahmad, Wu & Ahmed, 2024).

Politics: Alhaimer (2024) pointed out that the SMEs' DT of human interaction with government and public services is an important aspect of innovation and socially inclusive economic development. The use of virtual political campaigns has faced various challenges: First, politicians using social platforms to deliver political messages must be aware of issues related to transparency, confidentiality, data privacy, and the potential for security breaches, including hacking and inappropriate advertisements (Farahat et al., 2020). Second, Hoferer et al. (2020) noted that media biases can significantly impact vote shares by providing a skewed view of politicians, potentially leading to what Noam Chomsky perceives as the manufacturing of political consensus among voters. Furthermore, Polonski (2017) highlighted that there is a dark side to using technology for political campaigns. For example, technology can lead to risks such as the manipulation of public opinion through AI-supported campaigns targeting specific population segments based on psychological affinities, as demonstrated by Cambridge Analytica (Bakir, 2020). Third, although there were traces of virtual political campaigns in Kuwait using Twitter and Instagram prior to COVID-19, this usage was seen as complementary to traditional political campaigns (Tapsell, 2021). During the COVID-19 pandemic, however, the use of virtual campaigns shifted from being an exception to the mainstream method of communication with voters. This reliance on virtual campaigns during elections occurred suddenly and without proper preparation from decision-makers, as it was driven by a crisis rather than a choice (Sairambay, 2020).

Philosophy, Religion & Culture: Devterov et al. (2024) highlight DT through an analysis of its epistemological, axiological, ethical, and anthropological dimensions. The implications of SMEs' DT require a comprehensive characterization of digital space. SMEs' DT has reached significant scale and intensity within the sociocultural dimension, necessitating interpretation from scientific, philosophical, and cultural perspectives. A thorough philosophical characterization should include justifications for the institutional-organizational and structural-functional aspects of DT (Jamie Wheaton & David Kreps, 2023). In an era marked by technological revolution, the intersection of DT and ethical considerations has become a pressing concern (Firnando, 2024). Nida-Rümelin & Staudacher (2023) noted that a critical dimension of the philosophical interpretation of DT is its axiological-ethical component. As the first global DT projects proceed, the philosophy has shifted toward a deeper analysis of the impact of this process on individuals and society (Nadkarni & Prügl, 2021). The scientific discourse now examines various aspects of SMEs' DT, including the correlation between cultural development and digital activity during civilizational progress (Held, Heubeck & Meckl, 2025); maintaining a moral balance of ethical norms in the process of digital activity (O'Reilly et al., 2020); and the potential for replacing human potential with machine capabilities (Michel, 2020). Despite the significant number of philosophical works dedicated to DT processes, questions regarding the full cognitive potential of the digital world, the moral and ethical implications of digital advancements, and the value-based characteristics of DT achievements remain under explored. Addressing these questions is urgent, as DT has gained considerable trust and demand Vial, G. (2019) in society. Simultaneously, questions of safety and morality are largely excluded from scientific discourse.

The establishment of a digital-space value framework is considered essential for weighing potential benefits against drawbacks and for ensuring that issues of practicality and associated risks are systematically addressed. From an ethical standpoint, a set of normative principles is articulated to guide engagement within the digital environment and to govern human actions that take place in this domain (Mittelstadt, 2019). Nonetheless, the fast-evolving nature of digital transformation has

been interpreted as contributing to a swiftly growing level of confidence in digital ecosystems (Schaefer & Steinmann, 2020).

In the future, the philosophical dimension of DT should address problems arising in the new digital environment (Floridi, 2019). The synergy of digital technologies, scientific potential, and humanitarian strategies (Calvo & Peters, 2020) will facilitate the formation of a comprehensive concept of global well-being (Loi, 2020). Consequently, philosophy will realize its potential, and the digital space will become more human-centered.

The idea that religion is incompatible with modernity and digital structures is no longer valid (Campbell, 2019). Religion can no longer be viewed as separate from digital life; instead, digitalization breaks down traditional boundaries between the sacred and the secular, enabling new ways to share religious messages and engage believers. The digital age allows active participation, virtual communities, and new forms of religious expression, challenging the image of religion as static or resistant to change.

Overall, religion is adapting to digital technologies and using them to remain relevant in contemporary society. We are in a transitional phase in which religions update doctrines and practices to respond to digital-era opportunities and challenges (Cheong & Ess, 2012). This evolution requires further reflection and research to understand its implications. Firnando (2024) uses a qualitative approach to examine how Islamic ethics—particularly justice, compassion, and accountability—can guide digital transformation (DT). The study highlights ethical concerns in privacy, data security, AI, and social media, arguing that integrating Islamic values supports responsible technology use and protects human dignity. Future research may extend this analysis to other religious traditions such as Christianity, Buddhism, and Taoism.

Zimeng, Zhang (2024) propose that one strategy to address the concerns regarding the potential dangers associated with future super artificial intelligence (superAI) and to safeguard humanity is for superAI to actively engage with the religious principles of truth, goodness, and beauty. This approach may encourage superAI to interact with humans in a benevolent manner, thereby contributing to a more favorable future for humanity. Jiang, Wang, and Huang (2024) examined the effect of the religious atmosphere (a significant informal institution) on enterprises' DT decisions.

Hilary & Hui (2009) found that companies founded by religious entrepreneurs exhibited lower leverage and reduced investment in fixed and intangible assets compared to those established by non-religious entrepreneurs. Chen et al. (2023) argue that a CEO's pre-career religious exposure significantly influences their firm's risk-taking and subsequent innovation performance. Religious culture inhibits DT by enhancing risk aversion and diminishing innovation. The research results are more pronounced in companies with fewer executives and less conservative managers. The inhibitory effect of religion is particularly significant in non-state-owned enterprises and firms with low institutional ownership. Additionally, lower market competition and reduced government intervention amplify the impact of religion on SMEs' DT. Finally, while DT contributes to increased business productivity, this positive relationship is moderated by indigenous religious traditions. We find that the mechanisms through which the religious atmosphere influences SMEs' DT are the enhancement of risk aversion and the attenuation of innovation awareness. These results corroborate previous findings (e.g., El Ghoul et al., 2012; McGuire et al., 2012) that religion is strongly correlated with risk aversion, particularly in developing countries. Additionally, effective corporate governance and incentivized government policies can mitigate the adverse effects of religious traditions, revealing the interplay between formal and informal institutions.

Religion plays a pivotal role in human civilization; however, the impact of religious culture on SMEs' DT decisions has received scant attention. Although China is an officially atheist country, its religious culture is rapidly evolving due to the government's commitment to safeguarding citizens' freedom of belief. Consequently, it remains unclear whether and how religion affects SMEs' DT decisions.

4. Limitations

Like all research, this study has its limitations. It is conceptual and relies on a literature review, which collects and classifies various papers into the five previously mentioned clusters. Additionally, it does not encompass all research related to SMEs' DT, and the selection of literature is influenced by the authors' subjectivity during the research process. Furthermore, bibliometric analysis has its own limitations; for example, articles typically receive more citations over time rather than in the initial years after publication, and self-citations can contribute to biased results (Glänzel & Moed, 2002; Aksnes & Rip, 2009)

5. Future Research Implications

Extensive research has explored how SMEs engage in digital transformation (DT), revealing significant technological, organizational, and societal shifts. This underscores the need for studies that capture DT as a dynamic and evolving process. Most existing work focuses on DT's impact on organizational performance—particularly capabilities such as agility, digital capability, and dynamic capability—as well as related strategies and influencing factors. However, comprehensive frameworks that address standards, procedures, evaluation, and continuous improvement remain limited, and research is still concentrated mainly in manufacturing rather than education or services.

Future studies could benefit from multiple case analyses and closer examination of how SMEs implement DT and manage its costs. Recent scholarship also calls for broader perspectives that consider paradigm shifts affecting business, society, ethics, and sustainability (Schwab & Malleret,2020). As technologies like AI advance, DT increasingly permeates all aspects of life, highlighting the need for more holistic research on SMEs' digital transformation.

Author Contribution

Conceptualization, Yang Hu&Muhammad Faliq Abd Razak; Methodology, Ahmad Rizal Bin Mohd Yusof &Yang Hu; Software, Yang Hu; Validation, Chengwen Song; Formal analysis, Yang Hu; Investigation, Chengwen Song; Resources, Yang Hu; Data Collection, Yang Hu and Xueyan Zong; Writing original draft, Yang Hu; Writing—review & editing, Xie Qiong; Visualization, Xie Qiong & Xueyan Zong; Supervision, Sufian Jusoh; Project administration, Sufian Jusoh; All authors have read and agreed to the published version of the manuscript.

Compliance with Ethical Standards

This research was reviewed and approved by the Research Ethics Committee (Approval ID: SVTC20250518003) on May 18,

2025, with an approved research period from March 2024 to April 2027. The approval confirms that the study met the institutional requirements for research involving human participants. The survey was conducted by an independent research agency using anonymous data, ensured confidentiality, and posed minimal risk to participants. All procedures performed in this study complied with the ethical standards of the institution and with the principles of the Declaration of Helsinki.

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Competing Interest declaration

The authors declare no conflicts of interest.

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