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Bridging the Gap to Circular MSMEs: A Systematic Literature Review on Sustainability Transitions, Digital Technologies, and Policy Support Mechanisms

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ABSTRACT. *This study presents a systematic qualitative literature review examining how Micro, Small, and Medium Enterprises (MSMEs) transition toward circular economy (CE) practices, with a focus on sustainability transitions, digital technologies, and policy support mechanisms. Drawing on peer reviewed studies published up to 2024, the review synthesizes key drivers, barriers, and enabling factors shaping circular adoption in MSMEs. The findings reveal that MSMEs face structural constraints such as limited financial resources, technological capabilities, and institutional support, which hinder large scale implementation of circular practices. However, digital technologies such as IoT, data analytics, and platform based systems emerge as critical enablers for improving resource efficiency and operational transparency. Additionally, coherent policy frameworks, including financial incentives and capacity building programs, significantly influence adoption outcomes. The study proposes an integrated ecosystem perspective, highlighting the need for alignment between technological innovation, policy intervention, and organizational readiness to accelerate circular transformation in MSMEs.*

Keywords *Circular Economy; MSMEs; Sustainability Transition; Digital Technologies; Policy Support*

INTRODUCTION

The global transition toward sustainability has intensified scholarly and policy interest in the development of circular economy (CE) models, particularly among Micro, Small, and Medium Enterprises (MSMEs), which constitute the backbone of most developing economies. MSMEs play a critical role in employment generation, local innovation, and economic resilience, yet they are also responsible for significant environmental pressures due to their reliance on linear "take make dispose" production systems (European Commission, 2022; Ellen MacArthur Foundation, 2013). In contrast, circular economy principles emphasize resource efficiency, waste minimization, and the continuous reuse of materials within closed-loop systems, offering a transformative pathway toward sustainable production and consumption (Iacovidou et al., 2021; Schröder et al., 2020). Despite its promise, the adoption of circular models among MSMEs in developing countries remains limited, uneven, and fragmented.

Existing literature highlights that MSMEs face structural and systemic barriers that hinder their transition toward circular production models. These barriers include limited financial capacity, lack of technical expertise, insufficient institutional support, and restricted access to advanced technologies (Alayón et al., 2022; Rizos et al., 2016). Unlike large corporations, MSMEs often cannot afford complex or capital-intensive

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environmental technologies, which are frequently designed for industrial-scale operations (Hwang et al., 2018). As a result, environmental transition initiatives tend to rely on end of pipe solutions or corrective approaches that do not fundamentally alter production systems, thereby limiting their long term effectiveness (Rennings, 2000; de Oliveira Neto et al., 2022). This situation underscores the urgent need for low cost, accessible, and scalable strategies that can support MSMEs in achieving circular transformation. A clear and supportive regulation from the government can serve as a driver for SMEs to utilize cloud computing technology in order to enhance their efficiency and competitiveness (Rizal, M., et al., 2022).

In response to these challenges, recent studies have emphasized the importance of eco-innovation, cleaner production, and lean green integration as enabling frameworks for sustainability transitions. Lean manufacturing principles, which focus on waste elimination and process efficiency, align closely with circular economy objectives by reducing resource consumption and improving productivity (Fercoq et al., 2016; Serrano & Costa, 2018). Similarly, green innovation strategies promote the adoption of environmentally friendly technologies that minimize ecological impacts while enhancing operational performance (Demirel et al., 2019; Fahad et al., 2022). However, the effectiveness of these approaches in MSME contexts depends heavily on their simplicity, affordability, and compatibility with existing operational systems (Vásquez et al., 2024). This highlights the importance of designing incremental and context sensitive interventions rather than radical technological shifts that exceed the absorptive capacity of MSMEs. Digitalization plays a significant role in driving technological innovation in the Micro, Small, and Medium Enterprises (MSMEs) sector (Chaidir, M., et al, 2024).

Empirical evidence from developing countries demonstrates that even small scale interventions can generate significant environmental, economic, and social benefits when properly designed. For example, low cost eco technologies in agricultural MSMEs have been shown to reduce water consumption, improve waste utilization, and enhance productivity simultaneously (Oliveira Neto et al., 2017; Purwandani & Michaud, 2021). Such interventions not only improve environmental performance but also contribute to cost savings, improved health conditions, and increased operational efficiency (Vásquez et al., 2024). These findings suggest that MSMEs are more likely to adopt circular practices when they are embedded within practical, low risk, and high benefit solutions.

Another critical dimension in the circular transition of MSMEs is the role of systems thinking. Systems based approaches emphasize the interconnectedness of production processes, resource flows, and waste streams, enabling firms to identify opportunities for closing material loops and enhancing resource recovery (Iacovidou et al., 2021; Guzzo et al., 2019). Through systems thinking, MSMEs can redesign production systems to integrate waste valorization strategies such as composting, biodigesters, and resource cascading. These approaches transform waste into valuable inputs, thereby reducing dependency on external resources and lowering production costs (Schröder et al., 2020). Such systemic redesigns are particularly relevant in rural and resource constrained contexts where circular solutions can simultaneously address environmental and economic challenges. Challenges such as resource limitations, resistance to change, and digital readiness of SMEs are critical factors to consider in its implementation (Eka Wahyu Kasih, et al, 2024).

However, technological solutions alone are insufficient to ensure successful circular transitions. Organizational learning and absorptive capacity play a crucial role in enabling MSMEs to recognize, assimilate, and apply external knowledge (Cohen & Levinthal, 1990; Aboelmaged & Hashem, 2019). Prior studies indicate that firms with higher absorptive capacity are more capable of adopting green innovations and integrating sustainable practices into their operations (Volberda et al., 2010; Bell & Albu, 1999). In MSMEs, this capacity is often constrained by limited human resources and lack of technical expertise, making knowledge transfer and collaborative learning essential components of sustainability transitions.

Social learning and stakeholder collaboration further strengthen the circular transformation process. Multi stakeholder engagement, including partnerships with universities, consultants, and policy institutions, facilitates knowledge exchange and enhances innovation diffusion (Vickers & Cordey-Hayes, 1999; Ghassim & Bogers, 2019). Social learning theory also suggests that individuals and organizations learn effectively through interaction, observation, and participation within collaborative networks (Bandura, 1963; Heyes, 1994). In the context of circular MSMEs, such interactions help overcome cognitive barriers, correct misconceptions, and build trust in new environmental practices.

Despite the growing body of literature on circular economy and MSME sustainability, research remains fragmented across disciplines, sectors, and geographical contexts. Existing studies often focus on isolated aspects such as technology adoption, policy instruments, or environmental performance, without fully integrating these dimensions into a comprehensive framework for circular transition in MSMEs. Moreover, there is limited synthesis of how sustainability transitions, digital technologies, and policy support mechanisms interact to enable or constrain circularity in developing country contexts. This fragmentation limits the development of coherent theoretical and practical guidance for stakeholders.

Digital technologies, in particular, are increasingly recognized as key enablers of circular economy transitions. Technologies such as digital monitoring systems, data analytics, and smart production tools can improve resource tracking, optimize waste management, and enhance decision-making processes (European Commission, 2022; ADB, 2020). However, MSMEs often face barriers in adopting digital solutions due to cost constraints, lack of infrastructure, and limited digital literacy (Epede & Wang, 2022). This reinforces the need for scalable and context-appropriate digital interventions that align with MSME capabilities.

Similarly, policy support mechanisms are essential in shaping the enabling environment for circular MSME transitions. Policy instruments such as subsidies, training programs, regulatory frameworks, and innovation networks can significantly influence the adoption of sustainable practices (Jang et al., 2015; Jędrzejczyk, 2022). However, overly rigid or complex regulatory systems may discourage MSME participation, particularly when compliance costs are high (Ernst et al., 2022). Therefore, effective policy design must balance enforcement with facilitation, ensuring that MSMEs are supported rather than constrained in their sustainability efforts.

Against this backdrop, this study conducts a systematic literature review (SLR) to bridge the gap in understanding how MSMEs in developing countries can transition toward circular production models. Specifically, it synthesizes existing research on sustainability transitions, digital technologies, and policy support mechanisms to identify key drivers, barriers, and enabling conditions for circular MSME development. By integrating fragmented literature, this review aims to develop a comprehensive

conceptual foundation that explains how circular transformation can be accelerated in resource constrained environments.

Ultimately, this study contributes to advancing theoretical understanding and practical implications of circular economy adoption in MSMEs. It highlights the importance of low cost eco innovations, systems thinking approaches, absorptive capacity development, and multi stakeholder collaboration as critical enablers of transition. Furthermore, it underscores the need for integrated policy frameworks and context sensitive digital solutions that can support MSMEs in overcoming structural barriers. Through this synthesis, the study seeks to provide actionable insights for researchers, policymakers, and practitioners aiming to promote inclusive and scalable circular economy transitions in developing countries.

LITERATURE REVIEW

The transition of Micro, Small, and Medium Enterprises (MSMEs) toward circular economy (CE) models has emerged as a critical research domain within sustainability science, particularly in developing countries where resource constraints and environmental pressures coexist. MSMEs represent the dominant organizational form in most economies, yet they continue to operate largely under linear production systems characterized by high resource extraction, low reuse rates, and significant waste generation (Ellen MacArthur Foundation, 2013; Valavanidis, 2018). Recent literature increasingly emphasizes that shifting MSMEs toward circularity is not merely a technological upgrade but a systemic transformation requiring changes in organizational behavior, policy frameworks, and technological capabilities (Vásquez et al., 2024; Iacovidou et al., 2021).

A growing body of research highlights that the adoption of circular and green practices in MSMEs is strongly influenced by internal capabilities, particularly absorptive capacity. Aboelmaged and Hashem (2019) demonstrate that absorptive capacity significantly enhances SMEs' ability to adopt green innovations through improved organizational learning and knowledge assimilation. Similarly, Volberda et al. (2010) argue that absorptive capacity determines how effectively firms can recognize and apply external environmental knowledge, which is essential for circular economy implementation. Marrucci et al. (2022) further confirm that absorptive capacity is a key

antecedent in developing circular business models in SMEs, particularly when firms engage in continuous learning processes with external stakeholders.

However, despite the importance of internal capabilities, MSMEs face persistent structural and operational barriers that hinder sustainability transitions. Alayón et al. (2022) identify financial constraints, lack of technical expertise, and limited managerial awareness as key obstacles to adopting sustainable manufacturing practices. Rizos et al. (2016) similarly highlight that MSMEs often lack access to information, technology, and institutional support required for circular economy adoption. In developing country contexts, these barriers are further exacerbated by weak policy enforcement and limited access to financial incentives (OECD, 2021; European Commission, 2022). These findings suggest that without targeted support mechanisms, MSMEs remain locked in linear production systems.

From a technological perspective, cleaner production and eco innovation have been widely recognized as foundational strategies for enabling circular transitions. Cleaner production approaches emphasize preventive environmental strategies that reduce waste generation at the source rather than relying on end of pipe solutions (Bernal et al., 2016; United Nations Environment Programme, 2001). Empirical studies by Alpízar et al. (2011) and Cárdenas et al. (2019) show that cleaner production initiatives in agro industrial MSMEs can significantly reduce environmental impacts while improving resource efficiency. Similarly, Carvajal-Padilla et al. (2021) demonstrate that eco innovative interventions in small scale industries can enhance productivity while reducing ecological footprints, reinforcing the dual economic environmental benefits of cleaner production systems.

Lean manufacturing and green integration have also been widely discussed as complementary approaches for MSME sustainability. Fercoq et al. (2016) argue that Lean Green integration enables firms to simultaneously reduce waste and improve operational efficiency. Kafuku (2019) further confirms that lean manufacturing practices in SMEs significantly improve productivity by eliminating non value added activities. Dahmani et al. (2022) extend this argument by demonstrating that integrating lean design with eco design can improve product sustainability across the lifecycle. These findings suggest that hybrid frameworks combining lean and green principles are particularly suitable for resource constrained MSMEs due to their cost-effectiveness and operational simplicity.

In addition to technological and organizational dimensions, systems thinking has been identified as a critical enabler of circular MSME transformation. Systems theory emphasizes the interconnectedness of processes, resource flows, and environmental impacts, enabling firms to identify leverage points for circular interventions (Chikere & Nwoka, 2015; Monat & Gannon, 2015). Iacovidou et al. (2021) argue that systems thinking is essential for understanding circular economy challenges, as it facilitates the closing of material loops and optimization of resource flows. Empirical applications in agricultural and industrial sectors demonstrate that systems based approaches can significantly enhance waste valorization and resource recovery (Eshun et al., 2012; Musee et al., 2007). These studies collectively indicate that circular MSMEs require holistic redesign of production systems rather than isolated technological interventions.

The role of digital technologies in enabling circular MSME transitions has gained increasing attention in recent literature. Digital tools such as data analytics, smart sensors, and digital monitoring systems can improve resource tracking, optimize production processes, and enhance decision making in sustainability contexts (ADB, 2020; Howard et al., 2022). However, Epede and Wang (2022) emphasize that SMEs in developing countries often face digital adoption barriers, including infrastructure limitations and skill shortages. Urbaniec et al. (2021) further highlight that technological eco innovation, particularly through digitalization, plays a crucial role in improving environmental performance but requires supportive institutional ecosystems. These findings suggest that digital transformation is a necessary but insufficient condition for circular MSME development unless accompanied by capacity building initiatives.

Policy support mechanisms are also widely recognized as critical drivers of circular economy adoption. Jang et al. (2015) identify policy instruments such as subsidies, regulatory frameworks, and innovation incentives as key enablers of eco innovation in SMEs. OECD (2021) reports that targeted policy interventions significantly improve SME participation in green transition programs, particularly in ASEAN economies. However, Ernst et al. (2022) caution that excessive regulatory pressure may reduce SMEs' willingness to engage in sustainability initiatives due to compliance burdens. Therefore, effective policy design must strike a balance between enforcement and facilitation, ensuring that MSMEs are supported rather than constrained in their sustainability transitions.

Recent empirical research also highlights the importance of stakeholder engagement and knowledge networks in accelerating circular transitions. Ghassim and Bogers (2019) demonstrate that stakeholder engagement significantly improves sustainability oriented innovation and firm performance. González-Moreno et al. (2019) further show that knowledge network breadth and trust strongly influence eco-innovation outcomes in SMEs. Re and Magnani (2022) emphasize that value co creation through circular entrepreneurship enhances the development of circular business models. These findings suggest that MSMEs benefit significantly from collaborative ecosystems that facilitate knowledge exchange and innovation diffusion.

Despite the increasing volume of research, Vásquez et al. (2024) argue that circular transitions in MSMEs remain limited due to the lack of appropriate technological, organizational, and policy alignment. Their study demonstrates that simple, low cost eco technologies combined with preventive and systemic approaches can accelerate MSME transition toward circularity. This aligns with findings from Demirel et al. (2019), who emphasize the importance of green entrepreneurship and incremental innovation in fostering sustainability in resource constrained environments. Similarly, de Oliveira Neto et al. (2022) highlight that overcoming implementation barriers in SMEs requires integrated strategies that combine technological innovation with institutional support.

The literature reveals that MSME transition toward circular economy models is shaped by a complex interaction of internal capabilities, technological readiness, digital transformation, policy frameworks, and stakeholder engagement. While significant progress has been made in understanding individual components of circular transitions, there remains a lack of integrated synthesis that connects sustainability transitions, digital technologies, and policy support mechanisms in a unified framework. This gap is particularly evident in developing country contexts, where MSMEs face compounded constraints but also present significant opportunities for scalable sustainability transformation.

Therefore, this systematic literature review positions itself at the intersection of these fragmented research streams, aiming to provide a comprehensive understanding of how MSMEs can bridge the gap toward circularity through coordinated technological, organizational, and policy driven interventions.

METHODS

This study adopts a qualitative systematic literature review (SLR) approach to examine how Micro, Small, and Medium Enterprises (MSMEs) can transition toward circular business models through sustainability transitions, digital technologies, and policy support mechanisms. A qualitative SLR is appropriate because it enables the structured synthesis of fragmented and multidisciplinary knowledge across environmental management, innovation studies, and small business transformation, while preserving conceptual depth and contextual interpretation (Tranfield, Denyer, & Smart, 2003; Xiao & Watson, 2019).

The review process follows a systematic and transparent protocol inspired by established guidelines for management and sustainability research synthesis. First, the review protocol was developed by defining the research scope, objectives, and inclusion criteria aligned with the research question: How can MSMEs in developing countries bridge the gap toward circular production systems through enabling technologies, policies, and sustainability transitions? The formulation of the research question follows the SPIDER framework (Sample, Phenomenon of Interest, Design, Evaluation, Research type), which is widely used in qualitative evidence synthesis (Cooke, Smith, & Booth, 2012).

A structured search strategy was implemented across major academic databases to ensure comprehensive coverage of peer reviewed literature. The search string combined keywords and Boolean operators such as: “circular economy” and MSMEs or SMEs and sustainability transition and digital technology and policy support (Ellen MacArthur Foundation, 2013; Kirchherr, Reike, & Hekkert, 2017). Additional backward and forward snowballing techniques were applied to identify influential studies not captured in database searches, consistent with systematic review best practices (Webster & Watson, 2002).

The inclusion criteria consisted of: (1) peer reviewed journal articles, reports, and high quality working papers; (2) studies focused on MSMEs or SMEs in relation to circular economy, sustainability transitions, digital transformation, or environmental policy; (3) publications in English; and (4) empirical, conceptual, or review based contributions. Exclusion criteria included non-academic sources, duplicated records, and studies not addressing MSME-level analysis.

The selection process followed a PRISMA inspired flow, ensuring transparency in identification, screening, eligibility, and inclusion stages (Moher et al., 2009). Titles and abstracts were first screened to remove irrelevant studies, followed by full text assessment based on inclusion criteria. This structured filtering ensured that only studies with direct relevance to circular MSME transformation, digital technologies, and policy frameworks were retained for analysis.

Studies such as Vásquez, Gallego, and Soto (2024) were included due to their empirical demonstration that MSME circular transformation can be achieved through low cost, context sensitive technological interventions. Similarly, Aboelmaged and Hashem (2019) were selected because they highlight the role of absorptive capacity and organizational capabilities in enabling green innovation adoption in SMEs, which is central to understanding MSME readiness for circular transitions.

Data extraction was conducted using a structured coding framework to ensure consistency and comparability across studies. Extracted information included authorship, year of publication, geographical context, methodological approach, theoretical foundation, key findings, and identified barriers or enablers of circular MSME transformation. This process aligns with qualitative synthesis methods that prioritize thematic interpretation over statistical aggregation (Thomas & Harden, 2008).

A thematic analysis approach was employed to identify recurring patterns across the literature. The analysis focused on three core dimensions: (1) sustainability transition pathways in MSMEs, (2) the role of digital technologies in enabling circularity, and (3) policy and institutional support mechanisms. This approach is consistent with systems thinking perspectives that emphasize interdependencies between technological, organizational, and institutional factors in sustainability transitions (Iacovidou et al., 2021).

The synthesis is theoretically grounded in sustainability transition theory, circular economy frameworks, and innovation diffusion theory. Sustainability transition theory explains how socio technical systems evolve from linear to circular configurations through multi level interactions between actors, technologies, and institutions (Geels, 2011). Circular economy principles, as articulated by the Ellen MacArthur Foundation (2013), provide the conceptual foundation for resource loop closure, waste minimization, and regenerative production systems.

Furthermore, absorptive capacity theory is used to interpret MSME capability constraints in adopting digital and green technologies, as firms require the ability to acquire, assimilate, and apply external knowledge effectively (Aboelmaged & Hashem, 2019; Cohen & Levinthal, 1990). Policy analysis is integrated using an institutional lens, highlighting how regulatory frameworks, incentives, and innovation ecosystems shape MSME participation in circular transitions (OECD, 2021; Asian Development Bank, 2020).

To ensure the reliability and validity of findings, each selected study was assessed using qualitative appraisal criteria including methodological rigor, clarity of conceptual framework, relevance to MSMEs, and contribution to circular economy literature. This approach is consistent with established qualitative synthesis practices that emphasize interpretive robustness rather than purely quantitative scoring systems (Dixon-Woods et al., 2006).

As this research is based on secondary data, no human subjects were directly involved; therefore, ethical approval was not required. However, careful attention was given to proper citation, intellectual integrity, and avoidance of misinterpretation of original findings.

A key limitation of the methodology is the potential for publication bias, as peer reviewed literature may overrepresent successful circular economy implementations while underreporting failed MSME transitions. Additionally, geographic bias toward Europe and Asia may limit generalizability to all developing country contexts, a concern also highlighted in MSME sustainability literature (Ernst et al., 2022; Coldwell et al., 2022).

Overall, this qualitative systematic literature review integrates structured search strategies, transparent selection procedures, thematic synthesis, and theoretical triangulation to provide a comprehensive understanding of how MSMEs can bridge the gap toward circular economy adoption. By combining sustainability transition theory, digital innovation perspectives, and policy analysis, the methodology ensures a holistic and multi-dimensional interpretation of MSME circular transformation pathways.

RESULTS

Sustainability Transition Pathways in MSMEs toward Circularity. The transition of Micro, Small, and Medium Enterprises (MSMEs) from linear production systems to circular economy (CE) models is increasingly recognized as a multidimensional transformation requiring technological, organizational, and institutional changes. Recent systematic and empirical literature emphasizes that MSMEs face structural constraints in adopting circular practices, particularly due to limited financial capacity, technological capability, and managerial awareness (Vásquez, Gallego, & Soto, 2024; Rizos et al., 2016).

Evidence from multiple studies confirms that circular transition in MSMEs is not merely a technological upgrade but a systemic change involving production redesign, waste minimization, and resource looping strategies (Ellen MacArthur Foundation, 2013; Pichlak & Szromek, 2022). In particular, sustainability transitions in MSMEs are often driven by incremental eco-innovation practices rather than radical transformation due to resource constraints (Demirel et al., 2019; Fahad et al., 2022).

Furthermore, SMEs in developing countries demonstrate stronger dependence on external knowledge ecosystems, including universities, government agencies, and industry networks, to enable circular transition pathways (OECD, 2021; ADB, 2020). These findings highlight that sustainability transitions are deeply embedded in institutional support systems and regional innovation ecosystems.

Digital Technologies as Enablers of Circular MSME Transformation. The literature consistently identifies digital technologies as a central enabler of circular economy adoption in MSMEs. Industry 4.0 technologies such as the Internet of Things (IoT), blockchain, artificial intelligence (AI), and data analytics are shown to enhance traceability, resource efficiency, and waste valorization processes (Neri et al., 2023; Li et al., 2021).

Digital transformation enables MSMEs to overcome traditional inefficiencies in production and supply chain systems by improving real time monitoring of material flows and optimizing resource utilization (González-Varona et al., 2024; Neri et al., 2023). For instance, empirical studies show that digital capabilities significantly enhance SMEs' circular economy performance by strengthening adaptive and exploitative capabilities in resource management (Centobelli et al., 2021; Jędrzejczyk, 2022).

However, adoption barriers remain significant. SMEs often experience a "double digital and circular divide," where limited infrastructure, low digital literacy, and high investment costs restrict technology diffusion (Alayón, Säfsten, & Johansson, 2022; Rizos et al., 2016). Despite these challenges, digital technologies are increasingly recognized as transversal enablers that connect circular supply chains, facilitate reverse logistics, and support eco-design processes (Guzzo et al., 2019; Pichlak & Szromek, 2022).

Policy Support Mechanisms and Institutional Drivers. Policy support mechanisms are identified as critical determinants in accelerating circular economy adoption among MSMEs. Studies show that regulatory frameworks, financial incentives, and institutional support significantly influence SMEs' willingness and ability to adopt green and circular practices (OECD, 2021; Jang et al., 2015).

The European Commission (2022) highlights that MSMEs require targeted policy interventions such as subsidies for green technologies, tax incentives, and simplified compliance frameworks to overcome structural constraints. Similarly, ADB (2020) emphasizes that green financing mechanisms and public private partnerships are essential to reduce investment risks in developing economies.

Institutional theory suggests that regulatory pressure and stakeholder expectations act as external drivers of circular adoption (Ernst et al., 2022; Centobelli et al., 2021). However, fragmented policies and inconsistent enforcement in developing countries remain key barriers to effective implementation (Rizos et al., 2016; de Oliveira Neto et al., 2022).

In addition, policy ecosystems that integrate capacity building, digital infrastructure development, and innovation incentives are found to be more effective in supporting MSMEs' circular transition compared to isolated policy instruments (OECD, 2021; ADB, 2020).

Integration of Digital Technologies, Policy, and Sustainability Transition. Recent literature highlights the importance of integrating digital technologies with policy frameworks to enable systemic circular transformation in MSMEs. Studies indicate that digital tools amplify the effectiveness of policy interventions by enhancing transparency, compliance monitoring, and innovation diffusion (Neri et al., 2023; González-Varona et al., 2024).

Moreover, circular economy transition is most successful when supported by "twin transition" strategies that combine digitalization and sustainability policies (European Commission, 2022; Pichlak & Szromek, 2022). For example, Industry 4.0 technologies strengthen supply chain collaboration, which in turn improves circular resource flows and reduces environmental impact (Centobelli et al., 2021; Li et al., 2021).

However, the literature also reveals that MSMEs require absorptive capacity to effectively integrate external knowledge, digital tools, and policy incentives into operational practices (Aboelmaged & Hashem, 2019; Marrucci et al., 2022). Without such capacity, policy and technology interventions often fail to generate long term circular transformation.

The systematic review identifies several gaps in the literature. First, there is limited empirical integration between sustainability transitions, digital technologies, and policy mechanisms in MSME contexts (Vásquez et al., 2024; OECD, 2021). Second, most studies focus on large enterprises, leaving MSMEs underexplored despite their significant environmental impact.

Third, existing research tends to treat digitalization and circular economy as separate domains rather than interconnected systems (Guzzo et al., 2019; Neri et al., 2023). Finally, there is a lack of longitudinal studies that examine how MSMEs evolve across different stages of circular maturity under varying policy environments.

Overall, the literature demonstrates that bridging the gap to circular MSMEs requires a systemic integration of sustainability transitions, digital technologies, and policy support mechanisms. MSMEs can accelerate circular transformation when supported by enabling ecosystems that combine technological innovation, institutional support, and organizational learning capabilities. However, significant barriers remain, particularly in developing economies, where resource constraints and fragmented policy environments limit adoption speed.

DISCUSSION

The findings of this systematic literature review indicate that the transition of Micro, Small, and Medium Enterprises (MSMEs) toward circular economy (CE) models is a complex, multi layered process shaped by the interaction of sustainability transitions, digital technologies, and policy support systems. Across the reviewed literature, MSMEs

are consistently described as structurally constrained actors within sustainability transitions due to limited financial capacity, weak technological infrastructure, and insufficient institutional support (Rizos et al., 2016; Alayón, Säfsten, & Johansson, 2022). However, recent evidence suggests that circular transformation is increasingly feasible when supported by integrated technological and policy ecosystems that reduce adoption barriers and enhance organizational capabilities (Vásquez, Gallego, & Soto, 2024; OECD, 2021).

A key insight emerging from the synthesis is that circular MSME transition is not a linear adoption process but rather a staged and iterative transformation shaped by learning, experimentation, and external support mechanisms. This aligns with sustainability transition theory, which conceptualizes systemic change as a co evolution of technology, institutions, and organizational practices (Demirel et al., 2019; Pichlak & Szromek, 2022). In contrast to earlier studies that framed MSMEs as passive adopters of green practices, recent literature positions them as active participants in circular innovation ecosystems, provided that enabling conditions exist (Vence & Pereira, 2019; Fahad et al., 2022).

Sustainability Transitions: From Linear Constraints to Circular Capability Building. The reviewed literature highlights that MSMEs face persistent structural constraints that slow sustainability transitions, particularly in developing economies. Rizos et al. (2016) and Alayón et al. (2022) identify key barriers such as limited access to finance, low environmental awareness, and inadequate technical expertise. These findings are consistent with OECD (2021), which emphasizes that MSMEs often prioritize short term survival over long-term sustainability investments.

However, Vásquez et al. (2024) provide contrasting evidence from applied circular transition cases showing that even low cost eco innovations can significantly accelerate circular adoption when aligned with operational simplicity and resource efficiency. This supports the argument that sustainability transitions in MSMEs are more likely to succeed when framed as incremental and context specific transformations rather than radical system overhauls.

Similarly, Demirel et al. (2019) demonstrate that green entrepreneurship in SMEs is often driven by necessity based innovation rather than strategic environmental positioning. This differs from large corporations, where sustainability is often embedded

in formal ESG strategies. The implication is that MSME sustainability transitions are highly path dependent and strongly influenced by immediate operational constraints.

Comparatively, Vence and Pereira (2019) argue that circular business model innovation is a key driver of long term sustainability transition. However, their findings also suggest that adoption is uneven across sectors due to differences in resource intensity and knowledge accessibility. This reinforces the conclusion that MSME transitions depend heavily on external ecosystem support.

Digital Technologies as Accelerators of Circular MSME Transformation. A major finding across the reviewed studies is that digital technologies function as critical enablers of circular economy implementation in MSMEs. Technologies such as IoT, artificial intelligence (AI), blockchain, and data analytics enhance resource efficiency, traceability, and circular supply chain integration (Li et al., 2021; Centobelli et al., 2021).

Recent systematic reviews further confirm that digitalization improves circular performance by enabling real-time monitoring of resource flows and supporting predictive maintenance systems (Neri et al., 2023; González-Varona et al., 2024). For example, IoT based systems allow MSMEs to track material usage and waste generation, while AI based analytics optimize production processes to minimize resource consumption.

However, despite these advantages, digital adoption among MSMEs remains uneven. Alayón et al. (2022) highlight that technological complexity and lack of digital skills are major barriers to adoption. Similarly, Rizos et al. (2016) note that SMEs often lack the internal capacity to integrate advanced digital systems into their operations.

A recent systematic review by Muzondo et al. (2026) reinforces this perspective, identifying "technical readiness" and "financial constraints" as the most significant barriers, affecting more than 60% of MSME cases analyzed. This aligns with broader findings that digital transformation in SMEs is constrained not only by technology availability but also by absorptive capacity limitations (Aboelmaged & Hashem, 2019).

Comparatively, Li et al. (2021) argue that clean technologies can sometimes outperform end of pipe solutions in improving environmental outcomes. However, MSMEs often struggle to adopt such technologies due to high upfront investment costs. This suggests that digital technologies alone are insufficient unless accompanied by financial and institutional support mechanisms.

Policy Support Mechanisms and Institutional Influence. Policy support mechanisms emerge as a decisive factor in enabling MSME circular transitions. OECD (2021) and ADB (2020) both emphasize that targeted policy instruments such as green subsidies, tax incentives, and capacity building programs are essential to reduce adoption barriers.

The European Commission (2022) further highlights that MSMEs require simplified regulatory frameworks and access to green financing to accelerate sustainability transitions. Without such support, MSMEs remain locked in linear production systems due to risk aversion and capital constraints.

Empirical findings from Jang et al. (2015) confirm that eco innovation policy instruments significantly influence SME behavior, particularly in emerging economies where regulatory pressure is a key external driver. Similarly, Ernst et al. (2022) demonstrate that stakeholder pressure and institutional legitimacy concerns shape SME sustainability engagement.

However, contrasting evidence from Rizos et al. (2016) suggests that policy fragmentation and inconsistent enforcement reduce the effectiveness of circular economy initiatives. This indicates that policy design alone is insufficient unless accompanied by institutional coherence and cross sector coordination.

Comparatively, de Oliveira Neto et al. (2022) show that cleaner production adoption in SMEs is strongly influenced by localized policy interventions combined with technical assistance. This reinforces the importance of integrating policy with on the ground implementation support rather than relying solely on top down regulatory frameworks.

This review identifies seven key studies that provide foundational insights into MSME circular transitions: Rizos et al. (2016) Identifies structural barriers such as finance and knowledge gaps, emphasizing fragmented adoption of circular practices. Aboelmaged & Hashem (2019) Highlights absorptive capacity as a mediating factor in green innovation adoption. OECD (2021) Emphasizes policy driven green transition frameworks for SMEs.

ADB (2020) Focuses on green financing and investment ecosystems in developing Asia. Alayón et al. (2022) Identifies technological complexity and skills gaps as major adoption barriers. Vásquez et al. (2024) Demonstrates that low-cost eco-innovation

significantly accelerates MSME circular transformation. Li et al. (2021) Shows that clean technologies outperform end-of-pipe solutions in environmental performance.

Across these studies, three dominant patterns emerge: First, MSME circular transition is consistently constrained by resource limitations and capability gaps (Rizos et al., 2016; Alayón et al., 2022). Second, absorptive capacity and learning mechanisms significantly determine adoption success (Aboelmaged & Hashem, 2019; Vásquez et al., 2024). Third, policy and financial ecosystems are essential enabling structures that determine scalability (OECD, 2021; ADB, 2020).

This comparative synthesis suggests that MSME circular transformation cannot be explained through isolated technological or policy factors, but rather through their interaction within a multi level system.

Integrated Perspective: Toward a Systemic Circular MSME Model. The integration of sustainability transitions, digital technologies, and policy mechanisms reveals a systemic model of circular MSME transformation. Digital tools act as operational enablers, policy frameworks provide structural support, and organizational learning capabilities determine internal readiness.

This aligns with Centobelli et al. (2021), who argue that circular economy implementation requires alignment between technological readiness and organizational capability. Similarly, Pichlak and Szromek (2022) emphasize that eco-innovation and circular economy are interdependent systems that must evolve simultaneously.

Therefore, the findings suggest that circular MSME transformation is best understood as a multi layered ecosystem transition, rather than a firm level innovation process. Without integration across technological, institutional, and organizational dimensions, circular initiatives risk remaining fragmented and unsustainable.

The discussion highlights three major implications: MSME circular transitions require low-cost, scalable, and context-sensitive innovations rather than complex technologies. Digital transformation must be supported by absorptive capacity development and skills training. Policy frameworks must move from isolated interventions to integrated circular ecosystem governance. These insights collectively suggest that bridging the circular MSME gap requires synchronized action across technology, policy, and organizational learning systems.

CONCLUSION

This systematic literature review provides a comprehensive synthesis of the factors shaping the transition of Micro, Small, and Medium Enterprises (MSMEs) toward circular economy (CE) models, emphasizing the interplay between sustainability transitions, digital technologies, and policy support mechanisms. The findings confirm that MSMEs occupy a critical yet vulnerable position within circular economy ecosystems due to inherent structural constraints, including limited financial resources, technological capabilities, and institutional access (Rizos et al., 2016; OECD, 2021). Despite these constraints, the review demonstrates that MSMEs can successfully engage in circular transformation when supported by integrated ecosystems that combine technological innovation, policy facilitation, and organizational capability development (Vásquez et al., 2024; Centobelli et al., 2021).

A central conclusion of this study is that sustainability transitions in MSMEs are not linear processes but iterative and context dependent transformations shaped by incremental eco innovation and learning dynamics (Demirel et al., 2019; Pichlak & Szromek, 2022). Unlike large corporations, MSMEs tend to adopt circular practices gradually, often driven by operational efficiency and cost-saving considerations rather than formal sustainability strategies (Fahad et al., 2022). This highlights the importance of designing circular economy frameworks that align with MSMEs' resource constraints and operational realities.

The review further underscores the pivotal role of digital technologies as enablers of circular transformation. Technologies such as IoT, artificial intelligence, and data analytics enhance resource efficiency, transparency, and supply chain integration, thereby accelerating circular adoption (Li et al., 2021; Neri et al., 2023). However, the effectiveness of digital transformation is contingent upon MSMEs' absorptive capacity and digital readiness, which remain uneven across regions and sectors (Aboelmaged & Hashem, 2019; Alayón et al., 2022).

In addition, policy support mechanisms emerge as essential drivers of MSME circular transition. Targeted interventions including financial incentives, regulatory frameworks, and capacity building programs significantly influence adoption outcomes (ADB, 2020; European Commission, 2022). Nevertheless, the effectiveness of these policies depends on their coherence, accessibility, and alignment with MSMEs' needs,

particularly in developing economies where institutional fragmentation remains a key challenge (de Oliveira Neto et al., 2022; Rizos et al., 2016).

Overall, this review contributes to the literature by proposing a systemic perspective in which circular MSME transformation is understood as the result of dynamic interactions between technological, institutional, and organizational dimensions. Bridging the gap to circular MSMEs therefore requires not only technological adoption or policy intervention in isolation, but a coordinated and ecosystem based approach that integrates digital innovation, policy support, and capability development.

LIMITATION

Despite its contributions, this study has several limitations that should be acknowledged. First, the systematic literature review relies primarily on secondary data sources, which may introduce publication bias, as studies with significant or positive findings are more likely to be published than those reporting null results (Tranfield, Denyer, & Smart, 2003). This may limit the generalizability of the findings across different MSME contexts.

Second, the scope of the review is constrained by database selection and inclusion criteria, which may have excluded relevant studies published in non indexed journals or regional publications, particularly from developing economies where MSMEs play a dominant role (OECD, 2021). As a result, the findings may not fully capture the diversity of MSME experiences across different geographical and institutional contexts.

Third, the review adopts a qualitative synthesis approach, which, while suitable for exploring complex and multidimensional phenomena, does not provide quantitative measurement of effect sizes or causal relationships (Petticrew & Roberts, 2006). Future research could complement these findings with meta analytic or empirical approaches to enhance robustness.

Fourth, the integration of sustainability transitions, digital technologies, and policy mechanisms in the reviewed literature remains fragmented. Many studies focus on these dimensions in isolation, limiting the ability to draw fully integrated conclusions about their combined effects (Guzzo et al., 2019; Neri et al., 2023). This highlights the need for more interdisciplinary and longitudinal research designs.

Fifth, the dynamic nature of digital technologies and circular economy practices means that the findings may become outdated as new innovations and policy frameworks emerge. Although this review includes recent studies up to 2024, rapid technological advancements may shift adoption patterns in the near future (González-Varona et al., 2024).

Finally, the review does not deeply differentiate between sectors, even though circular economy adoption varies significantly across industries due to differences in resource intensity, regulatory environments, and technological requirements (Vence & Pereira, 2019). Future studies should explore sector specific pathways to provide more nuanced insights.

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