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Sustainable Technology and Green Business in MSMEs: A Literature Review of Digitalization, Resource Efficiency, and Business Sustainability

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ABSTRACT

This study examines how sustainable technology and green business practices contribute to resource efficiency and business sustainability among micro, small, and medium-sized enterprises (MSMEs). Using an integrative literature review, the study synthesizes theoretical and empirical perspectives on digitalization, environmental management, and organizational capabilities. The synthesis indicates that digital technologies can improve operational planning, resource monitoring, and waste reduction, but their adoption does not automatically generate environmental or economic benefits. Resource efficiency emerges as a potential mechanism connecting digitalization with business sustainability, while organizational capabilities, financial readiness, and external support influence implementation effectiveness. Integrating the Natural Resource-Based View and Dynamic Capabilities Theory, this study proposes a conceptual framework explaining how technological and environmental practices may support sustainable business operations. The findings emphasize that MSME sustainability depends on appropriate technological choices, effective resource management, and economic viability. The framework provides a foundation for future empirical investigation and sustainability-oriented business policies.

ABSTRAK

Penelitian ini mengkaji bagaimana teknologi berkelanjutan dan praktik bisnis hijau berkontribusi terhadap efisiensi sumber daya dan keberlanjutan usaha mikro, kecil, dan menengah (UMKM). Menggunakan pendekatan integrative literature review, penelitian ini menyintesis perspektif teoretis dan empiris mengenai digitalisasi, pengelolaan lingkungan, dan kapabilitas organisasi. Hasil sintesis menunjukkan bahwa teknologi digital berpotensi meningkatkan perencanaan operasional, pemantauan sumber daya, dan pengurangan limbah. Namun, adopsi teknologi tidak secara otomatis menghasilkan manfaat lingkungan maupun ekonomi. Efisiensi sumber daya diidentifikasi sebagai mekanisme potensial yang menghubungkan digitalisasi dengan keberlanjutan usaha, sedangkan kapabilitas organisasi, kesiapan keuangan, dan dukungan eksternal memengaruhi efektivitas implementasinya. Melalui integrasi Natural Resource-Based View dan Dynamic Capabilities Theory, penelitian ini mengusulkan kerangka konseptual yang menjelaskan kontribusi teknologi dan praktik lingkungan terhadap keberlanjutan UMKM. Temuan ini menegaskan pentingnya kesesuaian teknologi, pengelolaan sumber daya, dan kelayakan ekonomi. Kerangka tersebut menjadi landasan bagi penelitian empiris dan pengembangan kebijakan bisnis berkelanjutan.

1. INTRODUCTION

The rapid development of digital technologies and growing concerns about environmental sustainability have significantly influenced how businesses organize their economic activities. Traditionally, technology adoption has been associated with increasing sales, expanding market access, and improving service delivery. However, technological applications also offer opportunities to optimize energy consumption, reduce material waste, improve inventory management, and strengthen resource utilization. These opportunities

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have become increasingly important as economic activities continue to place considerable pressure on natural resources. The United Nations Environment Programme (UNEP, 2024), through the Global Resources Outlook 2024, emphasizes that global resource consumption is closely associated with climate change, biodiversity loss, and environmental pollution. This situation suggests that business performance should no longer be evaluated exclusively through financial growth but should also consider resource efficiency and environmental consequences. Within this context, sustainable technology and green business have emerged as relevant approaches for reconciling economic objectives with environmental responsibility.

For micro, small, and medium-sized enterprises (MSMEs), the transition toward environmentally sustainable business practices presents particular challenges. MSMEs contribute substantially to production, trade, employment, and service provision, yet many operate under financial, technological, and managerial constraints. Environmental sustainability issues often emerge from everyday operational activities, including inefficient electricity consumption, excessive raw material purchases, inventory deterioration, disposable packaging, and inadequate waste management. In food and beverage businesses, for example, inaccurate demand forecasting may result in unused ingredients and increased food waste. Similarly, laundry businesses may experience higher operating costs and environmental pressures due to excessive water, electricity, and detergent consumption. These examples illustrate that resource efficiency is not merely an environmental concern but also an economic issue directly associated with cost management and business continuity. Consequently, sustainable business practices need to be examined in relation to the operational realities and resource limitations of MSMEs.

Meanwhile, digitalization has created opportunities for MSMEs to improve their business operations and resource management. In Indonesia, Statistics Indonesia (BPS, 2025) reported approximately 3.82 million e-commerce businesses in 2023, representing an increase of 27.40% compared with the previous year. The estimated value of e-commerce transactions reached IDR 1,100.87 trillion during the same period. Although these figures demonstrate the growing importance of digital technologies in commercial activities, they do not necessarily indicate that all MSMEs have achieved comprehensive digital transformation. Technology adoption may remain concentrated on online marketing, customer communication, and electronic transactions. In fact, digital accounting applications, inventory management systems, electronic payments, and sales data analytics may also support more efficient operational decisions. These applications can help businesses estimate demand, monitor resource utilization, and reduce unnecessary purchases or production activities. Therefore, digitalization should be understood not simply as the transition from conventional to online markets but as a broader transformation of business management and operational processes.

Nevertheless, the relationship between digitalization and environmental sustainability is not automatically positive. Digital technologies may reduce paper consumption, improve procurement accuracy, and support energy monitoring, but their implementation also requires electronic equipment, electricity, communication infrastructure, and maintenance expenditure. Furthermore, the expansion of digital commerce may increase packaging consumption and distribution activities when logistics systems are not efficiently managed. The Organisation for Economic Co-operation and Development (OECD, 2024) highlights persistent digitalization gaps between SMEs and larger enterprises, despite the increasing availability of technological solutions. The report also identifies the growing relevance of data analytics for monitoring environmental performance. These considerations indicate that technology adoption should not automatically be classified as a green business practice. Its sustainability contribution needs to be evaluated through measurable changes in resource consumption, operational costs, and environmental impacts. Without such evaluation, digitalization risks being interpreted as evidence of sustainability even when its actual environmental benefits remain uncertain.

From a business management perspective, green business refers to the integration of environmental considerations into operational activities, resource allocation, and strategic decision-making. This approach extends beyond environmentally friendly products or packaging to include energy efficiency, waste reduction, responsible material utilization, process innovation, and sustainable production practices. For MSMEs, green business initiatives may begin with relatively accessible operational improvements, such as more accurate inventory records, energy-efficient equipment, reduced packaging materials, and the productive utilization of manufacturing by-products. However, implementing these practices requires careful consideration of economic feasibility. Environmentally preferable packaging, for example, may initially increase purchasing costs, while energy-efficient machinery may require investment beyond the immediate financial capacity of smaller enterprises. Consequently, green business implementation should be examined through the

relationship between environmental improvements, operational efficiency, and financial sustainability. A business practice cannot be considered economically sustainable merely because it reduces environmental impacts if its implementation simultaneously threatens the enterprise's ability to continue operating.

The relationship between sustainable technology, resource efficiency, and business sustainability can be explained through the Natural Resource-Based View (NRBV) and Dynamic Capabilities Theory. Hart (1995) introduced the NRBV to explain how environmentally relevant organizational capabilities, including pollution prevention and product stewardship, may contribute to competitive advantage. This perspective suggests that resource efficiency and environmental management can create strategic value when they are integrated into business operations. Meanwhile, Teece (2007) explains that dynamic capabilities enable organizations to identify opportunities, mobilize resources, and reconfigure existing capabilities in response to environmental and technological changes. These theoretical perspectives are particularly relevant to MSMEs because technology availability alone does not determine operational improvement. Businesses must possess the managerial knowledge, learning capacity, and organizational flexibility required to translate technological applications into effective resource management practices. Thus, the economic and environmental contributions of sustainable technology depend not only on technological adoption but also on the capabilities through which technology is implemented.

Previous studies have increasingly examined the relationship between digital transformation and sustainability among SMEs. Sagala & Őri (2024) emphasize that successful digital transformation requires strategies adapted to organizational conditions and resource limitations, including gradual implementation and continuous learning. Mick et al. (2024) discuss how sustainable digital transformation may support operational efficiency, innovation, and data-driven decision-making, while identifying financial constraints and the absence of practical implementation guidance as persistent challenges for SMEs. Similarly, Di Berardino & Jamshed (2024), through a structured review of 51 publications, demonstrate that research connecting digital transformation and SME sustainability remains distributed across several disciplinary perspectives. These studies collectively indicate that digitalization offers opportunities to support sustainable business practices, although its effectiveness depends on organizational readiness, resource availability, and implementation conditions. Nevertheless, the relationship between technological adoption and sustainability requires further conceptual clarification, particularly concerning the operational mechanisms through which environmental and economic benefits may emerge.

Despite the growing literature on digital transformation and sustainability, several conceptual issues remain insufficiently integrated. Some studies primarily examine digitalization as a determinant of business performance, whereas others emphasize green innovation, environmental management, or sustainability outcomes. Consequently, the mechanisms connecting digital technology adoption, resource efficiency, and long-term business sustainability are not always explicitly distinguished. Lu & Shaharudin (2024), for instance, discuss the role of digital transformation in developing sustainable competitive advantage through innovation and dynamic capabilities. However, sustainable competitive advantage should not be treated as equivalent to environmental sustainability. A business may improve sales performance and strengthen its market position through digital technologies without necessarily reducing energy consumption, material waste, or environmental impacts. Similarly, improved resource efficiency may reduce operating costs without guaranteeing business continuity under unfavorable market conditions. These distinctions suggest that economic competitiveness, environmental performance, and business sustainability should be examined as related but conceptually different outcomes.

Accordingly, the research gap addressed in this study does not concern the absence of literature on digitalization and MSME sustainability. Rather, it concerns the need for a more integrated explanation of how sustainable technologies and green business practices may contribute to resource efficiency and how these operational improvements relate to business sustainability. Resource efficiency is particularly important because it provides a potential connection between environmental responsibility and economic performance. Reducing raw material waste, for example, may simultaneously lower production costs and decrease environmental pressures. However, the relationship is not necessarily straightforward because technological investments may involve substantial initial expenditure, employee training, and operational adjustments. Moreover, efficiency improvements may not translate into sustained business performance when enterprises face declining demand, financial instability, or limited technological capabilities. An integrated literature review is therefore needed to clarify the mechanisms, enabling conditions, and limitations underlying the relationship between digitalization, resource efficiency, and sustainable business development.

The conceptual contribution of this study lies in integrating three interrelated areas of inquiry: MSME operational digitalization, resource efficiency, and business sustainability within a green business perspective. Rather than treating digital technology as an independent driver of business performance or sustainability as a broadly defined outcome, this study emphasizes the operational processes through which technological applications may create economic and environmental value. Digitalization is understood as the organizational utilization of technologies to generate information, improve operational control, and support business decisions. Resource efficiency refers to the ability to generate economic value while reducing unnecessary consumption of energy, water, raw materials, and other productive resources. Business sustainability is interpreted as the capacity to maintain economic viability while incorporating environmental responsibility and relevant social considerations into business operations. Integrating these concepts may provide a clearer understanding of the conditions under which technological adoption supports green business practices and the circumstances in which its benefits remain constrained by financial, technological, or managerial limitations.

Based on these considerations, this study aims to analyze and synthesize the literature on the role of sustainable technology and green business in supporting digitalization, resource efficiency, and business sustainability among MSMEs. Specifically, the review seeks to identify technological applications relevant to MSME operations, examine the mechanisms linking digitalization with more efficient resource utilization, and explore the organizational and economic factors that facilitate or constrain green business implementation. By integrating the Natural Resource-Based View and Dynamic Capabilities Theory, the study seeks to develop a conceptual explanation of how technological capabilities and resource management practices may contribute to sustainable business operations. The expected contribution is twofold: theoretically, the study seeks to clarify the relationship between digital transformation, environmental resource management, and business sustainability; practically, it aims to provide a conceptual basis for MSME owners and managers to evaluate technological investments and green business initiatives according to their operational needs, resource limitations, and long-term economic viability.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

2.1. Sustainable Technology and Green Business in MSMEs

Sustainable technology refers to technological applications that support business activities while improving resource utilization and reducing environmental pressures. For micro, small, and medium-sized enterprises (MSMEs), these technologies may include digital inventory systems, energy-efficient equipment, electronic accounting applications, and resource monitoring tools. However, technological adoption should not automatically be considered environmentally sustainable. Its contribution depends on whether implementation produces meaningful improvements in operational efficiency and environmental performance. Sagala & Őri (2024) emphasize that successful digital transformation among SMEs requires strategies aligned with organizational readiness and available resources. Green business extends this perspective by integrating environmental responsibility into business operations and strategic decisions. Hart (1995), through the Natural Resource-Based View (NRBV), explains that environmentally relevant capabilities, particularly pollution prevention and responsible resource management, may contribute to competitive advantage. For MSMEs, green business practices can involve reducing material waste, conserving energy, improving production processes, and selecting environmentally preferable materials. Nevertheless, these practices must remain economically feasible because limited capital and operational resources may constrain their implementation.

2.2. Digitalization and Resource Efficiency

Digitalization enables businesses to improve information management, operational monitoring, and decision-making through technological applications. In MSMEs, digital inventory management, sales analytics, and electronic accounting systems may help reduce unnecessary purchases, improve demand estimation, and identify inefficient resource utilization. The OECD (2024) highlights the growing importance of digital technologies in supporting SME adaptation, although technological readiness and adoption remain uneven. Resource efficiency concerns the ability to generate economic value while minimizing unnecessary consumption of energy, water, raw materials, and other productive inputs. Digitalization may contribute to this objective by providing information that supports more accurate operational decisions. However, the relationship is not automatic. Technology requires financial investment, electricity, maintenance, and employee com-

petencies. Furthermore, reductions in resource consumption per unit of output do not necessarily imply reductions in total environmental impacts when production expands. Therefore, the sustainability benefits of digitalization should be evaluated through observable improvements in resource utilization rather than technology adoption alone.

2.3. Organizational Capabilities and Sustainable Transformation

The effectiveness of sustainable technology depends on organizational capabilities that support technological adaptation and operational improvement. Dynamic Capabilities Theory explains how businesses recognize opportunities, mobilize resources, and reconfigure existing competencies in response to environmental changes (Teece, 2007). In MSMEs, these capabilities may involve identifying resource inefficiencies, selecting appropriate technologies, training employees, and adjusting production processes. Mick et al. (2024) highlight the potential contribution of sustainable digital transformation to operational efficiency and innovation while identifying financial constraints and implementation difficulties as important challenges. These considerations suggest that technological investment alone is insufficient to achieve sustainable transformation. Businesses must also develop managerial knowledge, employee competencies, and organizational flexibility to translate digital information into effective resource management practices. Consequently, the relationship between digitalization and resource efficiency may vary according to technological readiness, financial capacity, and managerial commitment.

2.4. Resource Efficiency and Business Sustainability

Business sustainability involves maintaining economic viability while addressing environmental responsibilities and relevant social considerations. For MSMEs, economic sustainability includes the ability to control costs, generate sufficient revenue, and maintain business continuity. Environmental sustainability concerns responsible resource utilization, waste reduction, and the mitigation of adverse environmental impacts. These dimensions are interconnected but should not be treated as equivalent. Resource efficiency may support business sustainability by reducing operational expenditure and unnecessary environmental pressures. For example, improved inventory management can potentially reduce material losses and purchasing costs. However, environmental improvements do not necessarily guarantee financial stability, particularly when implementation requires substantial investment. Lu & Shaharudin (2024) emphasize the relevance of digital transformation and organizational capabilities for sustainable competitive advantage. Nevertheless, long-term competitiveness differs conceptually from environmental sustainability. Therefore, resource efficiency should be understood as a potential mechanism contributing to business sustainability rather than a guarantee of sustainable performance.

2.5. Theoretical Integration and Research Gap

Previous studies have examined digital transformation, environmental management, and sustainability among SMEs. However, these discussions often emphasize technological adoption, business performance, or environmental practices separately. Sagala & Őri (2024) focus on the conditions supporting digital transformation, while Mick et al. (2024) examine sustainable digital transformation and its implementation challenges. Although these studies provide important insights, further conceptual integration is needed to clarify how digitalization contributes to resource efficiency and how these operational improvements relate to business sustainability. This study addresses that need by integrating the NRBV and Dynamic Capabilities Theory. The NRBV explains the strategic value of environmentally responsible resource management, while Dynamic Capabilities Theory explains the organizational processes required to implement technological and environmental improvements. Accordingly, the proposed conceptual relationship positions digitalization as a potential enabler of resource efficiency, green business practices and organizational capabilities as supporting conditions, and business sustainability as a broader economic and environmental outcome. This integration provides the theoretical foundation for examining the mechanisms, limitations, and trade-offs through which sustainable technology may contribute to MSME sustainability.

3. RESEARCH METHOD

3.1. Research Design

This study adopts a qualitative approach using an integrative literature review (ILR) to examine the relationships between sustainable technology, digitalization, resource efficiency, green business practices, and business sustainability among micro, small, and medium-sized enterprises (MSMEs). An integrative review is appropriate because it enables the synthesis of empirical and conceptual literature to develop a more comprehensive understanding of relationships across different research perspectives (Torraco, 2005; Snyder, 2019). The analysis is guided by the Natural Resource-Based View (NRBV) and Dynamic Capabilities Theory, which provide complementary explanations of environmental resource management and organizational adaptation. Rather than estimating causal relationships, this study seeks to identify recurring themes, conceptual connections, implementation challenges, and potential mechanisms through which technological adoption may contribute to sustainable business practices.

3.2. Literature Search Strategy

The literature search is designed to cover scholarly publications indexed in Scopus, Web of Science, ScienceDirect, SpringerLink, and Google Scholar. Studies published between 2015 and 2026 are prioritized to capture recent developments, while foundational theoretical contributions are included where necessary. Search terms combine relevant concepts, including sustainable technology, green business, MSMEs, digital transformation, resource efficiency, green innovation, and business sustainability. Boolean operators (AND and OR) are used to identify publications addressing the relationships between technological applications, resource management, and sustainability. Eligible sources include peer-reviewed empirical studies, conceptual articles, literature reviews, and selected institutional reports directly relevant to the research objectives. Publications without sufficient methodological or conceptual relevance are excluded.

3.3. Literature Selection and Data Analysis

The literature selection process consists of identification, screening, eligibility assessment, and final inclusion. Publications are assessed based on their relevance to MSMEs, sustainable technology, digitalization, resource efficiency, and business sustainability. Relevant information is organized according to publication characteristics, theoretical perspectives, technological applications, operational mechanisms, economic and environmental outcomes, and research limitations. The selected literature is then examined through thematic analysis, drawing on Braun & Clarke (2006), to identify recurring patterns and differences across studies. The analysis focuses on four interconnected themes: sustainable technology and digitalization, green business practices, resource efficiency, and business sustainability. Particular attention is given to distinguishing technological adoption from measurable environmental improvements and identifying organizational conditions that influence implementation outcomes.

3.4. Conceptual Synthesis and Research Limitations

The final stage integrates the identified themes using the NRBV and Dynamic Capabilities Theory to develop a conceptual explanation of how digitalization and green business practices may contribute to resource efficiency and MSME sustainability. The synthesis examines technological capabilities as potential enablers, resource efficiency as an operational mechanism, and business sustainability as a broader economic and environmental outcome. Contradictory findings and implementation trade-offs are considered to avoid assuming that technological adoption automatically improves sustainability. As a literature-based study, the proposed framework cannot establish causal effects or quantify economic and environmental benefits. Its conclusions also depend on the scope, quality, and contextual diversity of the literature included. Accordingly, the framework is intended to guide theoretical interpretation and future empirical investigation rather than represent a statistically validated model.

4. DATA ANALYSIS AND DISCUSSION

4.1. Sustainable Technology and Digital Transformation in MSMEs

The literature reveals that sustainable technology has become an important element of MSME transformation, particularly as businesses face increasing pressure to improve operational efficiency while responding to environmental concerns. However, the relationship between technological adoption and sustainability

is more complex than commonly assumed. Digital technologies can improve information management, production planning, and operational coordination, but these improvements do not necessarily translate into better environmental or economic performance. Sagala & Őri (2024) emphasize that successful digital transformation depends on organizational readiness and implementation strategies rather than technological adoption alone. Similarly, Kannan & Gambetta (2025) identify the importance of organizational context, knowledge management, and sustainability orientation in determining how technological applications contribute to SME development. This distinction is particularly relevant for MSMEs because technological capabilities are often constrained by limited capital, managerial expertise, and employee competencies. Unlike larger enterprises, smaller businesses may not have dedicated technological departments or sufficient resources to evaluate complex digital investments. Santos & Sant'Anna (2024) highlight the potential contribution of Industry 4.0 technologies to SME sustainability while recognizing the importance of implementation conditions. Their perspective suggests that the value of technology should be assessed according to its suitability for business operations rather than its technological sophistication.

For example, a small food-processing enterprise may improve material efficiency by using a simple digital inventory application to monitor stock movement and identify products approaching expiration. Such an application may reduce unnecessary purchases and prevent avoidable losses. However, the same enterprise may experience limited benefits if employees do not regularly update inventory records or if purchasing decisions continue to rely exclusively on managerial intuition. This example illustrates that technological availability and technological effectiveness are different issues. The environmental contribution of digitalization emerges only when digital information changes how resources are managed. Hernández et al. (2024) provide further evidence that digital data-driven technologies are associated with environmental sustainability activities among European MSMEs, although the relationships differ according to enterprise size and technological characteristics. Their findings indicate that technology does not operate independently of organizational context. Businesses with stronger managerial capabilities may be better positioned to transform digital information into operational improvements, while enterprises with limited resources may encounter difficulties achieving comparable results.

Another important consideration concerns the environmental consequences of technological infrastructure itself. Digitalization requires electricity, electronic devices, data processing, and periodic equipment replacement. Therefore, the adoption of digital applications cannot automatically be interpreted as environmentally beneficial. Chauhan et al. (2022) and Liu et al. (2022) explain that digital technologies may support circular economy practices, but their contribution depends on the functions they perform and the resource management improvements they enable. Consequently, the sustainability value of technology should be evaluated through observable operational and environmental outcomes rather than adoption rates. These findings suggest that sustainable technology should be understood as an organizational capability that enables more responsible business operations. Digital transformation becomes relevant to green business when technological applications improve resource allocation, reduce avoidable consumption, and support environmental decision-making. This relationship provides the foundation for examining resource efficiency as an operational mechanism connecting digitalization with business sustainability.

4.2. Digitalization and Resource Efficiency: From Technological Adoption to Operational Improvement

Resource efficiency emerges as a central concept in explaining how digitalization may contribute to MSME sustainability. While digital transformation is frequently associated with market expansion, electronic transactions, and customer engagement, its environmental relevance depends substantially on improvements in the utilization of productive resources. These resources include raw materials, energy, water, packaging, equipment, and working capital. A business may successfully increase its digital sales while continuing to operate inefficiently. Therefore, digital growth should not be confused with sustainable operational transformation. Liu et al. (2022) identify several mechanisms through which digital technologies can support circular economy strategies, including improved information management, resource tracking, and coordination. Similarly, Chauhan et al. (2022) explain that digitalization can facilitate circular economy practices by improving operational visibility and enabling more informed decisions. These findings suggest that technological applications may reduce resource inefficiencies when they provide reliable information about production activities and material consumption.

For MSMEs, the practical significance of this relationship is evident in everyday operations. A food-processing business may use sales records to estimate production requirements and reduce unsold inventory.

A laundry enterprise may monitor water and electricity consumption relative to the number of services completed. A small manufacturer may use digital production records to identify excessive material losses. Although these examples illustrate possible applications rather than measured outcomes from the reviewed studies, they demonstrate why resource efficiency provides a useful connection between digital technologies and sustainability. However, the relationship between digitalization and resource efficiency requires critical interpretation. Arroyabe et al. (2024), using evidence from European SMEs, examine the integration of digitalization and circular economy orientation and demonstrate that advanced circular practices do not necessarily require equally advanced technological capabilities. This finding challenges the assumption that greater technological sophistication always produces superior environmental outcomes. Some businesses may achieve substantial resource savings through relatively simple technologies and improved management routines, while others may invest in advanced systems without addressing their underlying operational inefficiencies. The distinction between relative efficiency and absolute environmental improvement is also important. Lower electricity consumption per unit of output does not necessarily mean lower total electricity consumption. If production expands rapidly, overall energy demand may continue to increase despite efficiency improvements. Similar conditions may occur in material utilization and packaging consumption. Consequently, resource efficiency should be assessed through both resource intensity and total resource consumption, rather than relying exclusively on productivity improvements.

The economic implications are equally significant. More efficient resource utilization may reduce purchasing expenses, material losses, and operating costs. Nevertheless, the financial benefits of technological adoption depend on implementation expenditure, employee training, maintenance, and the time required to recover initial investments. Miranda et al. (2024) examine digitalization in relation to environmental and economic sustainability among MSMEs, demonstrating the importance of considering these dimensions together rather than assuming that digital adoption directly improves financial performance. From the Natural Resource-Based View, Hart (1995) explains that pollution prevention and responsible resource management can become strategically valuable organizational capabilities. This perspective suggests that resource efficiency may support both environmental performance and economic competitiveness. However, the relationship remains conditional because operational savings alone cannot guarantee long-term business continuity. Market demand, financial management, and competitive conditions also influence whether efficiency improvements translate into sustainable business outcomes.

4.3. Green Business Practices, Eco-Innovation, and Sustainable Performance

Green business practices represent a broader organizational commitment to integrating environmental responsibility into business activities. While resource efficiency emphasizes the effective utilization of productive inputs, green business also involves environmentally responsible sourcing, waste management, cleaner production, product innovation, and stakeholder relationships. This distinction matters because environmental sustainability cannot be achieved solely by reducing production costs. Businesses must also consider how their products, processes, and operational decisions affect the surrounding environment. Hart (1995) identifies pollution prevention and product stewardship as important components of environmentally oriented organizational capabilities. Within MSMEs, these capabilities may emerge through incremental improvements rather than large-scale technological investment. Reducing production defects, improving material selection, managing waste, and extending product usefulness can contribute to environmental performance. However, such practices must be evaluated according to their actual consequences. Environmentally preferable packaging, for instance, may reduce certain environmental impacts while introducing additional costs or other resource requirements. Eco-innovation provides an important explanation for how environmental responsibility may contribute to business performance. Oduro (2024), through a meta-analysis of SME studies, identifies a positive but moderate relationship between eco-innovation and sustainable performance. The findings indicate that eco-innovation can contribute to economic, environmental, and social outcomes, although its effectiveness varies across innovation types and organizational contexts. Particularly important is the contribution of organizational eco-innovation, which suggests that environmental improvement depends not only on new products or technologies but also on changes in management practices and organizational routines.

This finding challenges the assumption that green innovation must always involve expensive equipment or technologically advanced products. For smaller businesses, environmentally responsible transformation may begin with improvements in purchasing procedures, employee awareness, waste separation, or

production scheduling. These changes may appear less sophisticated than technological innovation, but they can influence how effectively resources are utilized. Nevertheless, their economic benefits depend on implementation costs, customer expectations, and market conditions. Arroyabe et al. (2024) further demonstrate the relevance of integrating digital transformation with circular economy orientation. Their findings suggest that technological capabilities may support circular practices, but businesses can pursue different combinations of digital and environmental strategies. Similarly, Gennari (2023) highlights the importance of organizational governance and stakeholder relationships in SME transitions toward circular economy practices. Together, these studies suggest that green business transformation should be understood as a process involving technology, organizational innovation, and external relationships.

A further analytical distinction concerns the meaning of business sustainability. Lu & Shaharudin (2024) examine digital transformation in relation to sustainable competitive advantage, but competitive advantage should not be treated as equivalent to environmental sustainability. A business may improve market performance while increasing its environmental footprint. Conversely, an enterprise may reduce waste and energy consumption without achieving sufficient financial returns to maintain operations. Therefore, business sustainability requires consideration of economic viability, environmental performance, and relevant social responsibilities. These findings indicate that green business practices can contribute to sustainable performance when environmental improvements are integrated with operational capabilities and financial considerations. Eco-innovation provides opportunities for resource savings, product differentiation, and improved environmental management, but its contribution depends on organizational readiness and market conditions. Consequently, sustainable business development requires more than environmental awareness; it requires the capacity to convert environmental objectives into feasible and measurable business practices.

4.4. Organizational Capabilities and the Conditions for Sustainable Transformation

The literature consistently indicates that organizational capabilities influence whether sustainable technology and green business practices generate meaningful outcomes. MSMEs frequently operate with limited financial resources, technical expertise, and formal management systems. As a result, enterprises adopting similar technologies may experience different levels of operational efficiency and sustainability. These differences suggest that technological resources alone cannot adequately explain sustainable transformation. Dynamic Capabilities Theory provides a useful explanation for this relationship. Teece (2007) emphasizes the organizational capacity to recognize opportunities, mobilize resources, and reconfigure existing processes. Applied to MSMEs, these capabilities involve identifying inefficient resource utilization, evaluating technological alternatives, developing employee competencies, and adjusting operational routines. Sustainable transformation therefore depends on the ability to convert technological information and environmental objectives into practical managerial decisions.

Sagala & Őri (2024) reinforce this perspective by emphasizing organizational readiness as an important condition for digital transformation success. Hernández et al. (2024) further demonstrate that the relationship between digital technologies and sustainability-related activities varies according to enterprise characteristics. These findings indicate that organizational capacity influences the extent to which businesses benefit from technological applications. A digital monitoring system may provide valuable information, but its contribution remains limited when employees lack the skills to interpret the data or managers are unwilling to change existing procedures. Financial constraints represent another important barrier. Sustainable technologies may require expenditure on software, equipment, training, maintenance, and process adjustments. Mick et al. (2024) identify financial limitations and implementation difficulties as important challenges in sustainable digital transformation. These barriers are especially relevant for microenterprises, where investment decisions may directly affect short-term liquidity and business continuity. Consequently, technologies with substantial potential environmental benefits may remain economically impractical for enterprises with limited resources.

External conditions also influence sustainable transformation. Gennari (2023) emphasizes the importance of governance and stakeholder relationships in circular economy transitions, while Kannan & Gambetta (2025) identify organizational and sustainability-related factors shaping technology-driven SME development. Access to financing, technical assistance, supportive policies, and supplier cooperation may improve implementation opportunities. However, external assistance does not guarantee successful transformation unless businesses possess the internal capabilities required to apply and maintain technological improve-

ments. These findings suggest that sustainable transformation should not be understood as a uniform process. Enterprise size, financial readiness, managerial competencies, technological suitability, and institutional support can influence both implementation and outcomes. For MSMEs, an effective sustainability strategy therefore requires alignment between technological investment, organizational capabilities, and environmental objectives.

4.5. Integrated Findings and the Proposed Conceptual Framework

The preceding discussion reveals that the relationship between sustainable technology and business sustainability is neither automatic nor necessarily linear. Digitalization may improve operational information and resource allocation, but its contribution to environmental and economic performance depends on how businesses utilize these capabilities. Similarly, green business practices may support resource efficiency and environmental improvement, but their implementation is influenced by financial capacity, organizational readiness, and market conditions. These relationships suggest that an integrated conceptual framework is necessary to explain the mechanisms connecting technological adoption, resource management, and sustainable business development. The Natural Resource-Based View and Dynamic Capabilities Theory provide complementary foundations for this integration. Hart (1995) explains how environmentally responsible resource management may create strategic value, while Teece (2007) emphasizes the organizational capabilities required to recognize opportunities and reconfigure resources. Together, these perspectives suggest that digitalization provides technological opportunities, resource efficiency represents a potential operational mechanism, and green business practices guide environmentally responsible business decisions. Organizational capabilities and external conditions influence how effectively these relationships develop.

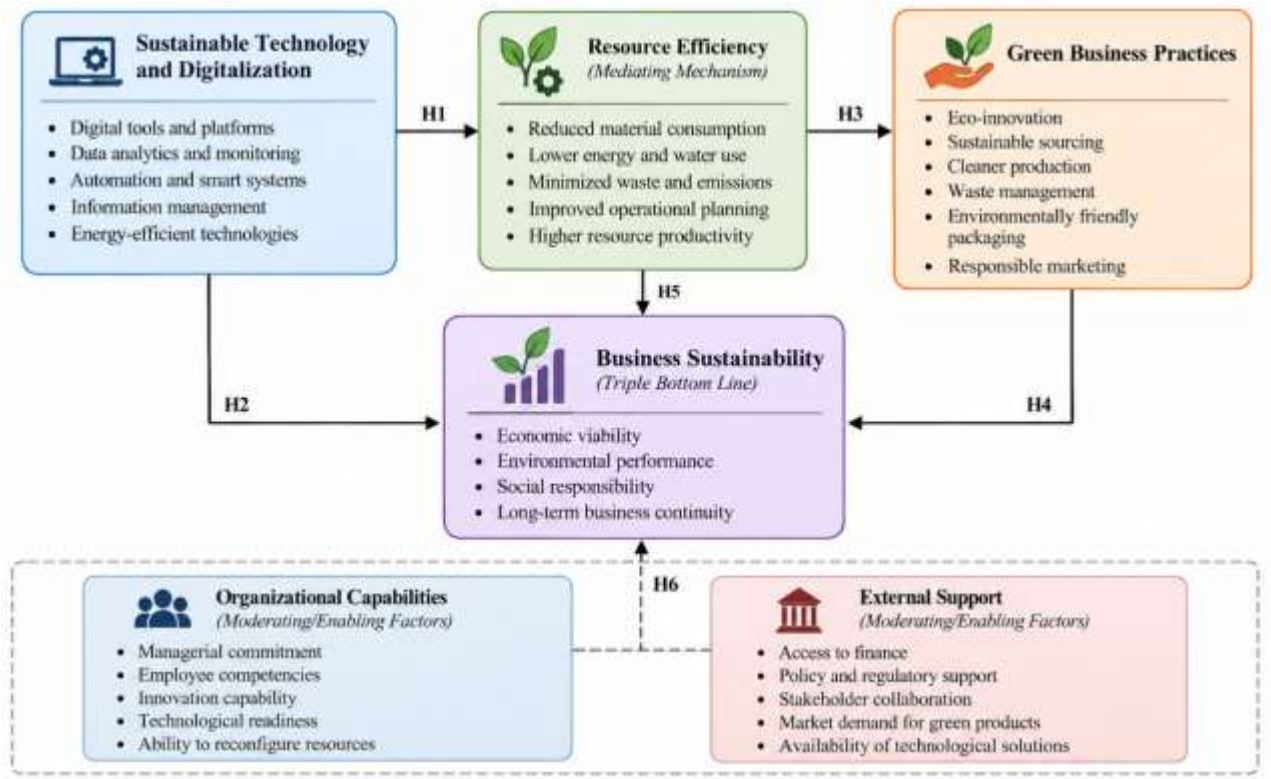


Figure 1. presents the proposed integrated conceptual framework derived from the literature synthesis.

The framework illustrates how sustainable technology and digitalization may support resource efficiency and green business practices, which can subsequently contribute to business sustainability. Resource efficiency is positioned as a potential connecting mechanism rather than a statistically established mediator. Organizational capabilities and external support are included as enabling conditions because the reviewed literature indicates that technological effectiveness depends on managerial competencies, financial readiness, and implementation context. The conceptual framework also reflects an important finding from Arroyabe et al. (2024): environmentally responsible business practices do not necessarily require advanced digitalization.

This indicates that the relationships illustrated in Figure 1 should be interpreted as potential pathways rather than a mandatory sequence of transformation. MSMEs may improve environmental performance through organizational changes, relatively simple technologies, or combinations of digital and green innovations. Therefore, the framework accommodates differences in enterprise characteristics and implementation strategies.

The theoretical significance of Figure 1 lies in its distinction between technological adoption, operational mechanisms, and sustainability outcomes. Previous research has examined digital transformation, circular economy practices, and sustainable performance from different perspectives (Chauhan et al., 2022; Liu et al., 2022; Miranda et al., 2024). The proposed framework integrates these discussions by emphasizing that technology becomes environmentally relevant when it supports identifiable improvements in resource management. At the same time, it recognizes that resource efficiency does not independently guarantee economic viability or long-term business continuity.

Table 1. Synthesis of Key Findings and Their Implications for MSME Sustainability

Research dimension	Main insights from the literature	Critical interpretation	Supporting studies
Sustainable technology	Digital tools can improve information management and operational coordination.	Technology adoption does not automatically improve sustainability.	Sagala & Őri (2024); Santos & Sant'Anna (2024)
Digitalization and resource efficiency	Digital monitoring and information systems can support more efficient resource utilization.	Efficiency improvements must be distinguished from absolute environmental reductions.	Chauhan et al. (2022); Liu et al. (2022)
Green business and eco-innovation	Environmental practices and eco-innovation can contribute to sustainable performance.	Benefits vary according to innovation type, organizational resources, and market conditions.	Gennari (2023); Oduro (2024)
Organizational capabilities	Managerial readiness and organizational adaptation influence technological effectiveness.	Similar technologies may generate different outcomes across enterprises.	Teece (2007); Hernández et al. (2024)
Business sustainability	Economic and environmental outcomes are interconnected.	Competitive advantage, resource efficiency, and environmental sustainability are distinct concepts.	Lu & Shaharudin (2024); Miranda et al. (2024)

As shown in Table 1, the literature provides support for several potential contributions of sustainable technology, but also identifies limitations that prevent universal conclusions. The evidence suggests that resource efficiency and organizational capabilities are particularly important for understanding why technological adoption produces different outcomes across MSMEs. However, the available studies do not establish that these relationships operate identically across industries, countries, or enterprise sizes. The integration of Figure 1 and Table 1 offers two complementary contributions. Figure 1 illustrates the proposed relationships among the major concepts, while Table 1 identifies the supporting literature and critical qualifications associated with each relationship. Together, they provide a basis for distinguishing the potential mechanisms of sustainable transformation from the conditions that may strengthen or constrain their effectiveness.

From a practical perspective, the synthesis suggests that MSMEs should begin sustainable transformation by identifying specific operational inefficiencies rather than adopting technologies without clear objectives. Businesses can assess material losses, energy consumption, production costs, and inventory accuracy before selecting technological applications. Environmental improvements should then be evaluated alongside financial outcomes to determine whether the investment supports long-term business operations. For future research, the proposed framework provides opportunities to examine whether resource efficiency mediates the relationship between digitalization and business sustainability, and whether organizational capabilities influence the effectiveness of technological implementation. Comparative research across enterprise sizes and industries would also help clarify why some MSMEs benefit more strongly from sustainable technologies than others. Longitudinal studies are particularly relevant because the costs of technological adoption may arise immediately, while economic and environmental benefits may require longer periods to become observable. Overall, the literature suggests that sustainable transformation depends not merely on adopting digital technologies or introducing green business practices, but on developing the organizational capacity to translate these initiatives into measurable operational and environmental improvements. Digitalization provides opportunities for better resource management, while green business practices establish an

environmental orientation for business decisions. Their combined contribution to sustainability remains conditional on financial feasibility, managerial capabilities, and the broader business environment.

5. CONCLUSION, IMPLICATION, SUGGESTION, AND LIMITATIONS

This study highlights that sustainable technology and green business practices can contribute to MSME sustainability, but their benefits depend on how effectively businesses translate technological capabilities into operational improvements. The literature suggests that digitalization can support resource efficiency through better information management, production planning, and resource monitoring, while green business practices encourage more responsible environmental decisions. However, adopting digital technologies does not automatically reduce environmental impacts or improve financial performance. The integration of the Natural Resource-Based View and Dynamic Capabilities Theory provides a conceptual explanation of these relationships by positioning resource efficiency as a potential mechanism connecting technological adoption with business sustainability. The central conclusion is that sustainable transformation depends not on technological sophistication alone, but on the ability of MSMEs to combine appropriate technologies, organizational capabilities, and environmentally responsible practices while maintaining economic viability.

The findings offer theoretical, managerial, and policy implications for sustainable MSME development. Theoretically, this study contributes an integrated conceptual framework that connects digitalization, resource efficiency, green business practices, and business sustainability, while recognizing organizational capabilities and external support as important enabling conditions. From a managerial perspective, MSMEs should evaluate technological investments according to their ability to address operational inefficiencies, reduce unnecessary resource consumption, and generate economic value rather than adopting technologies simply to follow digitalization trends. For policymakers, the findings highlight the importance of combining technological assistance with accessible financing, managerial training, and environmental management support. Such initiatives are particularly relevant for smaller enterprises whose limited resources may prevent them from translating technological opportunities into sustainable business outcomes.

This study has several limitations that should be considered when interpreting its conceptual contributions. As an integrative literature review, the analysis relies on previously published research rather than primary observations of MSME operations, limiting its ability to establish causal relationships or quantify the economic and environmental effects of sustainable technologies. Furthermore, differences in research settings, enterprise sizes, industry characteristics, and sustainability measurements may restrict the generalizability of the synthesized relationships. The proposed conceptual framework has not been empirically validated, and the roles of resource efficiency, organizational capabilities, and external support remain theoretical propositions. The absence of a fully documented final literature corpus and completed screening results also limits the reproducibility of the synthesis at this stage. Consequently, the findings should be interpreted as a conceptual foundation requiring further systematic verification and empirical investigation.

Future research should empirically examine the relationships proposed in the conceptual framework, particularly whether resource efficiency mediates the relationship between digitalization and business sustainability and whether organizational capabilities strengthen the effectiveness of sustainable technology adoption. Comparative studies involving micro, small, and medium-sized enterprises across different industries and developing economies would help explain variations in technological readiness, environmental practices, and financial outcomes. Longitudinal approaches are also recommended to distinguish short-term implementation costs from longer-term sustainability benefits. For practitioners, priority should be given to affordable and operationally relevant technologies supported by measurable indicators of energy consumption, material efficiency, waste reduction, and financial performance. Policymakers and business development institutions should strengthen access to financing, technical assistance, and sustainability-oriented training so that MSMEs can pursue environmental improvements without compromising their economic resilience.

REFERENCES

Arroyabe, M. F., Arranz, C. F. A., & de Arroyabe, J. C. F. (2024). The integration of circular economy and digital transformation as a catalyst for small and medium enterprise innovation. *Business Strategy and the Environment, 33*(7), 7162–7181. https://doi.org/10.1002/bse.3858

Badan Pusat Statistik. (2025). *Statistik e-commerce 2023*. https://www.bps.go.id/id/publication/2025/01/30/d52af11843aee401403ecfa6/statistik

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Chauhan, C., Parida, V., & Dhir, A. (2022). Linking circular economy and digitalisation technologies: A systematic literature review of past achievements and future promises. *Technological Forecasting and Social Change, 177*, Article 121508. https://doi.org/10.1016/j.techfore.2022.121508

Di Berardino, D., & Jamshed, K. (2024). Digital transition and sustainability in SMEs: A structured literature review. *ITAIS 2024 Proceedings*, Article 24. https://aisel.aisnet.org/itais2024/24/

Gennari, F. (2023). The transition towards a circular economy: A framework for SMEs. *Journal of Management and Governance, 27*, 1423–1457. https://doi.org/10.1007/s10997-022-09653-6

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review, 20*(4), 986–1014. https://doi.org/10.5465/amr.1995.9512280033

Hernández, V., Revilla, A., & Rodríguez, A. (2024). Digital data-driven technologies and the environmental sustainability of micro, small, and medium enterprises: Does size matter? *Business Strategy and the Environment, 33*(6), 5563–5582. https://doi.org/10.1002/bse.3765

Kannan, S., & Gambetta, N. (2025). Technology-driven sustainability in small and medium-sized enterprises: A systematic literature review. *Journal of Small Business Strategy, 35*(1), 129–157. https://doi.org/10.53703/001c.126636

Liu, Q., Trevisan, A. H., Yang, M., & Mascarenhas, J. (2022). A framework of digital technologies for the circular economy: Digital functions and mechanisms. *Business Strategy and the Environment, 31*(5), 2171–2192. https://doi.org/10.1002/bse.3015

Lu, H., & Shaharudin, M. S. (2024). Role of digital transformation for sustainable competitive advantage of SMEs: A systematic literature review. *Cogent Business & Management, 11*(1), Article 2419489. https://doi.org/10.1080/23311975.2024.2419489

Mick, M. M. A. P., Kovaleski, J. L., & Chiroli, D. M. de G. (2024). Sustainable digital transformation roadmaps for SMEs: A systematic literature review. *Sustainability, 16*(19), Article 8551. https://doi.org/10.3390/su16198551

Miranda, L. F., Saunila, M., Cruz-Cázares, C., & Ukko, J. (2024). Business digitalisation as a driver of environmental and economic sustainability in micro, small, and medium-sized enterprises. *Sustainable Development, 32*(6), 7036–7050. https://doi.org/10.1002/sd.3084

Oduro, S. (2024). Eco-innovation and SMEs' sustainable performance: A meta-analysis. *European Journal of Innovation Management, 27*(9), 248–279. https://doi.org/10.1108/EJIM-11-2023-0961

Organisation for Economic Co-operation and Development. (2024). *SME digitalisation to manage shocks and transitions: 2024 OECD D4SME survey* (OECD SME and Entrepreneurship Papers No. 62). OECD Publishing. https://doi.org/10.1787/eb4ec9ac-en

Sagala, G. H., & Őri, D. (2024). Toward SMEs digital transformation success: A systematic literature review. *Information Systems and e-Business Management, 22*, 667–719. https://doi.org/10.1007/s10257-024-00682-2

Santos, A. de M., & Sant'Anna, Â. M. O. (2024). Industry 4.0 technologies for sustainability within small and medium enterprises: A systematic literature review and future directions. *Journal of Cleaner Production, 467*, Article 143023. https://doi.org/10.1016/j.jclepro.2024.143023

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research, 104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319–1350. https://doi.org/10.1002/smj.640

Torraco, R. J. (2005). Writing integrative literature reviews: Guidelines and examples. *Human Resource Development Review, 4*(3), 356–367. https://doi.org/10.1177/1534484305278283

United Nations Environment Programme. (2024). *Global resources outlook 2024: Bend the trend – Pathways to a liveable planet as resource use spikes*. https://www.unep.org/en/publications/report/global-resources-outlook-2024