

SUSTAINABLE DIGITAL TRANSFORMATION IN MSMEs: A SYSTEMATIC REVIEW OF DRIVERS, CAPABILITIES, AND TRIPLE-BOTTOM-LINE OUTCOMES

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ABSTRACT

Sustainable digital transformation (SDT) has emerged as a strategic imperative for micro, small, and medium enterprises (MSMEs), reflecting the convergence of digitalization and sustainability agendas. This systematic literature review synthesizes research on the drivers, organizational capabilities, mechanisms, and outcomes of SDT in MSMEs. The review identifies regulatory, market, technological, and socio-cultural drivers, with variations across firm sizes. Key organizational capabilities—digital literacy, leadership, collaboration, innovation, and resource orchestration—enable MSMEs to align digital transformation with sustainability objectives. Mechanisms such as AI, IoT, cloud computing, and blockchain link digitalization to triple-bottom-line outcomes, while contextual moderators such as leadership tenure and regulatory environments shape their effectiveness. The findings reveal economic benefits (efficiency, market expansion), environmental gains (eco-efficiency, waste reduction), and social impacts (inclusivity, workforce empowerment), alongside trade-offs including financial strain, operational complexity, and risks of greenwashing. Methodological strengths include diverse empirical approaches, yet limitations persist regarding generalizability, longitudinal evidence, and gendered perspectives. Theoretical integration of the Resource-Based View, Dynamic Capabilities, and Institutional Theory provides a holistic framework for understanding SDT in MSMEs. The study concludes with practical recommendations for SMEs and policy implications for enabling resilient and sustainable competitiveness.

Keywords: Sustainable digital transformation (SDT); micro, small, and medium enterprises (MSMEs); organizational capabilities; digital technologies; sustainability outcomes; resource-based view; dynamic capabilities.

1. INTRODUCTION

Micro, small, and medium enterprises (MSMEs) are the backbone of global economies, representing over 90 percent of firms and providing critical employment worldwide. Beyond their economic significance, MSMEs play a vital role in advancing inclusive and sustainable development. In this context, the notion of sustainable digital transformation (SDT) has emerged as a central theme in both scholarship and practice, capturing the dual imperatives of digitalization and sustainability. SDT reflects not merely the adoption of digital tools, but the integration of technological innovation with environmental and social objectives, enabling MSMEs to secure long-term competitiveness and resilience in increasingly volatile markets (Rupeika-Apoga & Petrovska, 2022; Martínez-Peláez et al., 2023).

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The evolution of SDT illustrates a paradigm shift. Early initiatives often focused on digital adoption for efficiency or market expansion, but recent developments highlight a transition toward holistic strategies that align business processes with sustainability imperatives. In emerging economies such as Indonesia, MSMEs are increasingly embedding eco-friendly practices and stakeholder engagement into their digital strategies, emphasizing the importance of organizational change in achieving sustainable outcomes (Wahyono, 2024). Nevertheless, barriers persist. Limited financial resources, digital infrastructure deficits, and low digital literacy continue to constrain MSMEs' ability to fully implement SDT. Organizational resistance to change further complicates alignment between digital innovation and sustainability objectives, leaving many firms at risk of lagging behind in both areas (Hendrawan et al., 2024; Hariyanti & Kristanti, 2024; Luthra & Mangla, 2018).

The adoption of SDT is also shaped by external dynamics. The COVID-19 pandemic accelerated digitalization, compelling MSMEs to adopt e-commerce, digital logistics, and remote operations to ensure business continuity (Gao et al., 2023). Simultaneously, international frameworks such as the Paris Agreement and the Sustainable Development Goals (SDGs) have intensified pressure on firms to adopt environmentally responsible practices. National and regional policies that promote e-commerce ecosystems, carbon reduction, and green innovation provide new opportunities for MSMEs to leverage digital tools in pursuit of sustainable competitiveness (Khoiri et al., 2024; Noerchoidah et al., 2025; Liang et al., 2023).

Conceptually, scholars define SDT in diverse ways. Some emphasize the integration of digital technologies with explicit sustainability goals, including waste reduction, carbon tracking, and eco-friendly logistics (Rupeika-Apoga & Petrovska, 2022). Others view SDT as a transformative process that reconfigures business models toward long-term ecological and social responsibility (Megawati et al., 2024). For instance, Risdwiyanto et al. (2023) stress the importance of sustainable digital marketing strategies, while Garzoni et al. (2020) outline a multi-level approach linking digital maturity with sustainable practices. These perspectives converge on the recognition that SDT requires more than technological adoption—it demands embedding sustainability principles within digital transformation strategies.

The integration of sustainability within digitalization carries profound implications for competitiveness. Digital technologies enable process optimization, cost savings, and innovation (Budiarto et al., 2023; Purnomo et al., 2024). At the same time, sustainability-oriented strategies strengthen customer loyalty and brand identity, reflecting shifting consumer preferences toward responsible enterprises (Martínez-Peláez et al., 2023; Teng et al., 2022). Furthermore, SDT equips MSMEs with adaptive business models that enhance resilience against economic and environmental disruptions (Andriyani et al., 2023). Consequently, SDT is increasingly framed as both a strategic necessity and a pathway for sustainable growth. In a digital marketplace, small firms must embed platform-specific brand building into SDT—treating

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websites, SEO, YouTube, and affiliate channels as complementary levers to reach and engage customers (Fluhrer & Brahm, 2025).

Building on this foundation, this systematic literature review (SLR) seeks to consolidate fragmented research and provide a comprehensive synthesis of SDT in MSMEs. Specifically, it aims to (1) identify and categorize the drivers of SDT, including regulatory, technological, market, and socio-cultural enablers; (2) examine the organizational capabilities—such as leadership, human capital, and collaboration—that support SDT adoption; and (3) assess the outcomes of SDT across the triple bottom line of economic, environmental, and social dimensions. The review addresses three guiding research questions: What are the key drivers of SDT adoption in MSMEs? What organizational capabilities enable integration of digital transformation with sustainability? And what are the measurable outcomes of SDT across the triple bottom line?

The contribution of this study is twofold. For academia, it offers a taxonomy of drivers, capabilities, and outcomes, and advances a conceptual framework linking contextual enablers with sustainability impacts. For practitioners and policymakers, it distills actionable insights into how MSMEs can leverage digital and sustainable strategies despite resource limitations. By integrating insights across digital transformation, sustainability, and MSME research, this review advances a coherent and comprehensive understanding of SDT as a pathway toward resilient and sustainable enterprise development.

2. RESEARCH METHODS

2.1. Search Strategy

A systematic search strategy was employed to identify studies on SDT in MSMEs. Boolean search strings combined core concepts of digital transformation, sustainability, and MSMEs, ensuring broad coverage of relevant terminologies. An illustrative query was:

“TITLE-ABS-KEY (("Digital Transformation" OR "Industry 4.0" OR "Digitalization" OR "Digital Technologies") AND ("Sustainability" OR "Sustainable Practices" OR "Triple Bottom Line") AND ("Micro Small Medium Enterprises" OR MSME OR SME OR "Small Businesses"))”.

This approach captured diverse variations while maintaining focus on SDT in MSMEs (Pratiwi & Umam, 2025; Panduwinata et al., 2025; Rupeika-Apoga & Petrovska, 2022). Scopus served as the primary database. To strengthen comprehensiveness, backward and forward citation tracking was conducted (Huda et al., 2024; Bahtiar et al., 2025). The review focused on publications from 2014 to 2025, reflecting the period of accelerated digitalization and sustainability initiatives, and only English-language studies were considered.

2.2. Eligibility Criteria

Eligibility and exclusion criteria were defined to ensure relevance and quality. Included studies consisted of peer-reviewed journal articles, empirical research, systematic reviews, and selected conference or grey literature with substantive findings (Lubis, 2024). Studies had to explicitly address SDT in MSMEs, examining digital technologies in relation to sustainability, efficiency, or innovation. The scope covered global and regional perspectives, enabling comparisons across developed and developing economies (Wijaya et al., 2025). Exclusion applied to works outside the MSME or SDT context, purely theoretical pieces without evidence, methodologically weak studies, duplicates, and non-peer-reviewed materials such as blogs (Bahtiar et al., 2025; Nama et al., 2021; Baker et al., 2025; Kälín et al., 2016). The selection process followed PRISMA standards to maintain transparency and reproducibility (Ghalichi et al., 2022; Zhang et al., 2024).

2.3. Screening and Selection

The review followed the four PRISMA phases: identification, screening, eligibility, and inclusion. Records retrieved through database searches were cleaned of duplicates, then screened at abstract and full-text levels to exclude irrelevant or low-quality studies. Citation tracking was applied iteratively to capture additional material. In total, 56 studies met all criteria and were included in the synthesis. The process is summarized in the PRISMA flow diagram (Figure 1), which illustrates each stage of study selection.

2.4. Quality Assessment

To ensure methodological rigor and reliability, several complementary assessment tools were applied. PRISMA guided the reporting structure and transparency (Page et al., 2021). AMSTAR 2 was used to evaluate the quality of systematic reviews (Shea et al., 2017), while the Mixed Methods Appraisal Tool (MMAT) appraised studies using qualitative, quantitative, and mixed approaches (Kim & Kim, 2024). For cross-sectional research common in MSME studies, the AXIS tool ensured validity and accuracy (Downes et al., 2016). The Critical Appraisal Skills Programme (CASP) checklist further supported appraisal of qualitative and quantitative evidence (Kim & Kim, 2024). The integration of these frameworks reinforced confidence in the robustness and generalizability of the synthesized findings on SDT in MSMEs.

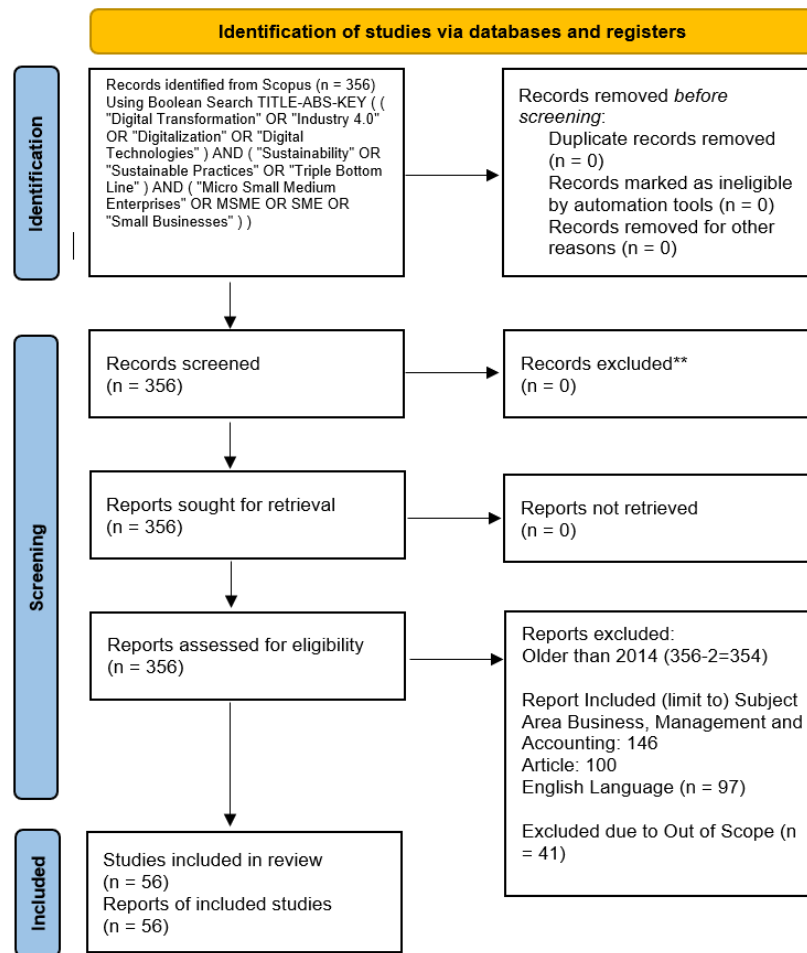


Figure 1. The PRISMA flow diagram detailing the screening and selection process of literature.

3. THEORETICAL BACKGROUND

3.1. Relevant Theories and Models

The analysis of SDT in MSMEs is grounded in three complementary theoretical perspectives: the Resource-Based View (RBV), the Dynamic Capabilities Theory (DCT), and Institutional Theory. Together, these frameworks explain how internal resources, adaptive processes, and external pressures interact to shape SDT adoption.

The RBV emphasizes that competitive advantage stems from resources and capabilities that are valuable, rare, inimitable, and non-substitutable (VRIN). For MSMEs, such resources include technological competencies, skilled human capital, and organizational culture, which can be leveraged to integrate digital and sustainable practices (Rupeika-Apoga & Petrovska, 2022). By aligning sustainability strategies with these core strengths, firms enhance efficiency and resilience in volatile environments. Complementing this, the DCT highlights the importance of developing adaptive capacities to sense opportunities, seize innovations, and reconfigure resources in response to change. These dynamic capabilities—such as

environmental scanning, agility, and collaboration—are essential for MSMEs facing rapid technological and sustainability pressures (Wong & Ngai, 2023; Elf et al., 2022). Institutional Theory further situates SDT within broader environmental contexts, underscoring how coercive (regulatory), mimetic (competitive imitation), and normative (societal expectation) pressures shape adoption. Regulatory frameworks can compel eco-friendly technology use (Khouroh et al., 2020), while mimetic forces drive SMEs to replicate best practices of industry leaders. Normative pressures, such as consumer demand for responsible businesses, reinforce sustainability commitments (Kurniawan & Nuringsih, 2023). The integration of RBV, DCT, and Institutional Theory is illustrated in Figure 2, which demonstrates the interplay of resources, capabilities, and external pressures in driving MSMEs' sustainable digital transformation.

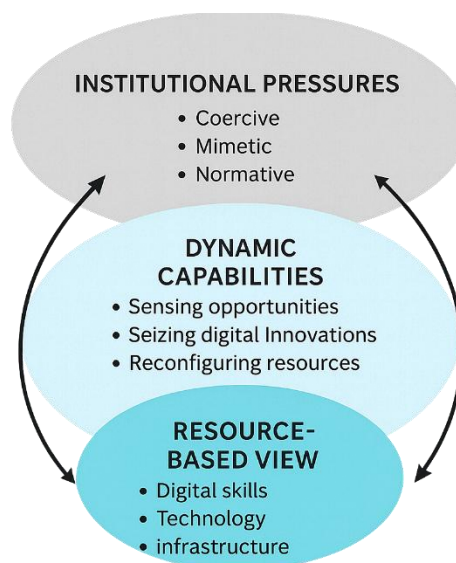


Figure 2. Theoretical Framework of Sustainable Digital Transformation in MSMEs
Conceptual framework integrating Resource-Based View, Dynamic Capabilities, and Institutional Theory for SDT in MSMEs.

3.2. Historical Development of the Topic

Over the past two decades, MSMEs' digitalization trajectory has become increasingly intertwined with sustainability imperatives. Initial efforts focused primarily on efficiency gains and market access (KV & Selvam, 2025; Fadillah et al., 2025). With the emergence of Industry 4.0, MSMEs began embedding sustainability through technologies that optimize resources and enable greener practices (Achmad & Subriadi, 2025; Murwenie et al., 2025). The COVID-19 pandemic further accelerated digital adoption, compelling MSMEs to integrate e-commerce, digital finance, and remote operations. These adaptations not only ensured survival but also supported sustainable practices, such as reduced physical infrastructure and improved stakeholder engagement (Huda et al., 2024; Harnida et al., 2024). Additionally, digital literacy and marketing capabilities were identified as key enablers of both sustainability and competitive positioning (Azzahra et al., 2025; Dyatmika et al., 2023).

Several milestones mark this evolution. The early 2000s saw alignment with global frameworks such as the UN Sustainable Development Goals (SDGs), which encouraged reporting and documentation of responsible practices ([Chibueze, 2022](#); [Affini et al., 2024](#); [Santoso et al., 2023](#)). In the 2010s, MSMEs increasingly integrated renewable energy, sustainable supply chains, and advanced analytics, reinforcing SDT's competitive advantage ([Hendrawan et al., 2024](#); [Yuliawati et al., 2025](#)). More recently, fintech and digital marketing innovations have become critical tools for scaling sustainability in resource-constrained contexts ([Budiarto et al., 2023](#); [Jayanti & Karnowati, 2023](#)). Collectively, these milestones reveal a progressive maturation of SDT as MSMEs move from basic digital adoption toward strategic integration of sustainability.

3.3. Debates & Controversies

Despite increasing recognition of SDT's potential, scholarly debates persist. One major contention concerns the relationship between sustainability and profitability. Some argue that sustainability initiatives burden MSMEs with high upfront costs, reducing short-term financial performance ([Achenbach, 2021](#); [Huynh, 2025](#)). Others highlight that integrating digital and sustainable practices enhances efficiency, reduces waste, and strengthens consumer trust, ultimately supporting long-term profitability ([Liu et al., 2024](#); [Ünal & Sinha, 2023](#)). Sector-specific dynamics complicate this further—for instance, the fashion industry faces strong consumer pressure for sustainability but also structural challenges such as overproduction and waste ([Liu et al., 2024](#)).

Methodological challenges also limit consensus. The absence of standardized metrics across environmental, social, and economic domains hampers comparability ([Achenbach, 2021](#); [Fatmah et al., 2025](#)). While mixed-method approaches that combine quantitative indicators with qualitative insights have been proposed ([Chen et al., 2025](#)), synthesizing such data remains difficult. Longitudinal studies, though valuable for capturing delayed outcomes, are resource-intensive and scarce ([Phaxaisithidet, 2025](#)). Moreover, contextual factors—such as regulatory frameworks, market dynamics, and organizational culture—introduce further complexity ([Bădulescu et al., 2025](#)).

In sum, while there is growing consensus that SDT can advance both sustainability and competitiveness, unresolved debates regarding trade-offs, sectoral differences, and methodological rigor highlight the need for more robust frameworks and empirical designs to fully capture SDT's impact on MSMEs.

4. REVIEW OF FINDINGS

4.1. Drivers of Sustainable Digital Transformation in MSMEs

The adoption of SDT in MSMEs is shaped by multiple drivers that span regulatory, market, technological, and socio-cultural domains. This section synthesizes key findings from the literature, highlighting both the broad categories of drivers and their differentiated impacts across firm sizes, while also recognizing the influence of government policies and supply-chain pressures.

4.1.1. Regulatory Drivers

Government regulations and sustainability mandates serve as strong external drivers of SDT adoption. Regulations on environmental compliance, sustainability reporting, and corporate social responsibility push MSMEs to integrate sustainable practices into their digital strategies. For instance, [Anaman et al. \(2023\)](#) demonstrate that policy-driven sustainability requirements encourage firms to adopt digital tools that support compliance and enhance environmental performance. Similarly, regulatory frameworks that introduce emission targets or conservation mandates act as catalysts for investment in green technologies and digital monitoring systems ([Sun et al., 2022](#)).

4.1.2. Market Drivers

Shifting consumer preferences and competitive market dynamics also motivate MSMEs to pursue SDT. Studies highlight that consumer demand for environmentally friendly products drives firms to redesign business models and embrace digital platforms that emphasize sustainability ([Gómez-Trujillo & González-Pérez, 2021](#)). The adoption of e-commerce and digital marketing tools allows MSMEs to highlight eco-friendly practices, strengthen customer loyalty, and remain competitive in rapidly evolving markets.

4.1.3. Technological Drivers

The rapid evolution of digital technologies provides critical tools for advancing sustainability objectives. Innovations such as big data analytics, cloud computing, and the Internet of Things (IoT) enable firms to optimize supply chains, enhance transparency, and reduce waste ([Ma et al., 2022](#); [Mavlutova et al., 2022](#)). For small and medium enterprises, these technologies are increasingly essential for balancing operational efficiency with environmental goals. As digital maturity increases, firms are better positioned to integrate eco-friendly practices into their operations.

4.1.4. Socio-Cultural Drivers

Organizational culture and social values also shape MSMEs' commitment to SDT. A sustainability-oriented culture fosters responsiveness to regulatory and market expectations, facilitating digital adoption that supports green practices ([Priyono et al., 2020](#)). MSMEs embedded in communities where sustainability is valued are more likely to adopt eco-friendly digital innovations. Training and human capital development in sustainability-related competencies further strengthen the socio-cultural foundation for SDT.

4.1.5. Firm Size and Differential Drivers

Firm size significantly mediates the relative importance of SDT drivers. Micro-enterprises are disproportionately influenced by regulatory and socio-cultural pressures due to their limited resources and close community ties (Priyono et al., 2020). Small enterprises, with greater resource flexibility, prioritize technological drivers to enhance efficiency and sustainability outcomes (Wisnujati et al., 2023; Purnomo et al., 2024). Medium-sized enterprises have the capacity to integrate market, technological, and regulatory drivers simultaneously, strategically embedding sustainability into their digital transformation initiatives (Gunawan et al., 2023; Martínez-Peláez et al., 2023).

4.1.6. Role of Government Incentives and Policy Frameworks

Supportive policy frameworks and government incentives further drive SDT in MSMEs. Regulatory compliance is reinforced by financial mechanisms such as grants, subsidies, and tax incentives, which bridge the resource gap for smaller firms (Kot, 2018). Infrastructure development programs—such as training initiatives, digital literacy campaigns, and technology transfer schemes—empower MSMEs to adopt SDT more effectively (Chen et al., 2024; Dong & Zhang, 2024). These interventions create an enabling environment where SDT adoption is both feasible and rewarding.

4.1.7. Customer and Supply-Chain Pressures

External pressures from customers and supply-chain partners significantly accelerate sustainability-focused digital transformation. Growing consumer awareness of ecological impacts drives MSMEs to adopt digital tools for transparency and accountability, such as sustainability reporting and product traceability (Li et al., 2017). Similarly, supply-chain pressures from larger corporations compel SMEs to comply with sustainability standards, leading to knowledge sharing and collaborative green innovation (Tian et al., 2024; Reynolds, 2024). Digital supply-chain solutions, including real-time tracking, strengthen sustainability outcomes by enabling agile and transparent operations (Khan et al., 2022). The reviewed studies are summarized in Table 1, while the overall structure of drivers influencing SDT adoption across MSMEs is illustrated in Figure 3.

Overall, the literature demonstrates that MSMEs' adoption of SDT is influenced by a combination of regulatory, market, technological, and socio-cultural factors, with the relative weight of these drivers varying by firm size. Government incentives and customer-supply-chain pressures act as amplifiers, reinforcing the adoption of digital tools for sustainability. These findings underscore that SDT is not driven by a single factor but emerges from a complex interplay of external pressures, technological opportunities, and organizational values.

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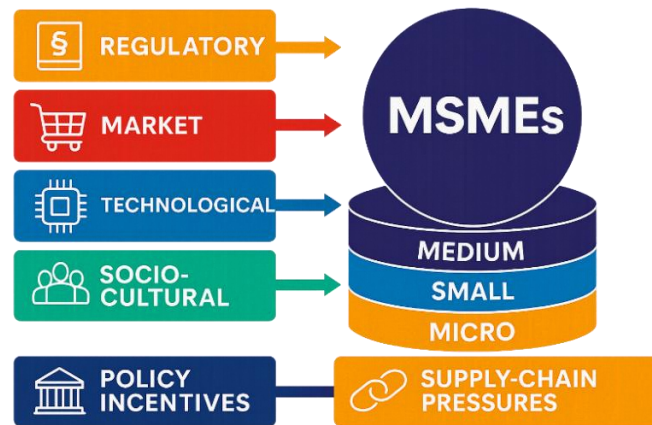


Figure 3. Drivers of Sustainable Digital Transformation in MSMEs.

Key regulatory, market, technological, and socio-cultural drivers of SDT adoption across MSME firm sizes.

Table 1. Drivers of Sustainable Digital Transformation in MSMEs

Author/Year	Research Context	Methodology	Key Findings (Drivers / Enablers / Barriers)	Strengths / Limitations
Anaman et al., 2023	SMEs (multi-sector)	Case-based analysis	Regulatory frameworks push adoption of environmentally sustainable business practices.	Context-specific; generalizability limited.
Gómez-Trujillo & González-Pérez, 2021	SMEs (Latin America)	Survey	Market demand for sustainability shapes DT adoption.	Regional focus; perception-based.
Ma et al., 2022	SMEs (China)	Quantitative study	Digital technologies (big data, IoT) optimize supply chains for sustainability.	Tech-focused; limited social outcomes.
Mavřutova et al., 2022	European SMEs	Comparative analysis	Cloud and digital tools enhance transparency and resource efficiency.	Context variation; cross-country differences.
Priyono et al., 2020	SMEs (Indonesia)	Case study	Socio-cultural orientation toward sustainability fosters SDT adoption.	Qualitative depth; limited scale.
Wisnujati et al., 2023	Small enterprises (Indonesia)	Mixed-methods	Technological drivers dominate sustainability-focused DT.	Small enterprise focus.
Purnomo et al., 2024	SMEs (Indonesia)	SEM	Tech adoption enhances efficiency and sustainability outcomes.	Cross-sectional; industry-specific.
Gunawan et al., 2023	Medium enterprises (Indonesia)	Survey	Medium firms integrate market and technological drivers.	Limited generalizability beyond sample.
Martínez-Peláez et al., 2023	SMEs (global)	SLR	Medium enterprises balance regulatory, market, and technological drivers.	Broad synthesis; limited empirical depth.

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Sun et al., 2022	SMEs (China)	Policy review	Environmental protection regulations act as catalysts for SDT.	Regulatory emphasis only.
Dong & Zhang, 2024	SMEs (China)	Survey	Green supply-chain policies promote operational resilience.	Sector-specific.
Kot, 2018	SMEs (Europe)	Policy analysis	Financial incentives (subsidies, grants) support green technology adoption.	Policy-oriented; lacks firm-level data.
Chen et al., 2024	SMEs (China)	Survey	Training and digital infrastructure programs drive SDT adoption.	National focus.
Li et al., 2017	SMEs (global)	Survey	Customer demand compels SMEs to enhance transparency via digital solutions.	Early-stage; global relevance.
Tian et al., 2024	SMEs (China)	Survey	Supply-chain standards enforce SME adoption of sustainability practices.	Supply-chain dependent.
Reynolds, 2024	SMEs (UK)	Case study	Collaborative supply-chain initiatives enhance green innovation.	Industry-specific.
Khan et al., 2022	SMEs (global)	Conceptual	Digital supply chains reinforce sustainability metrics.	Lacks empirical testing.

4.2. Capabilities for Sustainable Digital Transformation in MSMEs

The ability of micro, small, and medium enterprises (MSMEs) to integrate digital transformation (DT) with sustainability goals depends heavily on the development of distinct organizational capabilities. These capabilities shape how firms adapt to external pressures, exploit technological opportunities, and embed sustainability into their operations. The literature identifies several interrelated categories of capabilities—human capital, leadership, collaboration, innovation, and resource orchestration—that underpin effective SDT implementation.

4.2.1. Human Capital and Digital Literacy

A fundamental enabler of SDT in MSMEs is the digital literacy and skillset of employees. Workforces equipped with knowledge of digital tools and sustainability practices can drive the adoption of eco-efficient technologies, such as energy management systems and waste reduction applications ([Garzoni et al., 2020](#)). Investment in training programs not only enhances performance but also builds the adaptive capacity of MSMEs to innovate sustainably ([Haunstrup, 2024](#)). Digital literacy further empowers employees to align operational practices with sustainability targets, leveraging data analytics and digital platforms to monitor and optimize resource use ([Larsson et al., 2022](#); [Cuevas-Vargas, 2025](#)).

4.2.2. Adaptive and Transformational Leadership

Leadership plays a central role in shaping SDT outcomes. Resilience-oriented SDT depends on a positive organizational culture built on empowerment, accountability,

and ethical conduct, and it is impeded by ineffective leadership during crises (Koporcic et al., 2025). Transformational and empowering leadership styles foster organizational cultures that prioritize sustainability and innovation while encouraging experimentation with digital tools (Kim & Beehr, 2020; Chiniara & Bentein, 2016). Leaders who cultivate competence, autonomy, and employee engagement strengthen motivation to pursue sustainability initiatives (Waseel et al., 2023). Empirical studies show that adaptive leadership enables MSMEs to seize technological opportunities while simultaneously embedding sustainability into business strategy (Kovjanic et al., 2012).

4.2.3. Collaborative Networks and Ecosystem Capabilities

Collaboration with external stakeholders—including suppliers, customers, government agencies, and research institutions—enhances MSMEs' ability to pool resources and share knowledge. Digital innovation hubs and ecosystem partnerships provide technical support and access to resources that accelerate SDT adoption (Kasih, 2024). By participating in broader digital ecosystems, MSMEs can learn from peers, engage in co-creation, and adopt best practices, thereby strengthening resilience and innovation capacity (Karim et al., 2022; Ali et al., 2023). These ecosystem-building capabilities position MSMEs to respond collectively to sustainability challenges.

4.2.4. Change Management and Innovation Capacity

Effective change management is critical to align organizational structures, processes, and culture with SDT goals. Clear communication, stakeholder engagement, and strategic planning facilitate smoother transitions to digital and sustainable practices (Garzoni et al., 2020). Additionally, cultivating innovation capacity allows MSMEs to identify sustainable products, services, and processes that leverage digital tools (Get et al., 2024). This culture of continuous improvement not only strengthens competitiveness but also ensures alignment with evolving sustainability imperatives.

4.2.5. Financial and Resource Orchestration Capabilities

MSMEs' ability to manage and allocate financial and non-financial resources significantly influences SDT implementation. Financial orchestration capabilities allow firms to secure external funding, allocate budgets strategically, and invest in advanced digital technologies that promote sustainability (Awonuga et al., 2024). Resource orchestration involves coordinating human, technological, and financial assets to integrate new digital solutions with sustainability goals (Li, 2025; Wang, 2025). Strategic alignment of resources enhances efficiency, reduces waste, and strengthens adaptability to dynamic market conditions. Moreover, effective financial management promotes continuous investment in employee development, reinforcing organizational innovation and sustainability culture (Khan, 2024). The reviewed literature highlighting these core capabilities is synthesized in Table 2, while the interrelationships among them are visually represented in Figure 4.

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The evidence highlights that MSMEs require a balanced portfolio of capabilities to integrate digital transformation with sustainability objectives. Human capital and digital literacy build operational foundations, adaptive leadership sets the strategic tone, collaboration fosters external support, innovation drives competitive differentiation, and resource orchestration ensures strategic alignment. Together, these capabilities empower MSMEs to navigate constraints, respond to market and regulatory demands, and leverage digital technologies for sustainable growth.



Figure 4. Organizational Capabilities Enabling SDT.

Core organizational capabilities enabling MSMEs to align digital transformation with sustainability objectives.

Table 2. Capabilities for Sustainable Digital Transformation SDT in MSMEs

Author/Year	Geographical Scope	Analytical Framework	Results (Core Capabilities)	Implications
Garzoni et al., 2020	Italy (SMEs)	Multi-level capability framework	Digital literacy, collaborative networks, change management support SDT.	Training and knowledge-sharing essential for scaling SDT.
Kim & Beehr, 2020	SMEs (Global)	Leadership and organizational behavior model	Transformational leadership fosters innovation and sustainability alignment.	Empowering leadership enhances employee motivation.
Chiniara & Bentein, 2016	SMEs (Canada)	Empirical study	Empowering leadership improves psychological ownership and innovation.	Leadership style critical for sustaining SDT.
Haunstrup, 2024	SMEs (Europe)	Survey	Human capital investment enhances sustainability-aligned performance.	Employee training central to SDT success.
Larsson et al., 2022	SMEs (Sweden)	Quantitative study	Digital literacy drives adoption of eco-efficient technologies.	Policies should emphasize workforce upskilling.
Cuevas-Vargas, 2025	SMEs (Mexico)	Survey	Digital literacy empowers sustainability initiatives via	Managers should encourage cross-

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			active engagement.	departmental literacy.
Kasih, 2024	Indonesian MSMEs	Case study	Innovation hubs and collaboration expand SDT adoption.	Governments should promote digital ecosystems.
Karim et al., 2022	SMEs (Asia)	Case study	External partnerships accelerate sustainable digital adoption.	Co-creation fosters innovative outcomes.
Ali et al., 2023	SMEs (Middle East)	Conceptual	Ecosystem participation enhances resilience and adaptability.	Multi-actor ecosystems necessary for SDT scaling.
Get et al., 2024	SMEs (Global)	Case study	Innovation capacity drives sustainable product/process development.	Innovation culture links DT with sustainability.
Awonuga et al., 2024	African SMEs	Policy-oriented study	Financial orchestration capabilities bridge SDT funding gaps.	Subsidies and grants support MSMEs' SDT adoption.
Li, 2025	Chinese SMEs	Resource orchestration model	Resource integration aligns DT with sustainability.	Strong orchestration fosters eco-efficiency.
Wang, 2025	SMEs (China)	Survey	Resource orchestration enhances adaptability to market dynamics.	Coordination across resources critical for resilience.
Khan, 2024	South Asian SMEs	Survey	Strategic alignment of resources with sustainability improves outcomes.	Budget prioritization crucial for SDT.

4.3. Mechanisms Linking Digital Transformation to Sustainability Outcomes in MSMEs

The literature highlights several mechanisms through which DT contributes to sustainability outcomes in micro, small, and medium enterprises (MSMEs). These mechanisms are enabled by digital technologies, platform-based collaboration, robust data governance, and the moderating influence of contextual factors.

4.3.1. Digital Technologies as Mechanisms

Digital technologies serve as the central mechanisms through which MSMEs achieve sustainability outcomes in the process of DT. Among these, artificial intelligence (AI) plays a pivotal role in optimizing operational efficiency and resource management. AI-driven analytics allow MSMEs to predict demand accurately, minimize waste, and enhance decision-making processes through data-driven insights, thereby supporting more sustainable and efficient production systems ([Hernández et al., 2024](#)). Similarly, the IoT enables real-time monitoring of energy consumption and equipment performance, facilitating predictive maintenance and reducing operational inefficiencies that contribute to environmental degradation ([Yang & Zhang, 2020](#)). Cloud computing further strengthens sustainability efforts by providing scalable and cost-effective digital infrastructures. Through cloud-based services, MSMEs can access collaboration tools, data storage, and virtualization technologies that

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significantly reduce the need for physical resources and lower carbon footprints (Vergilio et al., 2022). Moreover, blockchain technology enhances transparency and accountability across supply chains by ensuring traceability of production processes and compliance with sustainability standards, thereby improving consumer trust and stakeholder confidence (Ostojić, 2023). Collectively, these technologies constitute a synergistic framework through which MSMEs can embed sustainability into their digital transformation journey, demonstrating how technological innovation functions as both an enabler and accelerator of sustainable business practices.

4.3.2. Platform-Based Collaboration

Digital platforms facilitate collaboration among SMEs, enhancing efficiency, inclusiveness, and sustainability outcomes. Platform ecosystems allow firms to share resources, knowledge, and logistics, resulting in operational efficiencies and reduced redundancies (Budiasa et al., 2022; Mohammad & Abbas, 2024). They also promote inclusiveness by providing smaller enterprises access to broader networks and markets (Lu et al., 2021). Importantly, collaborative platforms foster co-development of sustainable solutions and benchmarking of green practices, amplifying sustainability performance (Jing-jie et al., 2022).

4.3.3. Data Governance and Cybersecurity

The effectiveness of DT mechanisms for sustainability is contingent upon strong data governance and cybersecurity measures. Effective governance ensures data quality, consistency, and regulatory compliance, enabling evidence-based sustainability strategies (Lin & Mao, 2023). Cybersecurity safeguards data integrity and prevents disruptions that could undermine SDT outcomes. Robust cyber infrastructures build confidence for MSMEs to adopt advanced technologies, ensuring that sustainability gains are not compromised by vulnerabilities (Wrede et al., 2020; Böttcher et al., 2023).

4.3.4. Contextual Moderators

The effectiveness of DT mechanisms in achieving sustainability outcomes within MSMEs is strongly influenced by contextual moderators that shape how technological and organizational processes unfold. Among these moderators, leadership tenure plays a critical role in guiding the direction and consistency of sustainable digital initiatives. Leaders with longer tenures tend to possess a deeper understanding of organizational culture, strategic continuity, and stakeholder expectations, which enables them to align digital transformation with long-term sustainability objectives. Their experience fosters stability, vision, and a sustained commitment to green goals, ensuring that digital initiatives contribute meaningfully to environmental and social value creation (Zhang et al., 2024).

Equally significant is the regulatory environment, which determines the extent to which firms can integrate digital technologies for sustainability. Strong and well-defined regulatory frameworks provide incentives and guidance for MSMEs to engage in sustainable digital practices, such as adopting renewable energy systems,

enhancing supply chain transparency, and investing in green technologies. Conversely, weak or ambiguous regulations may create uncertainty, limiting MSMEs' willingness or capacity to adopt sustainable digital initiatives. Policy instruments such as tax incentives, sustainability certification schemes, and green financing mechanisms can amplify the impact of digital transformation by lowering entry barriers and reinforcing accountability (Gómez-Trujillo & González-Pérez, 2021; Sun et al., 2023).

Overall, contextual moderators such as leadership vision and regulatory support determine how effectively MSMEs can translate digital transformation mechanisms—ranging from AI and IoT to blockchain and cloud computing—into tangible sustainability outcomes. These findings underscore that SDT is not merely a technological process but a complex organizational and institutional endeavor requiring alignment across internal capabilities and external governance structures. The reviewed studies are summarized in Table 3, while the interaction between digital technologies, mechanisms, and sustainability outcomes is illustrated in Figure 5.

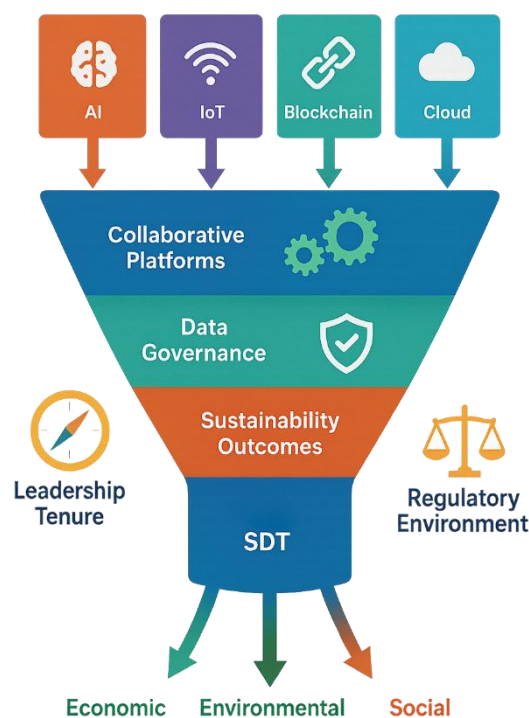


Figure 5. Mechanisms Linking Digital Transformation to Sustainability Outcomes. Digital technologies and contextual moderators shaping pathways from DT to triple-bottom-line sustainability outcomes.

Name: Title

Table 3. Mechanisms Linking DT to Sustainability Outcomes in MSMEs

Author/Year	Sample/Case	Variables / Concepts Examined	Outcomes (Econ / Env / Soc)	Critical Notes
Hernández et al., 2024	SMEs (Global)	AI-based predictive analytics	Efficiency gains, waste reduction, eco-friendly decision-making	Context of adoption influences impact.
Yang & Zhang, 2020	SMEs (China)	IoT-enabled monitoring	Energy savings, predictive maintenance, ↓ environmental footprint	Infrastructure dependency noted.
Vergilio et al., 2022	SMEs (Europe)	Cloud computing adoption	Resource virtualization, ↓ energy use, ↑ collaboration	Scalable, but data security concerns remain.
Ostojić, 2023	SMEs (Europe)	Blockchain for supply chains	↑ transparency, compliance with sustainability standards	Costs and technical expertise may limit adoption.
Budiasa et al., 2022	SMEs (Indonesia)	Platform-based collaboration	Operational efficiency, resource sharing	Early stage of ecosystem maturity.
Mohammad & Abbas, 2024	SMEs (Middle East)	Shared logistics platforms	Efficiency gains, ↓ redundancies	Limited sectoral coverage.
Lu et al., 2021	SMEs (Asia)	Digital platforms for inclusiveness	Market access, broader stakeholder engagement	Inclusiveness varies across regions.
Jing-jie et al., 2022	SMEs (China)	Collaborative sustainability platforms	Joint eco-innovation, benchmarking practices	Relies on stakeholder participation.
Lin & Mao, 2023	SMEs (China)	Data governance frameworks	Better decision-making, ↑ stakeholder trust	Alignment of tech-business goals critical.
Wrede et al., 2020	SMEs (Germany)	Cybersecurity resilience	Protected sustainability data and operations	Strong infrastructure required.
Böttcher et al., 2023	SMEs (Europe)	Cyber-innovation	Improved trust in DT adoption	Cost implications for SMEs.
Zhang et al., 2024	SMEs (China)	Leadership tenure as moderator	Stronger SDT commitment and implementation	Context-specific.
Sun et al., 2023	SMEs (China)	Regulatory incentives	↑ adoption of digital green practices	Dependent on government enforcement.

4.4. Outcomes of Sustainable Digital Transformation in MSMEs

SDT in MSMEs has produced a variety of outcomes spanning economic, environmental, and social domains. While evidence points to clear benefits, the literature also identifies unintended consequences and contextual differences that shape how outcomes are perceived and realized.

4.4.1. Economic Outcomes

SDT adoption enhances MSME performance through improved efficiency, cost reduction, and market expansion. Digital tools reduce operational costs and open new revenue streams by enabling participation in e-commerce and online marketplaces (Astuti et al., 2023). Empirical studies demonstrate a positive correlation between digital adoption and the creation of economic sustainability and social value (Vrontis et al., 2022). Moreover, process automation and data-driven decision-making contribute to productivity gains, ensuring long-term economic viability.

4.4.2. Environmental Outcomes

Environmental benefits emerge through improved resource management, energy efficiency, and reduced waste. Digital technologies such as IoT and AI allow real-time monitoring of resource use, enabling predictive interventions that minimize environmental impact (Corvello et al., 2022; Garzoni et al., 2020). SMEs adopting cleaner production techniques report significant reductions in emissions and waste streams (Rahmadyanti & Andre, 2016). IT innovations further strengthen operational efficiencies, indirectly enhancing environmental sustainability (Chege et al., 2019). Collectively, these outcomes highlight SDT's potential to align business growth with ecological stewardship.

4.4.3. Social Outcomes

On the social dimension, SDT fosters customer engagement, employee empowerment, and inclusivity. Digital adoption enables firms to respond effectively to consumer demand for sustainable products, strengthening loyalty and trust (Vrontis et al., 2022). Workforce training and upskilling initiatives not only improve productivity but also enhance employee confidence and cohesion (Lutfi et al., 2020). Furthermore, collaborative platforms amplify inclusivity by enabling SMEs to connect with diverse stakeholders and broaden market participation (Budiasa et al., 2022). These dynamics reinforce SDT's contribution to equitable and socially responsible enterprise development. The synthesis of these outcomes is summarized in Table 4, while their interconnections across economic, environmental, and social dimensions are visually depicted in Figure 6.

4.4.4. Contributions of Digital Tools to Eco-Efficiency and Cleaner Production

Digital tools are pivotal in promoting eco-efficiency and enabling cleaner production practices within MSMEs. Technologies such as the IoT and cloud computing facilitate real-time monitoring of energy and material consumption, allowing firms to identify inefficiencies and optimize resource use (Corvello et al., 2022). Automation further enhances process efficiency by minimizing emissions and integrating environmentally conscious operations across production cycles (Rahmadyanti & Andre, 2016). Through predictive analytics, MSMEs can make data-driven decisions that improve forecasting accuracy and reduce waste generation (Putri et al., 2023). In addition, collaborative digital platforms enable knowledge sharing and joint eco-innovation

initiatives, fostering collective approaches to waste reduction and resource optimization (Muslimah, 2020). Collectively, these tools empower MSMEs to transition toward cleaner, more sustainable production systems, enhancing both environmental performance and operational resilience.

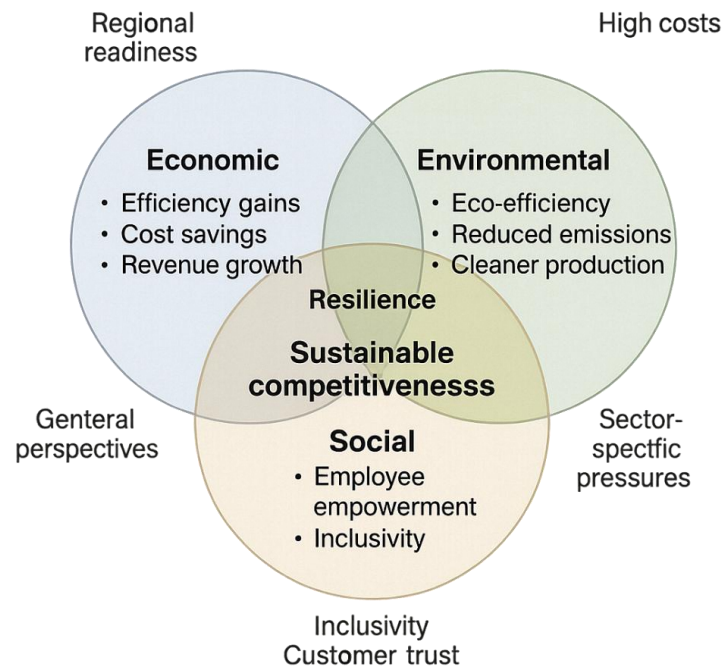


Figure 6. Outcomes of Sustainable Digital Transformation

Economic, environmental, and social outcomes of SDT in MSMEs, including benefits, trade-offs, and contextual perceptions.

4.4.5. Unintended Consequences and Trade-offs

Despite positive outcomes, SDT adoption also produces trade-offs. Increased operational complexity from integrating multiple digital systems may overwhelm small teams and detract from sustainability gains (Teng et al., 2022). High upfront costs of digital technologies and training can strain financial capacity, particularly for resource-constrained MSMEs (Šimberová et al., 2022). Additionally, digitalization itself carries environmental costs, such as resource depletion in device manufacturing (Hu et al., 2025). Risks of greenwashing also arise, where firms exaggerate sustainability claims without substantive practices, potentially eroding stakeholder trust (Šimberová et al., 2022).

4.4.6. Perceptions Across Regions, Sectors, and Genders

Perceptions of SDT outcomes vary significantly by context. SMEs in developed economies often perceive SDT as a competitive advantage due to stronger infrastructure, while firms in developing economies may view it as a resource-intensive challenge (Fauzi et al., 2023). Sector-specific pressures also shape perceptions: manufacturing and agriculture emphasize compliance and

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environmental benefits, while retail prioritizes customer engagement (Wu et al., 2024). Gendered perspectives highlight further diversity—female entrepreneurs often prioritize community and social outcomes, whereas male entrepreneurs tend to emphasize financial and market competitiveness (Alam et al., 2022).

The literature demonstrates that SDT delivers measurable economic, environmental, and social outcomes while also introducing complexities and trade-offs. Outcomes are mediated by contextual factors, including regional readiness, industry regulations, and gendered perspectives. Overall, SDT represents both an opportunity and a challenge for MSMEs, requiring careful management of its benefits and risks to ensure holistic sustainability.

Table 4. Outcomes of Sustainable Digital Transformation (SDT) in MSMEs

Author/Year	Discipline / Domain	Methods / Tools Used	Findings (Econ / Env / Soc)	Future Directions
Yrontis et al., 2022	SMEs (Europe)	Survey	Econ & Soc: ↑ economic sustainability, social value; digital adoption supports competitiveness.	Examine sector-specific effects.
Astuti et al., 2023	Indonesian SMEs	SEM	Econ: ↑ efficiency, revenue growth via e-commerce.	Replicate in other emerging economies.
Rahmadyanti & Andre, 2016	SMEs (Indonesia)	Case study	Env: Cleaner production reduces emissions and waste.	Extend to multiple industries.
Chege et al., 2019	SMEs (Kenya)	Survey	Env: IT innovations improve operational efficiency → sustainability.	Explore longitudinal impacts.
Corvello et al., 2022	SMEs (Italy)	Survey	Env: IoT improves energy/resource management.	Apply across varied contexts.
Garzoni et al., 2020	SMEs (Italy)	Case study	Env: Data analytics supports eco-efficiency.	Develop scalable solutions.
Lutfi et al., 2020	SMEs (Middle East)	Survey	Soc: Workforce upskilling boosts productivity & cohesion.	Comparative gender analysis.
Budiasa et al., 2022	SMEs (Indonesia)	Case study	Soc: Platforms enhance inclusivity & stakeholder reach.	Expand cross-sectoral scope.
Putri et al., 2023	SMEs (Indonesia)	Mixed methods	Env: Predictive analytics reduce waste.	Assess cost–benefit trade-offs.
Muslimah, 2020	SMEs (Indonesia)	Case study	Env: Collaborative eco-innovation improves cleaner production.	Evaluate long-term eco-impact.
Teng et al., 2022	SMEs (Asia)	Survey	Trade-off: Digital complexity challenges sustainability outcomes.	Simplify DT adoption processes.
Šimberová et al., 2022	SMEs (Europe)	Survey	Trade-off: Financial strain & risks of greenwashing.	Develop funding & accountability mechanisms.
Hu et al., 2025	SMEs (China)	Policy analysis	Trade-off: Digital device lifecycle → resource depletion.	Advocate circular IT practices.
Fauzi et al., 2023	SMEs	Survey	Regional: Developed vs. emerging	Tailor regional

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	(Indonesia)	economies show differing SDT perceptions.	strategies.
Wu et al., 2024	SMEs (China) Survey	Sectoral: Manufacturing vs. retail show divergent SDT priorities.	Sector-specific adoption frameworks.
Alam et al., 2022	SMEs (Asia) Survey	Gender: Women emphasize social equity, men emphasize financial returns.	Gender-sensitive SDT programs.

5. REVIEW OF FINDINGS

5.1. Methodological Strengths and Weaknesses in Current SDT–MSME Research

The existing literature on sustainable digital transformation (SDT) in micro, small, and medium enterprises (MSMEs) demonstrates significant methodological diversity and practical relevance but also faces notable limitations. A key strength lies in the use of varied research designs, including qualitative case studies, quantitative surveys, and mixed-method approaches, which collectively provide multidimensional insights into SDT processes and outcomes ([Vrchota et al., 2020](#)). Many studies are empirically grounded, emphasizing real-world evidence that illustrates how MSMEs adopt digital and sustainable practices, thereby generating actionable guidance for practitioners ([Hidayat, 2021](#)). Moreover, sector-specific analyses—particularly in agriculture and manufacturing—have enhanced contextual understanding and produced recommendations tailored to industry-specific challenges ([Mendo et al., 2021](#)). However, several methodological weaknesses remain. Much of the current research is context-dependent, with findings from developed economies offering limited generalizability to emerging markets ([Vrchota et al., 2020](#)). The dominant focus on short-term outcomes such as efficiency and cost reduction has overshadowed investigations into long-term sustainability impacts ([Hidayat, 2021](#)). Additionally, the lack of standardized quantitative indicators restricts cross-study comparability and benchmarking, constraining the ability to measure SDT performance systematically ([Fathurrahman & Fitri, 2024](#); [Wójcik-Karpacz et al., 2021](#)).

5.2. Gaps in Evidence and Research Limitations

Despite growing scholarly attention, several gaps continue to constrain the breadth and generalizability of research on sustainable digital transformation (SDT) in micro, small, and medium enterprises (MSMEs). One persistent limitation is the underrepresentation of diverse contexts, as existing studies disproportionately focus on developed economies while overlooking MSMEs in emerging markets, rural areas, and informal sectors, thereby restricting global insights ([Nurlina et al., 2023](#)). Sectoral bias also remains evident, with substantial attention devoted to ICT and manufacturing industries, while critical sectors such as hospitality, services, and agriculture receive comparatively little empirical investigation ([Vrchota et al., 2020](#)). Furthermore, the scarcity of longitudinal research limits understanding of the long-term impacts of SDT on resilience, innovation, and sustainability performance ([Abalala et al., 2021](#)). External contextual factors—political, cultural, and economic—

are often neglected, despite their significant influence on SDT adoption and outcomes (Elpisah et al., 2022). Finally, most studies adopt gender-neutral perspectives, overlooking how gender dynamics affect technology adoption, decision-making, and sustainability orientations, even though women-led MSMEs often exhibit distinct priorities and challenges (Nufus et al., 2021). Addressing these limitations is vital to enhance the validity, inclusivity, and applicability of future SDT research across diverse global contexts.

5.3. Theoretical Integration

The integration of multiple theoretical perspectives offers a more comprehensive understanding of sustainable digital transformation (SDT) in micro, small, and medium enterprises (MSMEs). The Resource-Based View (RBV) emphasizes the role of internal resources—such as a skilled workforce, technological infrastructure, and innovative culture—as critical enablers of sustainable competitive advantage (O’Cass & Sok, 2013). Complementing this, the Dynamic Capabilities Theory (DCT) explains how MSMEs develop adaptive capacities to sense opportunities, reconfigure resources, and respond effectively to evolving market, technological, and regulatory demands, thereby strengthening organizational resilience and long-term sustainability (Mukhtar et al., 2023).

Meanwhile, Institutional Theory highlights how coercive, mimetic, and normative pressures influence SDT adoption, aligning firm strategies with societal expectations, industry norms, and regulatory frameworks (Rihayana et al., 2023). Integrating these theoretical perspectives provides a holistic analytical lens that connects internal firm capabilities with external institutional contexts, enhancing explanatory depth and applicability across diverse MSME environments.

5.4. Practical and Policy Implications

The findings of this review yield important implications for both practitioners and policymakers seeking to advance SDT among MSMEs. From a practical perspective, SMEs should strategically allocate resources to digital tools such as AI and the IoT, which can optimize resource utilization, enhance efficiency, and align operations with sustainability objectives (Nakabuye et al., 2023). Collaborative engagement with peers, suppliers, and institutional partners is equally critical, as such networks foster co-innovation, resource sharing, and resilience in volatile environments (Hitt et al., 2015). Moreover, the adoption of sustainability performance measurement systems that capture both digital and environmental outcomes is essential for accountability and continuous improvement (Fornés & Cardoza, 2018).

From a policy standpoint, governments play a pivotal role in enabling SDT adoption through supportive frameworks and infrastructure. Incentives such as grants, tax benefits, and subsidies can reduce barriers for SMEs investing in green digital technologies (Varga et al., 2024; Torres, 2022). Expanding broadband access and strengthening digital infrastructure, particularly in rural and underserved regions, remain fundamental for ensuring equitable participation in the digital economy.

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(Ahmad et al., 2022). Additionally, capacity-building initiatives focused on digital literacy and sustainability skills can equip entrepreneurs and employees to navigate technological and environmental transitions effectively (Rehman et al., 2021). Finally, inclusive policy design is essential—supporting women entrepreneurs and minority-owned enterprises helps diversify innovation ecosystems and promote equitable growth (Kuděj et al., 2023; Negri et al., 2021). Collectively, these actions can accelerate SDT implementation, enhance MSME competitiveness, and contribute to broader sustainable development objectives.

5.5. Synthesis

The discussion highlights that while SDT research has made significant strides in identifying drivers, capabilities, mechanisms, and outcomes, its methodological and contextual limitations constrain broader generalization. Integrating RBV, DCT, and Institutional Theory provides a richer framework for understanding SDT's complexities. Practically, SMEs and policymakers must align resources, collaboration, and supportive policies to strengthen resilience and sustainable competitiveness. Future research must expand scope across regions, sectors, and gender perspectives while incorporating longitudinal and mixed-method designs to fully capture the transformative potential of SDT in MSMEs.

6. CONCLUSION

This systematic literature review explored the drivers, organizational capabilities, mechanisms, and outcomes of sustainable digital transformation (SDT) in micro, small, and medium enterprises (MSMEs). The findings demonstrate that SDT adoption is influenced by a complex interplay of regulatory, market, technological, and socio-cultural drivers, with firm size shaping the relative importance of these factors. Organizational capabilities—particularly digital literacy, leadership, collaboration, innovation, and resource orchestration—emerge as critical enablers of effective SDT implementation. Mechanisms such as AI, IoT, blockchain, and cloud technologies serve as pivotal tools for linking digital transformation to sustainability outcomes, reinforced by collaboration platforms, robust data governance, and conducive regulatory environments. Documented outcomes highlight economic benefits through efficiency and growth, environmental gains through eco-efficiency and waste reduction, and social advantages via inclusivity and workforce empowerment. However, trade-offs, such as financial strain, operational complexity, and risks of greenwashing, reveal that SDT is not without challenges.

The review underscores methodological strengths, including diverse approaches and empirical grounding, but also identifies gaps such as limited generalizability, lack of longitudinal studies, and underrepresentation of emerging economies and gender perspectives. Theoretical integration of the Resource-Based View, Dynamic Capabilities, and Institutional Theory offers a comprehensive framework to understand SDT as both a technological and socio-institutional process. For practice, SMEs must strategically invest in digital tools, build collaborative ecosystems, and

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measure sustainability performance, while policymakers should provide supportive regulatory frameworks, infrastructure investment, and inclusive capacity-building programs. Overall, SDT represents a pathway toward resilience, competitiveness, and sustainable growth for MSMEs, though its transformative potential will only be fully realized through targeted strategies addressing resource constraints and contextual challenges.

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