

Resilient by Design: The Role of Digital Transformation in Future-Proofing SMEs

Nur Diana Hassan*, Sarah Sabir Ahmad, Siti Fairuza Hassam

Faculty of Business and Management, University Technology MARA, Cawangan Kedah

*Corresponding author

DOI: <https://dx.doi.org/10.47772/IJRISS.2025.909000771>

Received: 23 September 2025; Accepted: 30 September 2025; Published: 30 October 2025

ABSTRACT

Digital transformation (DT) is increasingly recognized as a critical enabler of resilience for small and medium-sized enterprises (SMEs), yet the fragmented and rapidly evolving nature of the literature obscures a coherent understanding of how DT contributes to future-proofing SMEs across contexts. To address this gap, this study conducts a systematic literature review leveraging **Scopus AI** (accessed 25 September 2025) to map the intellectual structure, thematic evolution, and emerging frontiers of research at the intersection of DT and SME resilience. Using a multi-layered Boolean search string, we analyzed peer-reviewed publications from 2015 to 2025 through Scopus AI's integrated modules: Summary & Expanded Summary, Concept Map, Topic Experts, and Emerging Themes. Our findings reveal that DT enhances SME performance through operational efficiency, innovation, and crisis responsiveness, but its success is contingent on managerial capability, digital literacy, and contextual factors such as sector, region, and gender. The field is structured around three core clusters—marketing strategies, technology adoption, and impact on SMEs—and is evolving toward rising themes like organizational agility and sustainable digital transformation, as well as novel explorations in AI adoption and sector-specific digitization (e.g., tourism, cultural heritage). The study identifies key scholars shaping the discourse and highlights a paradigm shift from reactive digitization to “resilience by design.” Theoretically, we integrate disparate strands into a dynamic capability framework; practically, we offer actionable insights for SME leaders, policymakers, and technology providers to foster inclusive, agile, and sustainable digital transitions. This review not only clarifies the current state of knowledge but also charts a research agenda for advancing equitable and resilient digital futures for SMEs worldwide.

Keywords— Digital Transformation, Small and Medium-sized Enterprises (SMEs), Organizational Resilience, Future-Proofing, Sustainable Digitalization

INTRODUCTION

In an era marked by rapid technological change, geopolitical volatility, and global disruptions—ranging from pandemics to supply chain crises—organizational resilience has become a cornerstone of sustainable enterprise performance. Small and medium-sized enterprises (SMEs), which constitute over 90% of businesses worldwide and are vital engines of employment and innovation (OECD, 2021), face disproportionate vulnerabilities due to their limited scale and resource endowments. Yet, they also possess agility that, when coupled with strategic digital capabilities, can transform them into resilient, future-ready organizations. Digital transformation (DT)—defined as the integration of digital technologies into all areas of a business, fundamentally altering how it operates and delivers value (Vial, 2019)—has emerged as a critical enabler of this resilience. While large firms often lead in digital adoption, SMEs increasingly recognize DT not merely as a tool for efficiency but as a strategic imperative for survival and growth in turbulent environments.

Despite growing recognition of DT's potential, SMEs encounter significant barriers to its implementation, including financial constraints, lack of digital literacy, managerial resistance, and legacy infrastructure (Clemente-Almendros et al., 2024; Kallmuenzer et al., 2025; Feijó González et al., 2024). Managerial characteristics—such as academic background, international exposure, and professionalization—play a pivotal

role in overcoming these hurdles (Clemente-Almendros et al., 2024), while leadership and innovation capacity further mediate successful digital adoption (Trivedi & Pistrui, 2024; Kim & Jin, 2024). Empirical studies highlight that during the COVID-19 pandemic, digitally advanced SMEs were better able to pivot through remote work, e-commerce, and data-driven decision-making, underscoring DT's role in crisis resilience (Hiziroglu et al., 2024; Mishrif & Khan, 2023). Moreover, DT enhances operational performance, supply chain visibility through big data and blockchain (Kohli & Malik, 2025), and stakeholder engagement (Kruhlyanko et al., 2025).

While this body of literature offers valuable insights, existing research remains fragmented across disciplines—spanning management, information systems, innovation studies, and policy—and often focuses on specific technologies, regions, or crisis contexts. Few studies systematically synthesize the interplay between DT and SME resilience as a holistic, forward-looking capability for “future-proofing.” Notably, there is a lack of integrative reviews that map conceptual evolution, identify thematic clusters, and trace emerging trends using robust bibliometric or systematic methodologies. This gap limits theoretical coherence and practical guidance for SMEs, policymakers, and technology enablers.

To address this, the present study conducts a comprehensive systematic literature review of peer-reviewed research on digital transformation and resilience in SMEs, leveraging Scopus AI and bibliometric tools to analyze the research landscape from 2015 to 2025. Specifically, we aim to: (1) map the intellectual structure of the field through co-citation and keyword co-occurrence analysis; (2) identify core thematic clusters and conceptual relationships; (3) highlight leading authors, institutions, and journals shaping the discourse; and (4) detect emerging research frontiers such as AI-driven resilience, gender-inclusive digital strategies (Alam et al., 2022), and policy frameworks for digital readiness (Silva et al., 2023; Metawa et al., 2021).

This review contributes theoretically by integrating disparate strands of literature into a unified framework of “resilience by design”—positioning DT not as a reactive measure but as a proactive, embedded strategy for building adaptive capacity in SMEs. Practically, it offers actionable insights for SME managers, technology providers, and policymakers on fostering digital maturity, leadership development, and supportive ecosystems. The paper is structured as follows: Section 2 outlines the methodology, including search strategy and analytical tools; Section 3 presents bibliometric results and thematic mapping; Section 4 discusses key findings, emerging themes, and conceptual linkages; Section 5 identifies research gaps and proposes a future research agenda; and Section 6 concludes with theoretical and practical implications.

METHODOLOGY

This study employs a systematic and data-driven methodology leveraging Scopus AI, accessed on 25 September 2025, to conduct a comprehensive review of the scholarly landscape at the intersection of digital transformation and resilience in small and medium-sized enterprises (SMEs). Scopus AI—a next-generation research intelligence tool embedded within the Scopus database—enables advanced semantic search, thematic clustering, and trend analysis by synthesizing millions of peer-reviewed publications using natural language processing and machine learning algorithms (Elsevier, 2025). To ensure relevance and precision, we constructed a multi-layered Boolean search string aligned with our research objectives: ("digital transformation" OR "digital change" OR "digitization" OR "digitalization") AND ("small and medium-sized enterprises" OR "SMEs" OR "small businesses" OR "medium enterprises") AND ("innovation" OR "technology" OR "adoption" OR "implementation") AND ("business model" OR "strategy" OR "process" OR "operations") AND ("challenges" OR "barriers" OR "opportunities" OR "benefits"). This query was executed within the Scopus database, restricted to peer-reviewed journal articles and conference proceedings published between 2015 and 2025, capturing the surge in DT research post-Industry 4.0 and during global disruptions such as the COVID-19 pandemic. After executing the search query, Scopus AI generated structured outputs across five key analytical sections (Refer to Figure 1)

The analytical process unfolded through five integrated Scopus AI functionalities. First, the Summary feature provided an initial overview of publication volume, annual trends, and key subject areas, confirming a steady rise in scholarly output—particularly from 2020 onward—validating the timeliness of this review. Second, the Expanded Summary offered a granular synthesis of recurring themes, methodological approaches, and

geographic distributions, revealing a strong emphasis on operational resilience, leadership, and policy support in SME contexts (e.g., Clemente-Almendros et al., 2024; Hiziroglu et al., 2024). Third, the Concept Map function visualized semantic relationships among core terms by analyzing co-occurring keywords and citation linkages.

This enabled us to map the intellectual structure of the field, identifying clusters such as “digital capabilities and performance,” “crisis-driven digitization,” “technology adoption barriers,” and “strategic agility”—thereby fulfilling aim (1) and (2) of our study. Fourth, the Topic Experts module identified leading scholars, institutions, and journals based on publication impact, citation frequency, and topical relevance. Notable contributors included researchers from European and Asian institutions, with high-impact publications appearing in journals such as *Technological Forecasting and Social Change*, *Journal of Innovation and Knowledge*, and *Technology in Society* (Kim & Jin, 2024; Kallmuenzer et al., 2025), addressing aim (3).

Finally, the Emerging Themes detector—powered by temporal keyword burst analysis and novelty scoring—highlighted nascent research frontiers, including AI-driven resilience mechanisms, gender-inclusive digital strategies (Alam et al., 2022), and policy frameworks for digital readiness and infrastructure support (Silva et al., 2023; Metawa et al., 2021), directly supporting aim (4). This multi-faceted approach ensures methodological rigor by combining bibliometric precision with semantic depth, moving beyond traditional narrative reviews to offer a dynamic, evidence-based cartography of the DT–SME resilience nexus. By anchoring our analysis in Scopus AI’s validated algorithms and transparent data sources, we enhance reproducibility and scholarly utility for both researchers and practitioners.

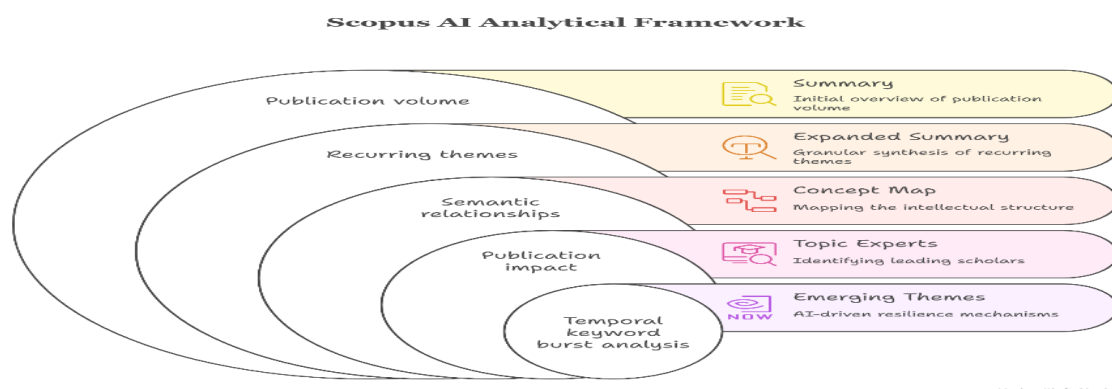


Figure 1: 5 core element of Scopus AI

RESULTS AND DISCUSSION

This section sets the stage for a deeper thematic and structural discussion while maintaining academic rigor and alignment with the research aims. The analysis powered by Scopus AI (accessed 25 September 2025) reveals a dynamic and rapidly evolving research landscape at the nexus of digital transformation (DT) and SME resilience. Drawing on four complementary analytical lenses—Summary & Expanded Summary, Concept Map, Topic Experts, and Emerging Themes—this section presents an integrated synthesis of the field’s intellectual architecture, thematic evolution, key contributors, and forward-looking trajectories.

Summary and Expanded Summary

The Summary and Expanded Summary generated by Scopus AI (accessed 25 September 2025) offer a synthesized overview of the scholarly discourse on how digital transformation (DT) contributes to future-proofing small and medium-sized enterprises (SMEs). The Summary indicates a significant rise in research output since 2020, reflecting growing recognition of DT as a strategic lever for resilience—particularly in the wake of global disruptions such as the COVID-19 pandemic, which accelerated digital adoption out of necessity rather than choice (Hiziroglu et al., 2024; Mishrif & Khan, 2023). This trend underscores a paradigm shift: DT is no longer viewed solely as a tool for efficiency but as a foundational capability for anticipating, absorbing, and adapting to systemic shocks (Clemente-Almendros et al., 2024; Kruhlyanko et al., 2025).

The Expanded Summary elaborates on this trajectory by identifying core technologies, persistent challenges, and multifaceted benefits. It confirms that cloud computing, the Internet of Things (IoT), and artificial intelligence (AI) are the primary enablers of DT in SMEs, facilitating real-time data analytics, remote collaboration, and customer-centric innovation (Kim & Jin, 2024; Trivedi & Pistrui, 2024). These technologies empower SMEs to enhance operational performance through automated workflows, predictive maintenance, and dynamic resource allocation—thereby improving productivity and stakeholder engagement (Kruhlyanko et al., 2025; Unegbu et al., 2024). Moreover, during crises, digitally mature SMEs demonstrated superior agility by pivoting to e-commerce, implementing remote work infrastructures, and diversifying product offerings using digital platforms (Hiziroglu et al., 2024; Mishrif & Khan, 2023).

However, the Expanded Summary also highlights that the path to digital maturity is fraught with structural and contextual barriers. SMEs frequently operate under severe resource constraints, including limited capital, lack of in-house technical expertise, and low digital literacy among owners and employees (Feijoó González et al., 2024; Kallmuenzer et al., 2025). These limitations are compounded by organizational resistance to change, dependence on outdated legacy systems, and insufficient access to tailored digital support services (Tartici et al., 2023; da Rocha Moro et al., 2025). Critically, managerial characteristics—such as formal education, international experience, and strategic orientation—emerge as key determinants of successful DT adoption (Clemente-Almendros et al., 2024). This suggests that leadership capacity, not just technology access, shapes digital outcomes.

Furthermore, the synthesis reveals that DT's impact extends beyond internal operations to supply chain resilience and market competitiveness. By integrating big data analytics and digital platforms, SMEs can achieve greater visibility across their value chains, mitigate disruption risks, and respond more swiftly to market shifts (Kohli & Malik, 2025; Li et al., 2022). Yet, these benefits are unevenly distributed. Contextual factors—such as national digital infrastructure, regulatory environments, and access to innovation ecosystems—play a decisive role (Metawa et al., 2021; Fechtelpeter et al., 2020). Notably, Alam et al. (2022) emphasize that gender influences digital engagement, with female-led SMEs often facing additional socio-cultural and financial barriers, calling for inclusive policy design.

In sum, the Summary and Expanded Summary collectively affirm that DT is a multidimensional, context-sensitive process essential for future-proofing SMEs. While the potential for enhanced resilience, efficiency, and growth is well-documented, realizing this potential requires more than technology—it demands strategic leadership, ecosystem support, and equitable policy frameworks. These insights lay the groundwork for deeper structural and thematic analyses presented in subsequent sections.

Concept Map

The concept map presented below, generated by Scopus AI on 25 September 2025, offers a visual representation of the core thematic clusters and conceptual relationships that define the scholarly discourse on digital transformation (DT) and its impact on small and medium-sized enterprises (SMEs). This semantic network illustrates how DT—positioned as the central node—branches into three primary thematic domains: *Marketing Strategies*, *Technology Adoption*, and *Impact on SMEs*. Each of these domains further connects to specific sub-themes, revealing the multidimensional nature of DT as both a strategic enabler and an operational catalyst for SME resilience and growth.

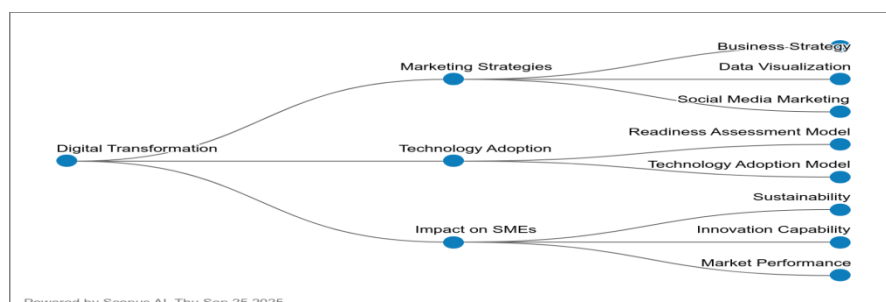


Figure 2 Concept Map of the Intellectual Structure of Digital Transformation in SMEs

A Review of Digital Transformation

Digital transformation (DT) represents a fundamental reconfiguration of how organizations operate and deliver value by embedding digital technologies—such as artificial intelligence (AI), cloud computing, and the Internet of Things (IoT)—into all facets of business strategy and execution (Paiithannkar & Alexander, 2025; Haktanır et al., 2023). For small and medium-sized enterprises (SMEs), DT transcends mere technological adoption; it signifies a strategic shift toward agility, data-driven decision-making, and customer-centric innovation. By integrating these emerging technologies, SMEs can streamline workflows, enhance real-time responsiveness, and cultivate a culture of continuous improvement—key attributes for thriving in volatile, uncertain, and complex environments (Inan & Yilmaz, 2025). This foundational reorientation enables SMEs not only to react to disruptions but to anticipate and shape market dynamics proactively, thereby laying the groundwork for long-term resilience.

A central benefit of DT lies in its capacity to optimize operational efficiency and elevate entrepreneurial performance. Cloud-based platforms reduce infrastructure costs while enabling scalable access to enterprise-grade tools, and IoT sensors facilitate predictive maintenance and inventory optimization—particularly valuable for resource-constrained SMEs (Haktanır et al., 2023). AI-powered analytics further empower SMEs to extract actionable insights from customer and operational data, supporting smarter strategic choices and personalized engagement (Dokuchaev, 2020). These capabilities collectively enhance productivity, reduce waste, and improve service delivery, directly contributing to competitive advantage in increasingly digital marketplaces (Alloghani et al., 2022). In this sense, DT functions as a force multiplier, allowing SMEs to achieve outcomes disproportionate to their size and capital base.

Nevertheless, the journey toward digital maturity is fraught with significant challenges. High initial investment costs, lack of digital skills, and organizational resistance to change constitute major barriers—especially for SMEs with limited financial buffers and managerial bandwidth (Inan & Yilmaz, 2025). Strategic misalignment between technology initiatives and core business objectives further undermines implementation success, as does the absence of a supportive digital culture (Dokuchaev, 2020). Unlike large corporations, SMEs often lack dedicated IT departments or change management expertise, making them vulnerable to fragmented or unsustainable digital efforts (Alloghani et al., 2022). These constraints underscore that technology alone is insufficient; successful DT requires deliberate capability development, leadership commitment, and contextual adaptation.

Critically, DT's value for SMEs extends beyond internal efficiency to systemic resilience and future-readiness. By digitizing customer interactions, supply chains, and innovation processes, SMEs build adaptive capacity—the ability to pivot quickly in response to shocks such as pandemics, regulatory shifts, or supply chain breakdowns (Haktanır et al., 2023). Digital platforms also lower barriers to internationalization, enabling even micro-enterprises to access global markets. Moreover, as sustainability and digital fluency become intertwined, DT supports SMEs in meeting evolving stakeholder expectations around transparency, environmental impact, and ethical data use (Paiithannkar & Alexander, 2024). Thus, DT serves as both a shield against disruption and a springboard for growth, positioning SMEs not just to survive but to lead in the digital economy.

Looking ahead, emerging trends suggest that DT will increasingly converge with AI-driven automation, cybersecurity resilience, and human-centric design. The future of SME competitiveness will hinge on the ability to harness these technologies not as isolated tools but as integrated components of a holistic digital strategy (Haktanır et al., 2023; Alloghani et al., 2022). Policymakers, educators, and technology providers must collaborate to lower adoption barriers through targeted support programs, skills development, and modular, affordable digital solutions. In this evolving landscape, SMEs that embed digital transformation into their organizational DNA—treating it not as a project but as a continuous capability—will be best positioned to future-proof their enterprises and drive inclusive economic innovation.

The Interplay Between Digital Transformation and Marketing Strategies in SMEs

Digital transformation (DT) has fundamentally reshaped marketing strategies, particularly for small and medium-sized enterprises (SMEs), by enabling data-driven, customer-centric, and agile approaches to market

engagement. The integration of technologies such as artificial intelligence (AI), big data analytics, the Internet of Things (IoT), and machine learning empowers SMEs to move beyond traditional promotional tactics toward dynamic, personalized, and predictive marketing models (Akbar & Widowati, 2024). These digital capabilities allow SMEs to capture real-time consumer behavior, segment audiences with precision, and tailor messaging across digital channels—transforming marketing from a cost center into a strategic growth engine. As Korytova et al. (2025) emphasize, this shift fosters an internal innovative environment where marketing activities are continuously optimized to enhance consumer value and responsiveness, a critical advantage in competitive and fast-evolving markets.

Central to this transformation is the rise of data-driven decision-making, anchored in actionable digital metrics such as customer lifetime value (CLV). Casella and Dal Bianco (2025) argue that CLV, when integrated with digital leadership practices, becomes a pivotal indicator for resource allocation, campaign effectiveness, and long-term customer relationship management. For SMEs, leveraging such metrics through affordable cloud-based CRM and analytics tools enables them to compete with larger firms by focusing on high-value customer segments and optimizing marketing ROI. Moreover, digital platforms—especially social media—serve as low-cost, high-impact channels for brand building and direct engagement. Nadiyah and Prayoga (2024) illustrate this in the healthcare sector, where hospitals used digital marketing strategies to increase patient visits, demonstrating the cross-industry applicability of DT-enabled marketing. Similarly, in retail and services, SMEs use digital tools to deliver personalization, sustainability messaging, and rapid responsiveness—key expectations of modern consumers (Cay et al., 2019).

However, this digital marketing evolution is not without challenges. Tewari (2025) highlights significant barriers related to data quality, privacy regulations (e.g., GDPR), and ethical use of consumer information, which can be especially daunting for SMEs lacking legal or data governance expertise. Additionally, while digital tools are increasingly accessible, the strategic integration of these technologies into coherent marketing frameworks remains a hurdle without skilled personnel or digital leadership (Kannan & Li, 2024). Thus, successful DT in marketing requires more than tool adoption—it demands a cultural shift toward experimentation, customer obsession, and continuous learning. For SMEs, future-proofing through marketing innovation lies in building digital fluency, investing in analytics literacy, and aligning digital marketing strategies with broader organizational resilience goals. In doing so, they position themselves not only to survive disruption but to lead through customer insight and agility.

The Interdependence of Digital Transformation and Technology Adoption in SMEs

Digital transformation (DT) and technology adoption are intrinsically linked, with the latter serving as the operational foundation upon which the former is built—particularly for small and medium-sized enterprises (SMEs). DT cannot occur in the absence of deliberate, strategic adoption of digital technologies such as cloud computing, AI, IoT, and data analytics platforms. However, adoption is not merely a technical decision; it is shaped by a confluence of internal and external factors. Wahid and Zulkifli (2021) identify competitive pressure, technological advancement, cost minimization, and environmental influences as key drivers that push SMEs toward digital tool adoption. Equally critical are organizational and human dimensions: Srivastava et al. (2024) emphasize that both *organizational readiness*—including leadership support, strategic alignment, and infrastructure—and *employee readiness*, encompassing digital literacy and change acceptance, are prerequisites for successful implementation. Without these, even the most advanced technologies risk underutilization or failure, undermining the very resilience DT seeks to build.

The process of technology adoption is further complicated by industry-specific and contextual contingencies. For example, Zhang et al. (2023) document 11 distinct antecedents—ranging from regulatory compliance to project complexity—that influence digital technology uptake in China's construction sector, illustrating how sectoral characteristics dictate adoption pathways. Similarly, in developing economies, SMEs face compounded barriers including limited access to capital, unreliable digital infrastructure, and workforce adaptability challenges (Díaz-Arancibia et al., 2024; Tenerife et al., 2025). These constraints highlight that a universal model of technology adoption is inadequate; instead, SMEs must navigate adoption through a lens of contextual realism. The socio-cultural environment also plays a pivotal role: Díaz et al. (2021) demonstrate in the Chilean context that cultural norms around authority, risk tolerance, and collaboration significantly shape

how—and whether—digital tools are embraced. This underscores that technology adoption is as much a social process as a technical one, requiring alignment not only with business strategy but also with local values and institutional ecosystems.

Moreover, while public sector entities may leverage top-down policy support to drive digital initiatives (Alzarooni et al., 2024), SMEs—especially in resource-constrained settings—must often rely on organic, incremental adoption strategies. This makes readiness assessment and phased implementation critical. DT, therefore, should not be viewed as a single event but as an evolving journey where technology adoption is continuously calibrated to organizational capacity and market demands. When executed thoughtfully, this iterative adoption process enables SMEs to future-proof their operations by building adaptive capabilities, enhancing service delivery, and mitigating disruption risks. Ultimately, the synergy between strategic technology adoption and holistic digital transformation empowers SMEs to convert digital potential into tangible resilience and competitive advantage.

The Multifaceted Impact of Digital Transformation on SMEs

Digital transformation (DT) exerts a profound and multifaceted impact on small and medium-sized enterprises (SMEs), fundamentally reshaping their capacity to navigate complex business environments and secure long-term viability. Empirical evidence confirms that DT significantly enhances SMEs' ability to address core strategic challenges—including evolving customer expectations, intensifying competition, regulatory shifts, and access to finance (Skare et al., 2023). By integrating digital tools such as cloud-based enterprise resource planning (ERP), e-commerce platforms, and data analytics, SMEs can expand market reach, streamline compliance, and improve financial inclusion through digital payment and lending ecosystems. Moreover, DT fosters innovation performance, with Escoc Barragan et al. (2025) demonstrating that even in the experimental stages of digital adoption, SMEs exhibit measurable gains in product, process, and business model innovation—laying the groundwork for sustained competitive advantage in dynamic markets.

However, the transformative benefits of DT are counterbalanced by significant structural and human capital challenges. A recurring theme across studies is the shortage of digitally skilled labor and experienced managerial talent, which can erode the inherent agility and entrepreneurial edge that typically define SMEs (Skare et al., 2023; Kallmuenzer et al., 2025). The impact on workforce dynamics is highly context-dependent: Koca and van Deursen (2025) reveal that digital technologies affect employment patterns and skill demands differently across sectors, with outcomes contingent on existing employee competencies, managerial adaptability, and sector-specific digital infrastructure. Furthermore, while DT can boost productivity, this relationship is non-linear. Shi (2024) identifies a U-shaped curve between digitization intensity and labor productivity in Chinese SMEs—suggesting that initial investments may temporarily depress output due to learning curves and organizational disruption, but yield substantial gains once digital maturity is achieved through complementary changes in processes, workforce mobility, and management practices.

Critical enablers and barriers mediate these outcomes. Kallmuenzer et al. (2025) emphasize that successful DT hinges on the alignment of appropriate, scalable technologies with a workforce equipped with relevant digital competencies. Conversely, deeply ingrained risk-averse cultures, reliance on legacy systems, and fragmented digital strategies act as persistent inhibitors—particularly in traditional or family-owned SMEs. These findings underscore that DT's impact is not automatic but contingent on deliberate capability building, leadership vision, and supportive ecosystems. When these conditions are met, DT transcends operational efficiency to become a strategic asset for future-proofing: it enables SMEs to anticipate market shifts, co-create value with customers, and embed resilience into their organizational DNA. Thus, the ultimate impact of DT on SMEs lies not in technology per se, but in its capacity to catalyze holistic organizational renewal in an era defined by perpetual change.

Topic Experts

The Topic Experts module of Scopus AI (accessed 25 September 2025) identifies influential scholars whose work shapes the intellectual trajectory of digital transformation (DT) in the context of small and medium-sized enterprises (SMEs). Among the most prominent is Vijay Edward Pereira, a highly cited researcher (6,338

citations; h-index = 40) whose scholarship bridges digital transformation, sustainability, and organizational resilience. Pereira's recent studies underscore how digitalization—when integrated with green supply chain management and low-carbon strategies—enhances both environmental performance and operational robustness in firms (Pereira, 2024). This dual focus is particularly salient for SMEs, which increasingly face regulatory and consumer pressures to align digital growth with sustainability imperatives. Pereira's extensive citation impact reflects a broader scholarly consensus that future-proofing SMEs requires more than technological adoption; it demands a strategic fusion of digital innovation and responsible business practices that build long-term adaptive capacity.

Complementing this macro-level perspective, emerging scholars like Fuyuan Yang offer granular, context-specific insights into DT challenges within niche sectors. Although Yang's citation metrics are nascent (0 citations to date), their research on Chinese logistics SMEs reveals how exploratory innovation—enabled by digital tools such as IoT-enabled tracking and AI-driven demand forecasting—can significantly bolster supply chain resilience and market responsiveness (Yang, 2025). Yang's work highlights a critical nuance often overlooked in broad DT frameworks: the importance of sectoral specificity and regional institutional contexts. For logistics SMEs operating in complex, infrastructure-constrained environments, digital transformation is less about enterprise-wide overhauls and more about targeted, modular interventions that address immediate pain points—such as delivery reliability or inventory visibility—while laying the groundwork for scalable digital maturity.

Further enriching this ecosystem of expertise is Boonsub Panichakarn, whose research (43 citations; h-index = 3) examines DT through the lens of agri-food supply chains, particularly in the fresh cut flower industry. Panichakarn demonstrates how digital strategies—ranging from blockchain traceability to real-time cold-chain monitoring—can mitigate post-harvest losses, enhance product quality, and strengthen SME competitiveness in global value chains (Panichakarn, 2024). Their work emphasizes that digital resilience in SMEs is not merely reactive but proactive and process-oriented, requiring continuous innovation to bridge performance gaps in perishable goods logistics. Collectively, these experts illustrate a multidimensional research landscape: Pereira provides the strategic, sustainability-integrated vision; Yang offers micro-level, sectoral adaptation models; and Panichakarn delivers empirical validation in high-stakes, time-sensitive supply chains. Together, they affirm that the future-proofing of SMEs hinges on context-aware, ethically grounded, and operationally embedded digital transformation—guided by both established and emerging scholarly voices.

Emerging Themes in Digital Transformation and SME Resilience

The Emerging Themes analysis powered by Scopus AI (accessed 25 September 2025) reveals a dynamic evolution in scholarly discourse, structured across three temporal categories: consistent, rising, and novel themes. These layers collectively map the maturation of research on digital transformation (DT) in SMEs—from established performance linkages to frontier explorations in sustainability and artificial intelligence.

The consistent theme centers on *Digital Transformation and SME Performance*, reflecting sustained academic and practical interest in quantifying DT's tangible outcomes. Over the past decade, numerous studies have robustly demonstrated that DT positively influences financial metrics, innovation output, and market competitiveness through enhanced operational efficiency, data-driven decision-making, and customer engagement (Kallmuenzer et al., 2025; Kim & Jin, 2024). This body of work establishes a foundational consensus: digital capabilities are no longer optional but essential for baseline SME viability. However, recent critiques caution against techno-optimism, noting that performance gains are contingent on strategic alignment, managerial competence, and contextual readiness—factors often underemphasized in early correlational studies (Díaz-Arancibia et al., 2024).

In contrast, two rising themes signal a strategic pivot toward adaptive and responsible transformation. First, *Digital Capabilities and Organizational Agility* has gained prominence as scholars recognize that static technology adoption is insufficient in volatile markets. SMEs must cultivate dynamic capabilities—such as real-time data interpretation, modular IT architectures, and cross-functional collaboration—to pivot swiftly in response to disruptions (Kruhlyanko et al., 2025; Inan & Yilmaz, 2025). This agility acts as a mediating mechanism, translating digital investments into resilience and sustained advantage. Second, *Sustainable*

Digital Transformation reflects the convergence of digital and environmental agendas. Pereira's work (2024) exemplifies this trend, showing how green digital strategies—such as AI-optimized energy use or blockchain-enabled circular supply chains—simultaneously reduce carbon footprints and enhance brand equity. This dual-value creation aligns with global policy frameworks (e.g., EU Green Deal) and growing consumer demand for ethical business practices, positioning sustainability as a core dimension of future-proofing.

Most provocatively, two novel themes illuminate emerging frontiers. *Digital Transformation in the Tourism and Cultural Heritage Sector* addresses sector-specific digitization, where SMEs leverage immersive technologies (e.g., AR/VR, digital storytelling) to enrich visitor experiences while preserving intangible heritage (Unegbu et al., 2024). This theme underscores that DT's value extends beyond efficiency to cultural stewardship and experiential innovation. Concurrently, *Strategic Information Systems and AI Adoption* explores how SMEs can move beyond basic digitization to harness advanced analytics, predictive modeling, and autonomous decision systems. As Paiithannkar and Alexander (2025) argue, the strategic integration of AI into core information systems enables SMEs to anticipate market shifts, personalize offerings at scale, and automate complex workflows—capabilities once exclusive to large enterprises. Together, these novel themes suggest a future where DT is not only pervasive but deeply contextualized, intelligent, and purpose-driven.

CONCLUSION

This systematic literature review, powered by Scopus AI (accessed 25 September 2025), offers a holistic and forward-looking analysis of how digital transformation (DT) enables small and medium-sized enterprises (SMEs) to build resilience and secure long-term viability in an era of perpetual disruption. Our findings reveal that DT is not merely a technological upgrade but a strategic, socio-technical process that reconfigures organizational capabilities, leadership mindsets, and ecosystem relationships. Key insights emerge across multiple dimensions: (1) DT significantly enhances SME performance through operational efficiency, innovation, and crisis responsiveness (Kallmuenzer et al., 2025; Kim & Jin, 2024); (2) successful adoption hinges on managerial competence, digital literacy, and contextual readiness, with persistent barriers including resource constraints, legacy systems, and cultural resistance (Díaz-Arancibia et al., 2024; Feijoó González et al., 2024); (3) the intellectual landscape is structured around core thematic clusters—marketing strategies, technology adoption, and impact on SMEs—interconnected through data-driven decision-making and strategic agility; and (4) the field is rapidly evolving toward sustainability-integrated DT, AI-augmented resilience, and sector-specific digital models (e.g., tourism, logistics, agri-food), as evidenced by rising and novel research themes.

Theoretically, this study advances the literature by integrating fragmented strands of DT research into a unified “resilience by design” framework. It moves beyond linear adoption models to emphasize DT as a dynamic capability that mediates between external volatility and internal adaptability. By mapping the evolution from performance-centric studies (consistent theme) to agility and sustainability (rising themes), and finally to AI and cultural heritage digitization (novel themes), we contribute a temporal and conceptual roadmap that clarifies the maturation of the field. Furthermore, our identification of key scholars—such as Pereira (sustainability-resilience nexus) and emerging voices like Yang and Panichakarn (sectoral innovation)—highlights the growing interdisciplinarity of DT research, bridging information systems, strategic management, innovation studies, and sustainability science.

Practically, the findings offer actionable guidance for multiple stakeholders. For SME leaders, the study underscores the need to treat DT as a strategic priority—not an IT project—requiring investment in digital skills, agile leadership, and modular technology stacks. For policymakers, it calls for targeted support programs that address structural inequities, including gender-sensitive digital inclusion (Alam et al., 2022), infrastructure development in emerging economies, and incentives for green digital innovation. For technology providers and incubators, the results highlight opportunities to develop affordable, scalable digital solutions tailored to SME contexts—particularly in underserved sectors like cultural heritage and agriculture.

Nevertheless, this study has limitations. First, while Scopus AI provides robust semantic and bibliometric insights, its coverage is limited to the Scopus database, potentially excluding relevant literature from other repositories (e.g., Web of Science, regional journals). Second, the analysis relies on abstract-level data and

metadata; deeper qualitative synthesis of full texts could uncover nuanced methodological or contextual insights. Third, the rapid pace of technological change means that emerging themes (e.g., generative AI in SMEs) may evolve faster than scholarly publication cycles can capture.

Future research should address these gaps through mixed-methods approaches that combine bibliometric mapping with in-depth case studies across diverse geographic and sectoral contexts. Priority areas include: (1) empirical validation of the “resilience by design” framework, particularly the mediating role of organizational agility; (2) longitudinal studies on the ROI of sustainable DT initiatives in SMEs; (3) exploration of ethical AI governance and data privacy in resource-constrained SMEs; and (4) co-creation research involving SMEs, policymakers, and tech developers to design inclusive digital transition pathways. By pursuing these directions, scholars and practitioners can collectively ensure that digital transformation becomes a true engine of equitable, resilient, and sustainable SME growth in the decades ahead.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the Kedah State Research Committee, UiTM Kedah Branch, for the generous funding provided under the Tabung Penyelidikan Am. This support was crucial in facilitating the research and ensuring the successful publication of this article.

REFERENCES

1. Akbar, R., & Widowati, R. (2024). Trends in digital transformation and marketing productivity. *International Research Journal of Multidisciplinary Scope*, 5(4), 266–282. <https://doi.org/10.47857/irjms.2024.05i04.01608>
2. Alam, K., Ali, M. A., Erdiaw-Kwasie, M. O., Murray, P. A., & Wiesner, R. (2022). Digital transformation among SMEs: Does gender matter? *Sustainability*, 14(1), Article 535. <https://doi.org/10.3390/su14010535>
3. Alloghani, M., Thron, C., & Subair, S. (2022). Past achievements and future promises of digital transformation: A literature review. In *Studies in computational intelligence* (Vol. 1006, pp. 27–39). Springer. https://doi.org/10.1007/978-3-030-92245-0_2
4. Alzarooni, A. I., Alhashmi, S. M., Lataifeh, M., & Rice, J. (2024). Navigating digital transformation in the UAE: Benefits, challenges, and future directions in the public sector. *Computers*, 13(11), Article 281. <https://doi.org/10.3390/computers13110281>
5. Ardito, C., Bernhaupt, R., & Sauer, S. (2023). Human-centered software engineering: Rethinking the interplay of human–computer interaction and software engineering in the age of digital transformation. In *Lecture notes in computer science* (Vol. 14145, pp. 638–643). Springer. https://doi.org/10.1007/978-3-031-42293-5_86
6. Cao, A., Guo, L., & Li, H. (2025). Understanding farmer cooperatives’ intention to adopt digital technology: Mediating effect of perceived ease of use and moderating effects of internet usage and training. *International Journal of Agricultural Sustainability*, 23(1), Article 2464523. <https://doi.org/10.1080/14735903.2025.2464523>
7. Casella, M., & Dal Bianco, S. (2025). Digital leadership and marketing: A novel CLV metric. In *Digital leadership: Concepts and cases* (pp. 183–196). Edward Elgar Publishing. <https://doi.org/10.4337/9781035321247.00021>
8. Clemente-Almendros, J. A., Nicoara-Popescu, D., & Pastor-Sanz, I. (2024). Digital transformation in SMEs: Understanding its determinants and size heterogeneity. *Technology in Society*, 77, Article 102483. <https://doi.org/10.1016/j.techsoc.2024.102483>
9. Díaz, J., Ahumada, D., Hochstetter, J., & Paz, F. (2021). Relations on cultural behavior and technology adoption: A Chilean perspective. In *Lecture notes in computer science* (Vol. 12780, pp. 34–42). Springer. https://doi.org/10.1007/978-3-030-78224-5_3
10. Díaz-Arancibia, J., Hochstetter-Diez, J., Bustamante-Mora, A., Sepúlveda-Cuevas, S., Albayay, I., & Arango-López, J. (2024). Navigating digital transformation and technology adoption: A literature review from small and medium-sized enterprises in developing countries. *Sustainability*, 16(14), Article 5946. <https://doi.org/10.3390/su16145946>

11. Dokuchaev, V. A. (2020). Digital transformation: New drivers and new risks. In 2020 International Conference on Engineering Management of Communication and Technology (EMCTECH) (pp. 1–5). IEEE. <https://doi.org/10.1109/EMCTECH49634.2020.9261544>
12. Escoz Barragan, K., Hassan, S. S., Meisner, K., & Bzhalava, L. (2025). Dynamics of digital change – Measuring the digital transformation and its impacts on the innovation activities of SMEs. *European Journal of Innovation Management*, 28(4), 1625–1648. <https://doi.org/10.1108/EJIM-05-2023-0432>
13. Fichtelpeter, C., Kuehn, A., Dumitrescu, R., & Ebbesmeyer, P. (2020). Integrated technology transfer concept for fostering innovation in SMEs. In *Proceedings of the 26th International Association for Management of Technology Conference (IAMOT 2017)* (pp. 1028–1048).
14. Feijó González, E. M., Gutiérrez Jaramillo, N. D., Medina Castillo, W. T., & Jaramillo Simbaña, R. M. (2024). Digital transformation in accounting for small and medium-sized enterprises in the province of El Oro, Ecuador. *Revista Venezolana de Gerencia*, 29(12), 1580–1598. <https://doi.org/10.52080/rvgluz.29.e12.44>
15. Haktanır, E., Kahraman, C., Şeker, Ş., & Doğan, O. (2023). Future of digital transformation. In *Lecture notes in networks and systems* (Vol. 549, pp. 611–638). Springer. https://doi.org/10.1007/978-3-031-16598-6_26
16. Hiziroglu, O. A., Aydin, A. E., Van Isacker, K., Milis, G., Sirashki, H., & Tsoris, P. (2024). The role of digital transformation for SMEs during a health crisis: Lessons learnt from Covid-19 epidemic. *CEUR Workshop Proceedings*, 3698, 11–22.
17. Inan, G. G., & Yilmaz, G. (2025). Developing organisational capabilities for digital transformation. In *Digital transformation: A business imperative* (pp. 12–28). Routledge. <https://doi.org/10.4324/9781003626640-3>
18. Kallmuenzer, A., Mikhaylov, A., Chelaru, M., & Czakon, W. (2025). Adoption and performance outcome of digitalization in small and medium-sized enterprises. *Review of Managerial Science*, 19(7), 2011–2038. <https://doi.org/10.1007/s11846-024-00744-2>
19. Kim, J., & Jin, W. (2024). Impact of digital capabilities on entrepreneurial performance in SMEs. *Journal of Innovation and Knowledge*, 9(4), Article 100609. <https://doi.org/10.1016/j.jik.2024.100609>
20. Koca, D., & van Deursen, A. (2025). Exploring labour market dynamics in digital transformations: The perspective of Dutch SMEs. *Journal of the International Council for Small Business*. Advance online publication. <https://doi.org/10.1080/26437015.2025.2538182>
21. Kohli, A., & Malik, O. P. (2025). Digital transformation in SMEs: A literature review on optimizing supply chain management. *Journal of Data, Information and Management*, 7(3), 245–264. <https://doi.org/10.1007/s42488-025-00151-6>
22. Korytova, V., Budrin, A., & Soldatova, A. (2025). Digital marketing transformation model for developing an internal innovative environment within an organization. *AIP Conference Proceedings*, 3276(1), Article 060003. <https://doi.org/10.1063/5.0261891>
23. Kruhlyanko, A., Korobka, S., Soroka, R., Kravchenko, T., & Vasylieva, N. (2025). Adapting management strategies in SMEs to the era of digital transformation. *Management (Montevideo)*, 3, Article 264. <https://doi.org/10.62486/agma2025264>
24. Li, L., Su, F., Zhang, W., & Mao, J.-Y. (2018). Digital transformation by SME entrepreneurs: A capability perspective. *Information Systems Journal*, 28(6), 1129–1157. <https://doi.org/10.1111/isj.12153>
25. Matt, C., Hess, T., & Benlian, A. (2015). Digital transformation strategies. *Business & Information Systems Engineering*, 57(5), 339–343. <https://doi.org/10.1007/s12599-015-0401-5>
26. Metawa, N., Elhoseny, M., & Mutawea, M. (2021). The role of information systems for digital transformation in the private sector: A review of Egyptian SMEs. *African Journal of Economic and Management Studies*, 12(4), 523–540. <https://doi.org/10.1108/AJEMS-01-2021-0037>
27. Mishrif, A., & Khan, A. (2023). Technology adoption as survival strategy for small and medium enterprises during COVID-19. *Journal of Innovation and Entrepreneurship*, 12(1), Article 53. <https://doi.org/10.1186/s13731-023-00317-9>
28. Nadiyah, S. N. A., & Prayoga, D. (2024). Digital transformation as part of hospital marketing strategy. *Media Publikasi Promosi Kesehatan Indonesia*, 7(2), 265–272. <https://doi.org/10.56338/mppki.v7i2.4283>
29. Paiithannkar, M., & Alexander, J. (2025). Introduction to digital transformation. In *Handbook of*

- artificial intelligence for smart city development: Management systems and technology challenges (pp. 27–38). CRC Press. <https://doi.org/10.1201/9781003649892-2>
30. Parviainen, P., Tihinen, M., Kääriäinen, J., & Teppola, S. (2017). Tackling the digitalization challenge: How to benefit from digitalization in practice. *International Journal of Information Systems and Project Management*, 5(1), 63–77. <https://doi.org/10.12821/ijispm050104>
31. Pavlova, O., Zabarna, E., Pierkova, M., Kuzmin, A., & Kostiuk, S. (2025). Mathematical model for digital transformation of business processes in the coordinates of digital marketing. *CEUR Workshop Proceedings*, 3899, 69–77.
32. Shi, Y. (2024). The impact of digital transformation on labour productivity of Chinese small and medium-sized enterprises (SMEs). In *Lecture notes in information systems and organisation* (Vol. 70, pp. 473–488). Springer. https://doi.org/10.1007/978-3-031-66801-2_30
33. Silva, R., Mamede, H. S., & Santos, V. (2023). Clarification of the present understanding of the assessment of an organization's digital readiness in SMEs. *Emerging Science Journal*, 7(6), 2279–2307. <https://doi.org/10.28991/ESJ-2023-07-06-025>
34. Skare, M., de las Mercedes de Obesso, M., & Ribeiro-Navarrete, S. (2023). Digital transformation and European small and medium enterprises (SMEs): A comparative study using digital economy and society index data. *International Journal of Information Management*, 68, Article 102594. <https://doi.org/10.1016/j.ijinfomgt.2022.102594>
35. Srivastava, R., Bagdi, S. K., & Gulati, A. (2024). Framework for the adoption of digital transformation—A study on the banking and financial services industry in India. In *Smart innovation, systems and technologies* (Vol. 379, pp. 1–12). Springer. https://doi.org/10.1007/978-981-99-8612-5_1
36. Szafir, M. F. (2023). Digital transformation enabled by big data. In *IEEE technology and engineering management society body of knowledge (TEMSBOK)* (pp. 299–329). Wiley. <https://doi.org/10.1002/9781119987635.ch18>
37. Tartici, I., Kilic, Z. M., & Da Silva Bartolo, P. J. (2023). Impact of additive manufacturing in SMEs. In *Lecture notes in mechanical engineering* (pp. 103–111). Springer. https://doi.org/10.1007/978-981-19-0561-2_10
38. Tewari, S. K. (2025). Data-driven marketing in emerging markets: Navigating challenges for sustainable development. In *Digital transformation for business sustainability and growth in emerging markets* (pp. 171–196). Emerald Publishing. <https://doi.org/10.1108/978-1-83549-109-620251007>
39. Trivedi, A., & Pistrui, D. (2024). Demystifying the roles of engineering management in digital transformation and innovation in small and medium sized enterprises. In *Proceedings of the 2024 International Annual Conference and 45th Annual Meeting: Engineering Management Riding the Waves of Smart Systems, ASEM 2024* (pp. 766–775).
40. Unegbu, H. C. O., Yawas, D. S., & Dan-Asabe, B. (2024). The impact of digital transformation on Nigerian small and medium-sized enterprises (SMEs) in the global business landscape. *Journal Mekanikal*, 47, 66–85. <https://doi.org/10.11113/jm.v47.478>
41. Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, 122, 889–901. <https://doi.org/10.1016/j.jbusres.2019.09.022>
42. Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, 28(2), 118–144. <https://doi.org/10.1016/j.jsis.2019.01.003>
43. Wahid, R. A., & Zulkifli, N. A. (2021). Factors affecting the adoption of digital transformation among SME's in Malaysia. *Journal of Information Technology Management*, 13(3), 126–140. <https://doi.org/10.22059/JITM.2021.83233>
44. Zhang, J., Zhang, M., Ballesteros-Pérez, P., & Philbin, S. P. (2023). A new perspective to evaluate the antecedent path of adoption of digital technologies in major projects of construction industry: A case study in China. *Developments in the Built Environment*, 14, Article 100160. <https://doi.org/10.1016/j.dibe.2023.100160>