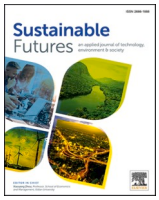
Sustainable Futures 10 (2025) 100840

Contents lists available at ScienceDirect

Sustainable Futures

journal homepage: www.sciencedirect.com/journal/sustainable-futures



Unpacking green growth in SMEs: A framework for dynamic capabilities, value co-creation, and sustainable performance

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ARTICLE INFO

Keywords:
SMEs
Green dynamic capabilities
Value co-creation
Sustainability transitions
Green growth
Sustainable performance

ABSTRACT

This study examines how green dynamic capabilities and value co-creation drive sustainability transitions in small and medium-sized enterprises (SMEs), enabling them to integrate sustainability into their business models and improve environmental, economic, and social performance. A systematic literature review using PRISMA guidelines analyzed 108 peer-reviewed articles from the Scopus database. Thematic analysis identified key factors influencing SME sustainability through dynamic capabilities and value co-creation. The findings reveal that green dynamic capabilities—sensing, seizing, and transforming sustainability opportunities—are essential for SMEs to adapt to regulatory, market, and technological shifts. Value co-creation, facilitated by stakeholder collaboration, digital technology adoption, and regulatory engagement, further enhances sustainability outcomes. Mediating factors, including financial accessibility, digital transformation, institutional support, and market pressure, influence how effectively SMEs integrate green practices. The study developed a framework showing that SMEs should enhance green capabilities and stakeholder engagement to overcome resource constraints, while policymakers and industry players must strengthen institutional support, regulatory incentives, and tailored green financing. This study integrates green dynamic capabilities and value co-creation into the structured framework.

1. Introduction

Small and medium-sized enterprises (SMEs) play a crucial role in fostering sustainable economic development, yet their contribution to green growth remains underexplored. As global sustainability challenges intensify, the transition toward environmentally conscious business models is no longer an option but a necessity [1]. Green growth, which emphasizes economic prosperity while minimizing environmental degradation, has emerged as a strategic priority for SMEs [2]. However, SMEs often face structural and institutional barriers that hinder the adoption of green practices, including resource constraints, market competition, and regulatory uncertainty [3]. Despite growing research on corporate sustainability, there is still a need to unpack the mechanisms through which SMEs develop green dynamic capabilities, co-create value with stakeholders, and achieve long-term sustainability performance.

The existing literature on green growth predominantly centers on broad policy frameworks and large corporations [4–6], critically overlooking the unique dynamics of Small and Medium Enterprises (SMEs). Given that SMEs represent a significant share of global economic activity and play a pivotal role in sustainable transitions [7–9], this oversight is particularly significant. While research on sustainability transitions has extensively examined technological innovation, regulatory compliance, and market-based incentives, it has paid limited attention to how SMEs develop green dynamic capabilities—the ability to sense opportunities, seize resources, and transform business models in response to evolving environmental and market pressures [10–13]. The challenges of these transitions are further intensified by resource scarcity, knowledge barriers, and institutional constraints that impede SMEs' ability to effectively scale green practices [6,7,14]. Consequently, despite the growing emphasis on environmental responsibility, research remains fragmented in explaining how SMEs navigate these challenges and sustain green capabilities over time.

The role of value co-creation in SME sustainability is gaining

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https://doi.org/10.1016/j.sftr.2025.100840
Received 20 October 2024; Received in revised form 9 June 2025; Accepted 10 June 2025
Available online 16 June 2025

recognition, yet remains under-theorized and inconsistently examined [15,16]. In contrast to large corporations benefiting from economies of scale and established sustainability networks, SMEs operate within more dynamic and interdependent ecosystems. In these complex environments, collaboration becomes crucial, with interactions among customers, suppliers, regulators, and financial institutions playing a pivotal role in shaping sustainability strategies [17–19].

Existing research on value co-creation in sustainability contexts has predominantly focused on consumer engagement and service industries, failing to provide a comprehensive understanding of its role in SME-driven green business model innovation [20,21]. The impact of external stakeholder collaboration on environmental and business performance in SMEs remains an open question, particularly in emerging markets characterized by weak institutional support for green initiatives [18,22,23]. Critical research gaps are evident through the insufficient understanding of multi-stakeholder collaboration mechanisms [17,24,25], limited insights into external partnerships driving green innovation in resource-constrained environments [7,14,26], and inadequate frameworks explaining the interaction between collaborative strategies and internal green capabilities [10,12,13]. These gaps ultimately constrain the development of targeted strategies to strengthen multi-stakeholder cooperation in green SME ecosystems [20,27].

Prior systematic literature reviews on SME sustainability have been narrowly focused, examining specific aspects such as green business model innovation [9,20], value co-creation performance [21], and stakeholder engagement [24]. These reviews have failed to develop a comprehensive framework that integrates green dynamic capabilities with multi-stakeholder collaboration. The existing literature remains predominantly concentrated on consumer engagement and service industries, thereby failing to offer a structured understanding of SME-driven green business model innovation, especially in emerging markets with weak institutional support [22,23,27]. The research gap is further highlighted by insufficient exploration of multi-stakeholder collaboration mechanisms [17,25], limited insights into external partnerships driving green innovation in resource-constrained environments [7,14,26], and the lack of robust frameworks explaining the interaction between collaborative strategies and internal green capabilities [10,12,13].

To bridge these gaps, this research aims to develop a comprehensive framework for understanding green growth implementation in SMEs. Specifically, we focus on three questions: (1) How has green dynamic capabilities and value co-creation emerged in the growth sustainable practices in SMEs? (2) How do green dynamic capabilities and value co-creation interact to drive sustainable practices in SMEs? (3) In what ways do SMEs leverage their organizational capabilities to enhance both environmental and business performance?

By integrating perspectives from dynamic capabilities theory, institutional theory, and value co-creation literature, this research provides a structured and actionable approach to SME sustainability. In doing so, it contributes to a deeper understanding of how small businesses can navigate the complexities of green growth while remaining competitive in an evolving economic landscape. This study's findings will offer valuable insights for SMEs, policymakers, and sustainability advocates seeking to promote green economic transitions. By addressing capability-building strategies, stakeholder collaboration, and institutional variations, this research moves beyond one-size-fits-all sustainability models, advocating for tailored, context-sensitive approaches to green growth in SMEs.

2. Theoretical background

To address these research questions and conceptualize how SMEs develop and implement green growth strategies, this study draws upon two complementary theoretical perspectives: Value Co-Creation Theory and Dynamic Capabilities Theory. These frameworks were selected for their distinct yet interconnected contributions to understanding sustainable business transformation in SMEs. Dynamic Capabilities Theory provides a foundation for examining how SMEs develop and deploy the internal competencies needed to sense environmental opportunities, seize resources, and transform their operations toward sustainability [28]. Meanwhile, Value Co-Creation Theory offers insights into how SMEs leverage multi-stakeholder relationships to overcome resource constraints and develop innovative sustainable solutions through collaborative processes [29]. By integrating these theoretical lenses, we can better understand both the internal capabilities and external collaborative mechanisms that enable SMEs to achieve green growth. The following sections elaborate on each theoretical perspective and their synthesis in the context of SME sustainability transitions.

2.1. Value co-creation theory

Value co-creation theory in SME green growth stems from two foundational perspectives: Stakeholder Theory [30] and Service-Dominant Logic [31]. Stakeholder Theory emphasizes how multi-stakeholder collaboration creates sustainable value, while Service-Dominant Logic conceptualizes value creation as an interactive process where firms and stakeholders integrate resources and capabilities for innovation. In the SME context, this theoretical integration explains how smaller firms overcome resource limitations through collaborative approaches to sustainability [32]. empirically demonstrates that SMEs engaging multiple stakeholders in sustainable solution development achieve superior environmental and economic outcomes compared to those operating in isolation. Further evidence from [12,16] reveals how ecosystem collaboration enables SMEs to develop more comprehensive sustainability solutions through three key mechanisms: structured knowledge sharing, joint problem-solving initiatives, and resource pooling. These studies highlight how value co-creation processes help SMEs transcend their individual resource constraints to achieve broader sustainability impact.

2.2. Dynamic capabilities theory

Dynamic capabilities theory complements value co-creation by explaining how SMEs develop and deploy internal abilities to pursue green growth opportunities. Building on Teece et al.'s [33] framework, this perspective delineates three critical capabilities for sustainability transitions: sensing environmental opportunities, seizing necessary resources, and transforming operational processes. The Resource-Based View [34] enriches this understanding by explaining how firms build and optimize internal resources for sustainable competitive advantage. Recent empirical studies validate these theoretical predictions in the SME context [10]. and Tian et al. [35] show that SMEs with strong sensing capabilities more effectively identify emerging sustainability opportunities and market demands. Additionally, [11] and [36] demonstrate that SMEs integrating dynamic capabilities with strategic resource management achieve superior sustainability outcomes, particularly in developing and scaling green innovations. These capabilities prove especially crucial for SMEs navigating resource constraints while pursuing ambitious sustainability goals.

This integration of theories provides a robust framework for understanding how SMEs can simultaneously develop internal capabilities and leverage external collaborations to achieve green growth objectives. The synthesis suggests that successful sustainability transitions require both strong organizational capabilities and effective stakeholder engagement, particularly in resource-constrained SME contexts (Table 1).

3. Methodology

To conduct this systematic review, we implemented a comprehensive search strategy following PRISMA guidelines [37] to ensure methodological rigor and reproducibility (Fig. 1). The literature search was conducted in June 2025 using the Scopus database, which was selected

Table 1
Theoretical foundations.

Theory	Concept	Key Insights
Value Co-Creation Theory	Stakeholder Theory [30]	Emphasizes the importance of multi-stakeholder collaboration in value creation. SMEs engage with various actors to develop sustainable solutions, focusing on interactions and relationships.
	Service-Dominant Logic	Views value co-creation as an interactive process between firms and stakeholders. Highlights the importance of resource and capability integration in sustainability efforts.
Dynamic Capabilities Theory	Dynamic Capabilities Framework [33]	Explains organizational capabilities for sensing sustainability opportunities, seizing them, and transforming resources to adapt. Focuses on developing adaptive capabilities in response to environmental changes.
	Resource-Based View (RBV)	Stresses the role of internal resources and capabilities in achieving competitive advantage. Highlights how dynamic capabilities support SMEs in optimizing and reconfiguring resources for sustainability.
Interrelation of Both Theories	Green Growth and Sustainability	Dynamic capabilities enable SMEs to identify and leverage sustainability opportunities, while value co-creation facilitates the integration of resources and knowledge from stakeholders to drive innovation and effective sustainability solutions.

for its extensive coverage and credibility in social sciences research [38]. Our search strategy employed a comprehensive Boolean string designed to capture terminological variations commonly used in academic literature: (TITLE-ABS-KEY("SME" OR "SMEs" OR "small and medium enterprise" OR "small and medium-sized enterprise" OR "small and medium-size enterprise" OR "small-and-medium enterprise" OR "small and medium business")) AND (TITLE-ABS-KEY("green economy" OR "green growth")).

This expanded search string was developed following preliminary keyword analysis of relevant literature, which revealed significant terminological variations across different regions and publication contexts. While "SME" and "SMEs" represent the most universal and widely recognized international abbreviations for small and medium enterprises, we also included variations such as "small and medium business", "small and medium-sized enterprise", "small-and-medium enterprise", and their plural forms to ensure comprehensive coverage of how SMEs are referenced in international literature [39]. This approach was designed to mitigate the risk of excluding relevant studies due to terminological variations and initially yielded 237 documents for further evaluation.

The systematic screening process involved multiple stages of document evaluation conducted in a sequential and structured manner. During the initial screening phase, the 237 documents from our preliminary search underwent careful evaluation, resulting in the exclusion of 49 documents that were clearly irrelevant to our search keywords, leaving 188 documents for further analysis. These exclusions primarily involved documents where search terms appeared in unrelated contexts or technical fields that did not align with our research focus. Subsequently, we applied language restrictions by limiting our search to English-language publications, which reduced our document set from 188 to 156 documents, with 32 non-English documents being excluded at this stage.

Following the language filter, documents were further refined to include only peer-reviewed journal articles, systematically excluding conference proceedings, book chapters, and other publication types to ensure academic quality and rigor. This filtering process resulted in 148 documents, with 8 documents excluded for not meeting our peer-review criteria. The final and most critical phase involved conducting a comprehensive relevance evaluation of the remaining 148 documents, which resulted in the exclusion of 40 additional documents based on specific relevance criteria, ultimately yielding 108 high-quality studies for our final analysis.

Articles were systematically excluded if they did not align with the specific scope of this review, which focuses on SME green dynamic capabilities, value co-creation, and multi-stakeholder collaboration. Our exclusion criteria were applied rigorously, with papers being removed if they addressed broad green policy frameworks or macroeconomic analyses without establishing clear links to SME-level capabilities (12 documents), focused solely on internal organizational outcomes such as employee satisfaction or HRM impacts without addressing inter-organizational collaboration or co-creation mechanisms (18 documents), were highly sector-specific with limited generalizability to SMEs across sectors (9 documents), explored green job creation or consumer behavior rather than SME innovation capabilities (8 documents), or presented conceptual discussions without empirical grounding in SME dynamic capabilities or multi-stakeholder collaboration processes (6 documents). Through this systematic and rigorous screening process, we successfully identified 108 high-quality studies that were directly relevant to our research focus for comprehensive analysis.

The data extraction and analysis process followed a structured approach using a standardized form adapted from prior reviews in sustainability research [40]. Given the narrative nature of this review, thematic analysis was employed to synthesize findings, identifying recurring patterns and conceptual linkages across studies [41]. reflexive thematic analysis approach was applied to systematically code and categorize themes, ensuring a structured yet flexible interpretation of SMEs' role in green growth. This approach allowed for a qualitative synthesis of the literature, providing deeper insights into the key drivers, barriers, and strategies related to SMEs' sustainable transitions.

4. Results and discussion

Building on our systematic review methodology, this section presents and develop the findings through the theoretical lenses of value co-creation and dynamic capabilities. We structure our analysis around the three research questions posed earlier, examining how SMEs develop and leverage green capabilities while engaging in collaborative sustainability initiatives. Our findings draw from the 108 reviewed studies, incorporating empirical evidence, comparative case analyses, and statistical findings to provide a comprehensive understanding of SME sustainability transitions.

4.1. RQ1: How has green dynamic capabilities and value co-creation emerged in the growth sustainable practices in SMEs?

The development of sustainable practices in SMEs from 2011 to 2024 reveals a dynamic interaction between green dynamic capabilities and value co-creation processes. While early adoption efforts were largely driven by regulatory compliance and cost-saving imperatives, sustained and scalable green growth required SMEs to actively develop adaptability, innovation, and knowledge-sharing capabilities while fostering collaborative relationships with key stakeholders [20,42,43]. As illustrated in Table 2, the three phases of green SME evolution—early adoption, growth and standardization, and digital transformation—demonstrate how these dimensions intersect to shape sustainability trajectories, with each phase reflecting distinct drivers, barriers, and implementation strategies that influence how SMEs develop and sustain green practices over time.

Table 3, Table 4, Table 5, Table 6

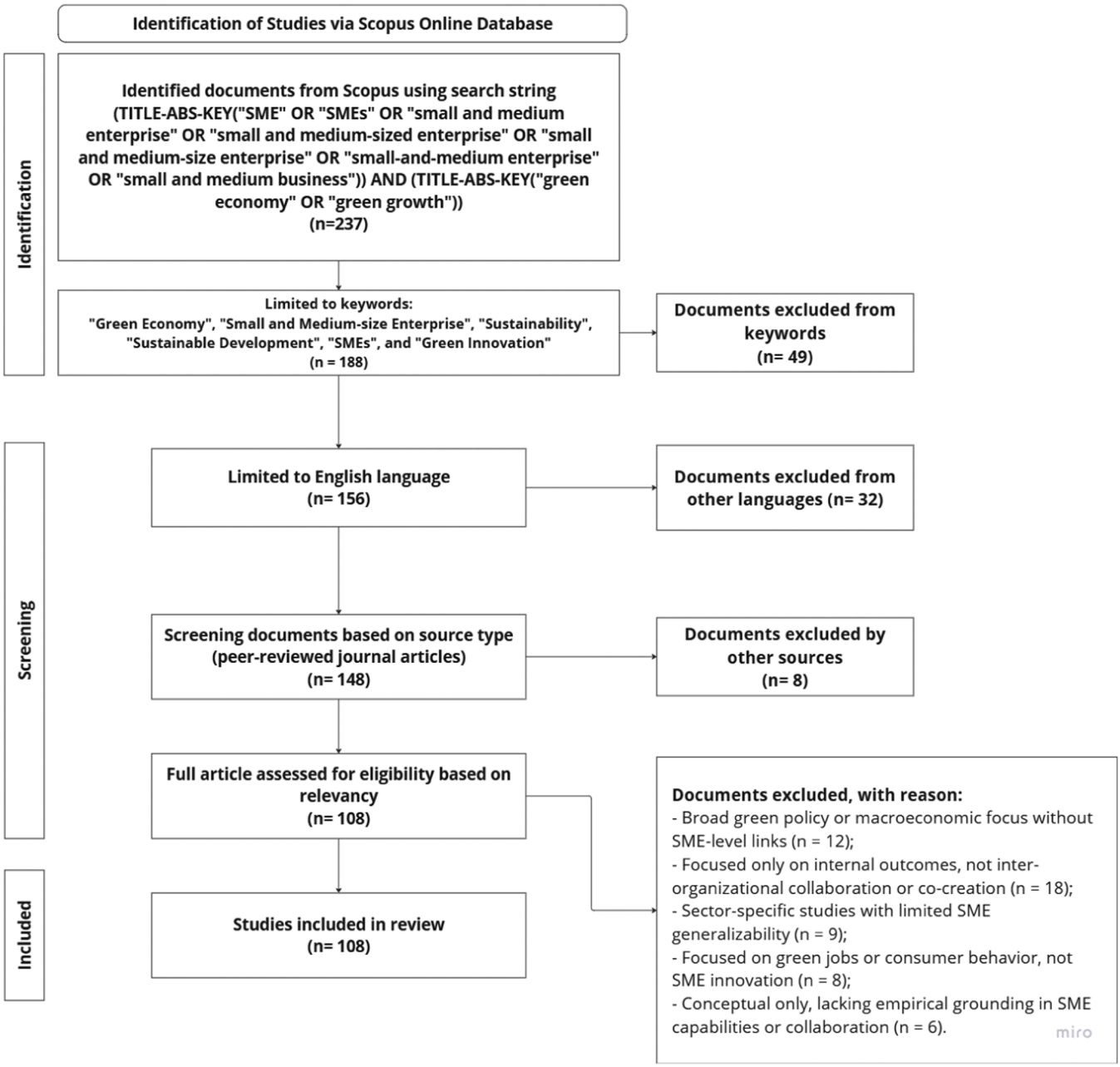

Fig. 1. PRISMA flow diagram.

4.1.1. Early adoption phase (2011–2014): Developing foundational green capabilities

The initial phase of SME sustainability efforts (2011–2014) was characterized by compliance-driven sustainability adoption, primarily in response to regulatory pressures [43]. SMEs focused on incremental innovations in resource conservation, particularly energy efficiency and waste reduction measures to minimize operational costs. However, the adoption of sustainability practices remained reactive rather than strategic, as many SMEs lacked the financial and technical resources to integrate green innovation as a long-term business model [70].

Value co-creation during this period was minimal, with SMEs engaging primarily with regulatory bodies rather than broader stakeholder ecosystems. Many firms struggled to move beyond regulatory compliance, facing financial constraints, limited technical expertise, and an absence of collaborative sustainability networks. The geographical distribution of research during this period highlights early compliance-driven efforts in SMEs in China, Vietnam, and Italy, where environmental regulations spurred initial sustainability adoption, particularly in manufacturing and cleaner production sectors [22,48]. These early compliance-driven efforts laid the groundwork for more strategic sustainability approaches in the following years.

4.1.2. Growth and standardization phase (2015–2019): Strengthening green innovation and multi-stakeholder collaboration

Between 2015 and 2019, SMEs progressed from compliance-driven adoption to integrating sustainability into competitive strategy [49]. Green dynamic capabilities evolved to proactively sense sustainability opportunities, leading to the adoption of circular economy principles, eco-certifications, and resource efficiency measures [50]. Supply chain adaptability also became a key capability, with firms incorporating sustainable procurement and logistics optimization into operations [45].

During this phase, value co-creation became a central enabler of green business model innovation. SMEs increasingly engaged with suppliers, customers, and industry networks to co-develop eco-friendly

Table 2
Emergence for green dynamic capabilities and value co-creation mechanisms in SMEs' green practice (2011–2024).

Period & Characteristics	Key Green Dynamic Capabilities	Value Co-Creation Mechanisms	Implementation Strategies	Geographical Areas Emerging in Research
Early Adoption (2011–2014)Initial compliance-driven sustainability efforts	SMEs primarily focused on sensing regulatory shifts to ensure compliance with emerging environmental policies [43]. They engaged in incremental innovation efforts, particularly in improving energy efficiency to reduce operational costs (Woo et al., 2014). Resource efficiency and waste management capabilities were prioritized [22,44]. Initial efforts also included limited adoption of Environmental Management Systems (EMS) and participation in voluntary certifications [45,46].	During this phase, SMEs had limited engagement with external stakeholders beyond regulatory bodies. Most collaborations were compliance-focused, involving interactions with regulators to meet environmental mandates [46]. Industry peer learning and donor-driven programs began to introduce basic forms of value co-creation [47], but networks remained underdeveloped.	SMEs implemented basic EMS and cleaner production initiatives [44]. Cost-saving efficiency initiatives such as waste reduction, water conservation, and energy optimization were adopted to offset sustainability investment burdens [22]. Limited efforts toward green supply chain management were initiated [45].	China, Vietnam, Italy, Uganda, Eastern Europe [22,43–48]
Growth & Standardization (2015–2019) Integration of sustainability into competitive strategy	SMEs began expanding their capacity for green innovation, integrating sustainability into their long-term business strategies to gain a competitive advantage [49]. Supply chain adaptability became a critical capability, with firms strengthening their networks to incorporate sustainable practices across operations [45].	Collaboration with suppliers and customers intensified, as SMEs sought to co-develop sustainable products and services. Partnerships for environmental certification and eco-labeling became more common, ensuring market differentiation and credibility [50].	The development of circular economy principles gained traction, leading SMEs to focus on resource efficiency and waste reduction. Green supply chain initiatives, such as sustainable sourcing and logistics optimization, became increasingly standardized within SME operations.	Zimbabwe, Eastern Europe, Thailand, Turkey [17,23,45,51]
Digital Transformation (2020–2024) Technology-driven sustainability scalingOECD	SMEs leveraged digital sustainability solutions to enhance environmental performance monitoring and optimize resource use [32]. Advanced technologies, such as artificial intelligence, were deployed for real-time environmental tracking and predictive analytics [10].	Value co-creation mechanisms became more sophisticated, with SMEs engaging in digital collaborations with suppliers and customers to develop innovative sustainability solutions [27]. Additionally, partnerships in green financing emerged as a means to secure investments for scaling sustainability initiatives.	AI and IoT-enabled sustainability monitoring tools were widely adopted, allowing SMEs to track and improve their environmental impact. Digital stakeholder collaboration platforms facilitated ecosystem-wide engagement, promoting transparency and efficiency in green business practices.	Saudi Arabia, Nigeria, Indonesia, China, United States (Abualfaraa et al., 2023; [52]; Nohong et al., 2024; [26,53]

Table 3
Interactions at an organizational level.

Dimension	Key Components	Outcomes	Supporting Evidence
Dynamic Capabilities	SMEs develop dynamic capabilities through sensing opportunities, seizing them effectively, and reconfiguring resources to align with sustainability goals.	Enhanced operational efficiency, improved sustainable practices, and better environmental performance.	[9,10,12, 13,32,54]
Value Co-Creation	Collaboration among internal stakeholders, integration of knowledge across departments, and efficient resource utilization drive value co-creation.	Stronger innovation outcomes, enhanced business performance, and improved sustainability results.	[8,16,19, 25,55–57]
Implementation	Implementing green supply chain management, fostering environmental innovation, and integrating sustainability into operations improve business competitiveness.	Operational improvements, increased competitiveness, and better resource utilization.	[10,11,19, 25–27,36]

Table 4
Interactions at an industry network level.

Dimension	Activities	Benefits	Key References
Resource Management	Optimizing resources collectively, utilizing shared infrastructure, and planning resource allocation collaboratively.	Increased cost efficiency, reduced resource waste, and better resource allocation.	[8,19, 57–59]
Knowledge Dynamics	Sharing knowledge across organizations, exchanging best practices, and engaging in joint learning initiatives.	Enhanced innovation capacity, improved technical capabilities, and knowledge spillover effects.	[12,16,25, 32,54]
Innovation Networks	Developing collective environmental innovations, conducting shared R&D projects, and collaborating across industries for broader innovation.	Accelerated green development, reduced innovation costs, and a broader scope for industry-wide sustainability initiatives.	[11,13,56, 60]
Infrastructure Development	Utilizing shared technology platforms, developing joint facilities, and investing in collaborative green infrastructure.	Cost-effective technology implementation, enhanced operational efficiency, and improved sustainability impact.	[10,27,36, 56,61]

Table 5
Interaction at an ecosystem level.

Dimension	Activities	Benefits	Key References
Stakeholder Engagement	Facilitating collaboration through multi-stakeholder platforms, engaging in joint problem-solving initiatives, forming cross-sector partnerships, and integrating decision-making processes.	Improved stakeholder coordination, enhanced problem resolution, stronger ecosystem relationships, and better alignment of interests among organizations.	[8,9,16,62,63]
Sustainability Solutions	Developing shared green infrastructure, implementing sustainability initiatives across ecosystems, creating integrated environmental programs, and coordinating collective sustainability actions.	More effective environmental solutions, lower implementation costs, broader sustainability impact, and greater resource efficiency.	[10,12,19,36,51]
Value Chain Integration	Enhancing supply chain coordination, fostering cross-industry collaboration, managing shared resources effectively, and adopting collective environmental practices.	Optimized supply chain operations, minimized environmental impact, better resource utilization, and increased value creation.	[8,11,14,16,25]
Innovation Ecosystem	Advancing joint technology development, conducting shared research initiatives, driving collaborative green innovation, and establishing knowledge exchange networks.	Faster adoption of green technologies, enhanced innovation capabilities, stronger competitive positioning, and improved technological solutions.	[9–12,51]

products and services. Firms investing in green supply chains, sustainable product differentiation, and lifecycle sustainability approaches gained a competitive advantage through increased market access and stronger customer loyalty [45,57]. However, financial and technological barriers remained significant constraints, particularly in regions where institutional support for sustainability was weak.

Research during this period highlights regional variations in green SME adoption, with studies identifying Zimbabwean SMEs leveraging industrial energy efficiency, Eastern European SMEs integrating green financing incentives, Thai SMEs adopting eco-innovation models, and Turkish SMEs incorporating humane entrepreneurship for sustainability performance [17,45,71]. These geographical trends illustrate how institutional environments shaped SME sustainability transitions across different economic and regulatory contexts.

4.1.3. Digital transformation phase (2020–2024): AI-Enabled sustainability and digital co-creation

The most recent phase (2020–2024) marks a paradigm shift in SME sustainability, with digital transformation emerging as a key enabler of green innovation [32]. SMEs have leveraged AI, IoT, and big data analytics to enhance environmental performance monitoring, waste reduction, and energy efficiency optimization [10,55]. These technological advancements enable SMEs to develop predictive capabilities, allowing for real-time sustainability adjustments and automated

Table 6
Sustainability performance outcomes of green dynamic capabilities and value co-creation in SMEs.

Sustainability Dimension	Outcome	Empirical Evidence	Types of SMEs
Environmental	Carbon footprint reduction and energy efficiency	[8] found that SMEs using AI-driven energy solutions reduced emissions by 15 % [11]. demonstrated that IoT-based carbon tracking cut energy waste by 20–30 % [10]. found that SMEs adopting renewable energy saw 12 % lower operational costs [13]. highlighted that AI-driven green process innovation enhanced both energy efficiency and environmental performance.	Manufacturing, renewable energy, logistics
	Waste reduction and circular economy adoption	[64] found that SMEs using circular economy models reduced waste by 40 % [21]. reported that closed-loop production cut landfill waste by 50 % [27]. highlighted that supplier collaboration reduced material costs by 15–25 % [25]. showed that green co-creation strategies in supply chains significantly improved waste reduction and resource sharing.	Agribusiness, food processing, packaging
	Eco-innovation and green product development	[54] found that ambidextrous SMEs were 30 % more likely to develop successful green products [20]. showed that stakeholder collaboration boosted SME market share by 20 % in eco-conscious sectors [9]. demonstrated that SMEs adopting green innovation saw both improved market positioning and stronger sustainability outcomes.	Consumer goods, electronics, textiles
Economic	Cost reduction via lean-green practices	Queiroz et al. [65] found that lean-green supply chains reduced costs by 10–18 %. Zaid & Sleimi (2023) reported 25 % waste disposal cost savings [57]. showed 12–16 % lower production costs due to environmental incentives [19]. found that green supply chain practices reduced waste management costs and improved resource efficiency among Thai SMEs.	Retail, manufacturing, supply chain
	Revenue growth through green	[27] found 15 % higher revenue for SMEs with sustainability certifications [63].	High-tech startups, service industries

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Table 6 (*continued*)

Sustainability Dimension	Outcome	Empirical Evidence	Types of SMEs
	market positioning	reported 10 % growth in exports for SMEs adopting green practices [22]. found 8–12 % sales growth among environmentally certified SMEs [54]. reported that firms with stronger green product innovation experienced sustained revenue growth and new market penetration.	
	Improved financial stability and green financing access	[66] reported 35 % lower interest rates for SMEs using green credit [26]. found 25 % higher investment inflows for SMEs using blockchain-based green finance [13]. showed that SMEs engaging in AI-driven green innovation and fintech-enabled financing experienced enhanced financial performance and investment attractiveness.	Fintech, emerging market SMEs
Social & Institutional	Employee engagement and workforce stability	[67] reported 20 % higher employee engagement in green SMEs [46]. found 35 % lower turnover rates in sustainability-driven firms [68]. highlighted that eco-management and eco-logistic innovations during the pandemic improved workforce stability and engagement in Malaysian SMEs.	Hospitality, education, professional services
	Community development and local economic impact	[45] documented that Zimbabwean SMEs engaged in green energy adoption contributed to local job creation, supporting up to 50 % of their workforce through sustainability initiatives [22]. found that Vietnamese SMEs partnering with local NGOs on sustainability projects saw 20 % higher community participation in environmental initiatives [69]. showed that South African SMEs engaging in green marketing and community partnerships strengthened local economic ties and social impact.	SMEs in developing regions, cooperative businesses
	Regulatory compliance and institutional legitimacy	[62] found that SMEs engaged in government sustainability programs experienced 40 % fewer regulatory compliance costs. Rodrigues & Franco (2023) showed that SMEs adopting eco-certifications and transparent sustainability reporting faced 30 % lower risk of regulatory fines and greater institutional credibility [62]. further emphasized that firms enhancing their resource efficiency through EU green deal programs improved institutional standing and policy compliance.	SMEs in regulated industries, certification-focused firms

regulatory compliance tracking [35].

Value co-creation mechanisms have evolved into digitally integrated sustainability ecosystems, where SMEs engage in AI-driven supply chain collaboration, blockchain-enabled green financing partnerships, and digital stakeholder platforms to co-develop sustainability solutions [27]. Access to green financing mechanisms has expanded through blockchain-enabled transparency and AI-powered risk assessment tools, allowing SMEs to secure investment for long-term sustainability initiatives.

Despite these advancements, barriers remain, including organizational resistance to digital transformation, high adoption costs, and knowledge gaps. Research on SMEs in Saudi Arabia, Nigeria, Indonesia, China, and the United States highlights regional variations in AI-enabled sustainability adoption, with Saudi SMEs integrating lean-green manufacturing, Nigerian SMEs advancing green supply chains, Indonesian SMEs enhancing financial sustainability, Chinese SMEs adopting AI-driven environmental tracking, and US SMEs exploring AI-based carbon neutrality strategies [26,53,63].

Successful SMEs in this phase have prioritized digital upskilling, established strategic collaborations, and developed AI-enhanced sustainability strategies, positioning themselves as leaders in the transition toward digitally enabled green economies [63]. These transformations underscore the growing convergence between digital innovation and green growth in SMEs, highlighting the increasing role of technological adaptability, collaborative ecosystems, and financial innovation in driving sustainability transitions.

4.2. RQ2: How do green dynamic capabilities and value co-creation interact to drive sustainable practices in SMEs?

The interaction between green dynamic capabilities and value co-creation plays a critical role in shaping sustainable practices in SMEs. Unlike large corporations that can allocate extensive resources toward sustainability initiatives, SMEs must strategically develop dynamic capabilities—the ability to sense opportunities, seize resources, and transform business models—to integrate environmental considerations into their operations [28,42]. At the same time, value co-creation enables SMEs to engage with stakeholders, including customers, suppliers, financial institutions, and regulators, to collaboratively generate sustainability solutions [20,29]. The synergy between green dynamic capabilities and stakeholder collaboration fosters innovation, resilience, and competitive advantage in SME sustainability transitions.

Green dynamic capabilities allow SMEs to identify and act on sustainability opportunities through three core dimensions: (1) sensing environmental trends and regulatory shifts, (2) seizing financial and technological resources, and (3) transforming business models to integrate sustainability into long-term strategies [28,57]. SMEs with strong market-sensing capabilities proactively adopt circular economy

practices, green certifications, and waste-reduction strategies [32,49,50]. The ability to balance exploration of new technologies with the exploitation of existing processes—referred to as ambidexterity—has further strengthened SMEs' dynamic capabilities, enabling them to drive green product innovation and sustainability outcomes [14]. However, financial and technological constraints often hinder implementation. Firms overcome these barriers by leveraging green financing mechanisms such as sustainability-linked loans and AI-driven cost-saving technologies [10,27]. Bibliometric trends confirm that SMEs are increasingly integrating dynamic capabilities to support sustainable business innovation and eco-innovation [9]. This is particularly critical in emerging economies, where capital shortages restrict sustainability investments, making tailored financing a key enabler of green transitions. Beyond acquiring resources, SMEs must reconfigure internal processes to ensure sustainability initiatives align with core operations, enhancing adaptability and resilience to regulatory and market shifts [35,53].

While dynamic capabilities form the internal foundation for sustainability, value co-creation acts as an external enabler, embedding SMEs within collaborative sustainability ecosystems [15,72]. SMEs engage in value co-creation through three mechanisms:

SMEs that co-develop eco-friendly products and sustainable production methods enhance both environmental and market performance [21]. Green supply chain partnerships improve resource optimization and knowledge-sharing, helping SMEs overcome financial and technological barriers [27]. Collaborative green co-creation strategies between supply chain partners—including manufacturers, suppliers, competitors, and retailers—facilitate shared investment and risk in green innovation efforts [25]. Moreover, supplier engagement and green distribution significantly strengthen collaborative green value chains [19].

Public-private partnerships in Europe and Southeast Asia provide SMEs with subsidies, certifications, and advisory support, reinforcing institutional infrastructure for green growth [22,48]. In emerging economies, environmental incentives such as tax concessions and eco-material discounts are increasingly shaping green responsiveness [57]. However, institutional gaps remain in many contexts, requiring stronger policy frameworks to broaden SME participation [17].

The rise of AI-driven environmental tracking, blockchain transparency, and digital green financing has transformed SME sustainability efforts [10,55]. AI-driven green process innovation acts as a strategic pivot for integrating sustainability with financial and environmental performance [13]. Blockchain adoption further enhances transparency in green energy and innovation practices, facilitating trust across SME ecosystems [56]. This shift is especially prominent in tech-enabled SMEs in China, Indonesia, and Saudi Arabia, where fintech solutions are reshaping access to green investments [26].

The Interaction between green dynamic capabilities and value co-creation must occur at multiple levels within SMEs to drive truly sustainable practices. Unlike large corporations with dedicated sustainability teams, SMEs rely on agility, adaptability, and stakeholder engagement to integrate sustainability into their business models [28,42]. While dynamic capabilities enable firms to sense, seize, and transform sustainability opportunities, value co-creation facilitates knowledge exchange, risk-sharing, and access to financial and technological resources [20,29]. For sustainability to be successfully embedded in SME operations, the interaction between these two elements must extend beyond strategic intent and permeate through all organizational levels, from leadership decision-making to operational execution and external stakeholder integration.

At the micro level, green dynamic capabilities enable SMEs to sense, seize, and reconfigure resources for sustainability [10]. demonstrate that firms with strong green dynamic capabilities are better positioned to implement sustainable practices, particularly in green supply chain management. These capabilities enhance operational efficiency while facilitating environmental innovation. The value co-creation process at this level involves internal stakeholder collaboration and knowledge integration, leading to improved environmental performance and business outcomes.

In modern industry, green dynamic capabilities play a crucial role at the industry network or *meso* level. At this level, companies, particularly SMEs, no longer operate in isolation but engage in complex collaborative networks to create sustainable value [10,16]. Recent research by Tian et al. [35] demonstrates how SMEs strategically leverage their capabilities to participate in industry networks, creating value through various shared sustainability initiatives that encompass resource optimization, infrastructure development, and sustainable supplier programs [12]. further emphasize how this network-level integration enables companies to achieve economies of scale in their sustainability efforts while reducing individual investment burdens.

The value created through collaboration at the industry network level manifests in various interconnected aspects [11]. Inter-organizational knowledge transfer and learning accelerates the adoption of sustainable practices while reducing learning curves [25,36]. The integration of technology and joint innovation fosters the development of more effective green solutions with shared costs and risks [19,56]. Meanwhile, coordinated supply chain integration enhances compliance and minimizes environmental impact [10,19]. The integration of technology and joint innovation fosters the development of more effective green solutions with shared costs and risks. Meanwhile, coordinated supply chain integration enhances compliance and minimizes environmental impact [10]. Additionally, collective market development and stakeholder engagement strengthen the industry position, leading to improved resource efficiency, accelerated capability development, broader environmental impact through collective action, and robust market positioning and stakeholder relationships [12,35].

At the macro level, green dynamic capabilities facilitate extensive stakeholder engagement and ecosystem-wide sustainability initiatives that transcend traditional organizational boundaries [16,62]. Research demonstrates that SMEs with advanced environmental capabilities are better positioned to orchestrate multi-stakeholder collaborations and create integrated sustainability solutions across their ecosystems [12,35]. This ecosystem-level integration enables firms to develop shared environmental infrastructure, coordinate sustainability initiatives across supply chains, and foster innovation networks that accelerate the adoption of green practices across industries [11,36]. Public-private partnerships and government incentives further enhance SME ecosystem participation by addressing institutional and financial barriers [22,48,57]. Additionally, cross-national studies show that SMEs in developing and emerging markets—such as Thailand, Nigeria, and Vietnam—leverage ecosystem collaborations to overcome resource limitations and drive broader environmental and social outcomes through collective learning, supply chain alignment, and stakeholder engagement [19,63,71].

The value created through ecosystem-level engagement manifests in several key dimensions that enhance overall environmental performance. SMEs leverage their capabilities to establish collaborative platforms that facilitate knowledge sharing and joint problem-solving among diverse stakeholders [10,12]. These platforms enable the development of integrated sustainability solutions that address complex environmental challenges through coordinated action. Furthermore, ecosystem-wide collaboration leads to shared value creation across supply chains, as firms work together to implement sustainable practices and reduce their collective environmental impact [16]. The resulting innovation ecosystems accelerate theeveloppment and diffusion of green technologies while strengthening the competitive position of participating firms [11,35].

4.2.1. Mediating mechanisms in the interaction between green dynamic capabilities and value co-creation

The interaction between green dynamic capabilities and value co-creation in SMEs does not occur in isolation but is influenced by

several mediating mechanisms that enable or constrain sustainability adoption. These mechanisms emerge across diverse institutional and market contexts, shaping how SMEs translate their internal capabilities and stakeholder collaborations into sustainable business practices. By analyzing existing literature, key mediating mechanisms can be identified, including knowledge absorption, financial accessibility, digital transformation, institutional support, and market pressure.

Absorptive capacity—the ability to acquire, assimilate, and apply external knowledge—emerges as a fundamental mediator in the literature on SME sustainability transitions. While green dynamic capabilities provide SMEs with the ability to sense and seize sustainability opportunities, these capabilities are only effective if firms can integrate sustainability-related knowledge obtained through co-creation processes (Cohen & Levinthal, 1990; [57]. Several studies highlight that SMEs engaged in supplier collaborations, customer feedback loops, and industry networks are better positioned to internalize sustainability insights and convert them into actionable green strategies [9,35]. For instance, [21] illustrate how SMEs in circular economy industries enhance their sustainability performance by co-creating knowledge with suppliers and customers, leading to innovations in product design, resource efficiency, and waste reduction. This learning-based co-creation process fosters a deeper integration of sustainability across SME operations, demonstrating that absorptive capacity acts as a bridge between green capabilities and effective implementation.

A major constraint faced by SMEs in their sustainability transitions is limited access to financial resources, which frequently prevents them from fully deploying green dynamic capabilities. Multiple studies identify financial accessibility as a critical mediating mechanism in this interaction [25]. While green dynamic capabilities enable SMEs to identify sustainability opportunities, implementation often requires substantial investment in eco-friendly technologies, sustainable raw materials, and certification processes. Value co-creation mechanisms, particularly partnerships with financial institutions and sustainability-focused government programs, help mitigate these financial barriers by providing access to green financing options such as sustainability-linked loans, subsidies, and public-private green investment networks [22,27]. Empirical research in emerging markets finds that SMEs engaged in co-creation with banks and impact investors are more likely to secure funding for sustainability projects, underscoring the role of financial collaboration in mediating capability development and green practice adoption [17].

Technological advancements are reshaping how SMEs leverage green dynamic capabilities and engage in value co-creation, positioning digital transformation as a key mediator in sustainability transitions. The literature emphasizes that SMEs utilizing AI, IoT, and digital sustainability solutions are better able to implement resource-efficient processes, track environmental performance, and strengthen supply chain transparency [10,13,55]. Simultaneously, digitalization expands opportunities for value co-creation by enabling SMEs to collaborate with stakeholders through digital platforms [26]. highlight how SMEs in China, Indonesia, and Saudi Arabia leverage fintech solutions and digital green financing to scale their sustainability efforts. Moreover, digitally enabled co-creation mechanisms—such as virtual supplier collaborations, AI-driven consumer engagement—enhance SMEs' ability to integrate sustainability into business models [19,20].

Institutional environments, including regulatory frameworks and policy incentives, are consistently identified as mediating factors in SME sustainability adoption [48]. and [17] find that SMEs operating in regions with strong policy incentives—such as eco-certifications, sustainability tax benefits, and mandated environmental standards—are more likely to integrate green dynamic capabilities into their business models. Conversely, research on SMEs in emerging economies indicates that weak institutional support creates additional barriers to sustainability adoption, leading firms to rely more heavily on industry-led co-creation networks and voluntary sustainability initiatives [27,62]. Public-private partnerships and industry sustainability alliances play an important role in mediating these challenges by providing SMEs with regulatory guidance, knowledge-sharing platforms, and structured pathways for sustainability compliance [22].

Sustainability is increasingly being driven by market forces, positioning consumer preferences, industry competition, and global value chain expectations as significant mediators in SME green transitions. Literature on sustainability-driven business models emphasizes that firms experiencing heightened consumer demand for eco-friendly products are more likely to develop green dynamic capabilities and co-create sustainability solutions with stakeholders [14,21]. Competitive differentiation through sustainability branding has become a major driver of SME innovation, particularly in industries where environmental responsibility is a key purchasing criterion [20]. Moreover, [27] highlight how SMEs embedded in global value chains face external pressures from multinational corporations to adhere to green supply chain standards, further reinforcing sustainability adoption. This market-driven mediation effect suggests that SMEs integrating sustainability into their brand identity and supply chain collaborations are more likely to achieve long-term green growth [63] (Fig. 2).

The interaction between green dynamic capabilities and value co-creation in SMEs is not a linear process but rather a complex, multilevel dynamic influenced by mediating mechanisms. These mechanisms—knowledge absorption and financial innovation—serve as crucial enablers, ensuring that SMEs effectively integrate sustainability into their operational models. Fig. 3 illustrates this conceptual framework, depicting the interplay between value co-creation, green dynamic capabilities, and mediating mechanisms in driving sustainable practices in SMEs. Knowledge absorption facilitates the internalization of sustainability practices by enabling SMEs to acquire, integrate, and apply external knowledge gained through stakeholder engagement. Meanwhile, financial innovation enhances SMEs' ability to mobilize resources, allocate investments strategically, and scale green initiatives. These mediators act as reinforcing loops, continuously shaping and refining the relationship between dynamic capabilities and co-creation efforts.

4.3. RQ3: How do green dynamic capabilities and value co-creation drive sustainable performance outcomes in SMEs?

The integration of green dynamic capabilities and value co-creation in SMEs has been shown to result in tangible sustainability outcomes across environmental, economic, and social-institutional dimensions. Unlike large corporations with abundant resources, SMEs must strategically leverage internal competencies and external stakeholder collaboration to achieve long-term sustainable growth. This section explores the key performance outcomes that emerge when SMEs align dynamic capabilities with value co-creation mechanisms, enabling them to navigate sustainability transitions effectively.

4.3.1. Environmental performance outcomes

SMEs that successfully integrate sustainability principles into their business models achieve significant environmental improvements, particularly in carbon footprint reduction, circular economy adoption, and eco-innovation. One of the most critical outcomes is reduced carbon emissions and improved energy efficiency. SMEs that implement AI-driven energy management systems, IoT-enabled environmental monitoring, and advanced carbon tracking experience substantial declines in emissions [11,13,35]. Additionally, SMEs that collaborate with government agencies and financial institutions secure sustainability funding, enabling them to transition toward cleaner production processes and energy-efficient operations [10,36,57].

Another key environmental benefit is the adoption of circular economy strategies, which significantly enhances resource efficiency and waste reduction. SMEs that integrate material flow cost accounting and sustainable sourcing strategies report notable improvements in waste management and resource optimization [21,25,64]. Through

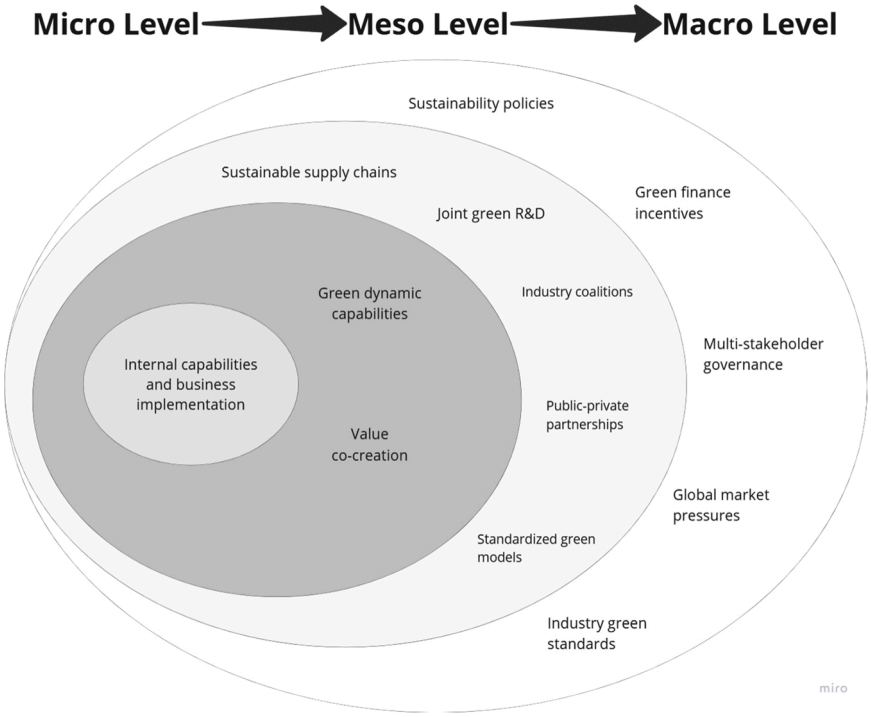

Fig. 2. Multi-level interaction of green dynamic capabilities and value co-creation.

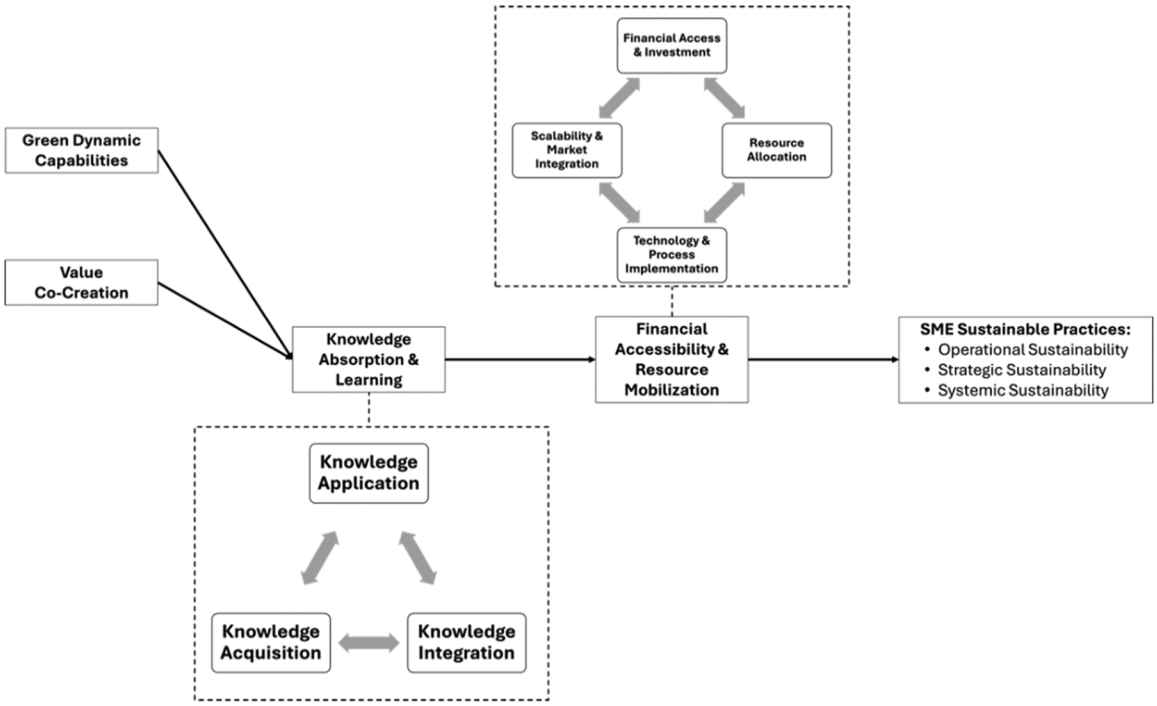

Fig. 3. General framework of green dynamic capabilities and value co-creation for SME sustainability.

stakeholder collaboration, SMEs develop closed-loop production systems, allowing them to repurpose waste into new materials and reintegrate them into the supply chain [27,63].

Furthermore, SMEs that invest in eco-innovation and green product development achieve dual benefits—enhanced sustainability performance and increased market competitiveness. Firms that co-develop green products with customers and suppliers capitalize on the growing demand for sustainable solutions, securing long-term business viability [9,20,54]. Additionally, adopting eco-friendly branding strengthens consumer trust, making SMEs more attractive to sustainability-conscious customers.

4.3.2. *Economic performance outcomes*

SMEs that develop green dynamic capabilities and engage in value co-creation gain not only environmental advantages but also substantial economic benefits, particularly in cost efficiency, market expansion, and

financial stability. One of the most immediate and measurable financial gains is cost reduction through improved resource efficiency. By integrating lean-green supply chain strategies, SMEs can lower operational costs by reducing material waste and optimizing energy use [19,65]. Moreover, research highlights that the long-term financial savings from sustainability investments often exceed initial costs, especially when SMEs collaborate with industry partners to co-develop cost-effective green solutions [57,73].

Beyond cost efficiency, sustainability-oriented SMEs experience notable revenue growth and market expansion. Engaging in eco-certifications, green financing programs, and partnerships with sustainability-conscious investors provides access to premium markets, allowing SMEs to differentiate their products, command higher prices, and expand their reach [27,52,54]. The credibility gained through sustainability commitments fosters stronger customer trust, which in turn enhances brand reputation and long-term customer loyalty [17,22].

As sustainability becomes increasingly tied to financial resilience, SMEs that integrate green initiatives strengthen their financial stability and investment appeal. Access to green finance mechanisms, such as sustainability-linked loans and digital-enabled financial transparency, significantly improves their creditworthiness and ability to attract investors [13,18,66]. Additionally, digital innovations in financial reporting and risk assessment further position these SMEs as reliable and forward-thinking investment opportunities, ensuring greater capital inflows and long-term financial security [17,26].

4.3.3. Social and institutional sustainability outcomes

SMEs that embed sustainability into their core strategies gain extensive social and institutional benefits, reinforcing their long-term resilience while strengthening community ties and workforce stability. One of the most significant social outcomes is the development of a sustainability-driven organizational culture. Research by [67] and [46] shows that SMEs implementing green human resource management (HRM) practices foster stronger employee engagement and commitment to sustainability goals. Employees actively involved in co-creative sustainability efforts experience higher job satisfaction and lower turnover rates, ultimately contributing to a more stable and motivated workforce [68,74].

In addition to internal improvements, SMEs engaged in sustainability-driven partnerships play a crucial role in local economic stability and community development. Firms that collaborate with public institutions, NGOs, and local businesses help create green jobs, support sustainable supply chains, and launch community-based environmental programs [22,45,69]. These collaborative sustainability initiatives position SMEs as responsible corporate citizens, strengthening their reputation, stakeholder relationships, and social license to operate.

At the institutional level, regulatory compliance and legitimacy become key sustainability outcomes. SMEs that proactively integrate environmental measures into their operations mitigate risks associated with regulatory penalties, legal challenges, and reputational damage [62]. Moreover, firms participating in government-backed sustainability programs and industry-led eco-certifications enhance their institutional credibility, improving their chances of securing long-term partnerships and funding opportunities [17,27,62]. By staying ahead of evolving regulatory frameworks, SMEs future-proof their operations, ensuring their long-term viability in an increasingly sustainability-driven economy.

5. Developing a green dynamic capabilities and value co-creation framework for sustainable SME performance

This study explores how green dynamic capabilities and value co-creation drive SME sustainability through adaptability, innovation, and collaboration. SMEs progress through three phases: Early Adoption (2011–2014), focused on compliance; Growth & Standardization (2015–2019), integrating sustainability as a strategy; and Digital Transformation (2020–2024), leveraging AI, IoT, and green financing. Green capabilities develop through trend sensing, resource mobilization, and business model reconfiguration, while value co-creation evolves from compliance to multi-stakeholder collaboration. At the micro level, SMEs implement green supply chain management; at the *meso* level, they engage in industry networks for R&D and certifications; and at the macro level, they align with policies and global value chains. Mediators such as financial access, digital transformation, and institutional support enhance sustainability outcomes, including environmental (carbon reduction, energy efficiency), economic (cost savings, revenue growth), and social (community engagement, regulatory compliance) benefits, strengthening long-term competitiveness.

The conceptual framework in Fig. 4 illustrates the interaction between green dynamic capabilities, value co-creation, and sustainable performance. Green capabilities enable SMEs to sense sustainability trends, seize financial and technological resources, and transform business models, supply chains, and internal processes. These are reinforced through stakeholder collaboration (customers, suppliers, government agencies), technology integration (AI, IoT, blockchain for efficiency and green innovation), and market engagement (regulatory alignment, industry initiatives, and public-private partnerships). When effectively integrated, these mechanisms yield measurable sustainability outcomes—environmental benefits (lower emissions, resource efficiency, circular economy adoption), economic advantages (cost savings, revenue growth, investor attractiveness), and social impacts (workforce engagement, community development, regulatory compliance). External support, including financial accessibility, policy incentives, and market demand, further strengthens SME sustainability transitions.

The conceptual framework also highlights the role of mediating factors in shaping both value co-creation mechanisms and sustainable performance outcomes in SMEs. Knowledge absorption, financial accessibility, and digital transformation directly enhance value co-creation by enabling SMEs to collaborate with stakeholders, integrate advanced technologies, and align with institutional requirements for sustainability. These elements provide the necessary foundation for SMEs to effectively engage in co-development efforts, secure financial backing, and leverage digital tools to drive green innovation. On the other hand, institutional support and market pressure have a more direct impact on sustainable performance outcomes by influencing regulatory compliance, financial incentives, and consumer-driven sustainability demands. Strong institutional backing ensures that SMEs benefit from structured policies and industry-led sustainability programs, while market pressure reinforces the need for firms to adopt sustainable practices to remain competitive. Together, these mediating mechanisms ensure that SMEs can bridge the gap between capability development, collaborative value creation, and measurable sustainability achievements.

5.1. Future research directions for green growth in SMEs

Building on our analysis of SME sustainability transitions, we identify four key directions for future research that warrant systematic investigation (Table 7). These directions address critical gaps in current understanding while providing structured pathways for advancing knowledge in this field. The first direction emphasizes the need to examine multiple levels of analysis along with temporal dynamics and competing priorities in SME sustainability adoption. The second direction focuses specifically on how temporal aspects and shifting priorities influence implementation outcomes over time. The third direction calls for more balanced theoretical and empirical approaches to resolve existing research conflicts. Finally, the fourth direction addresses fundamental methodological challenges that need to be overcome to advance research in this domain. Each direction encompasses specific research questions and observations that can guide future scholarly inquiry, as detailed in Table 7.

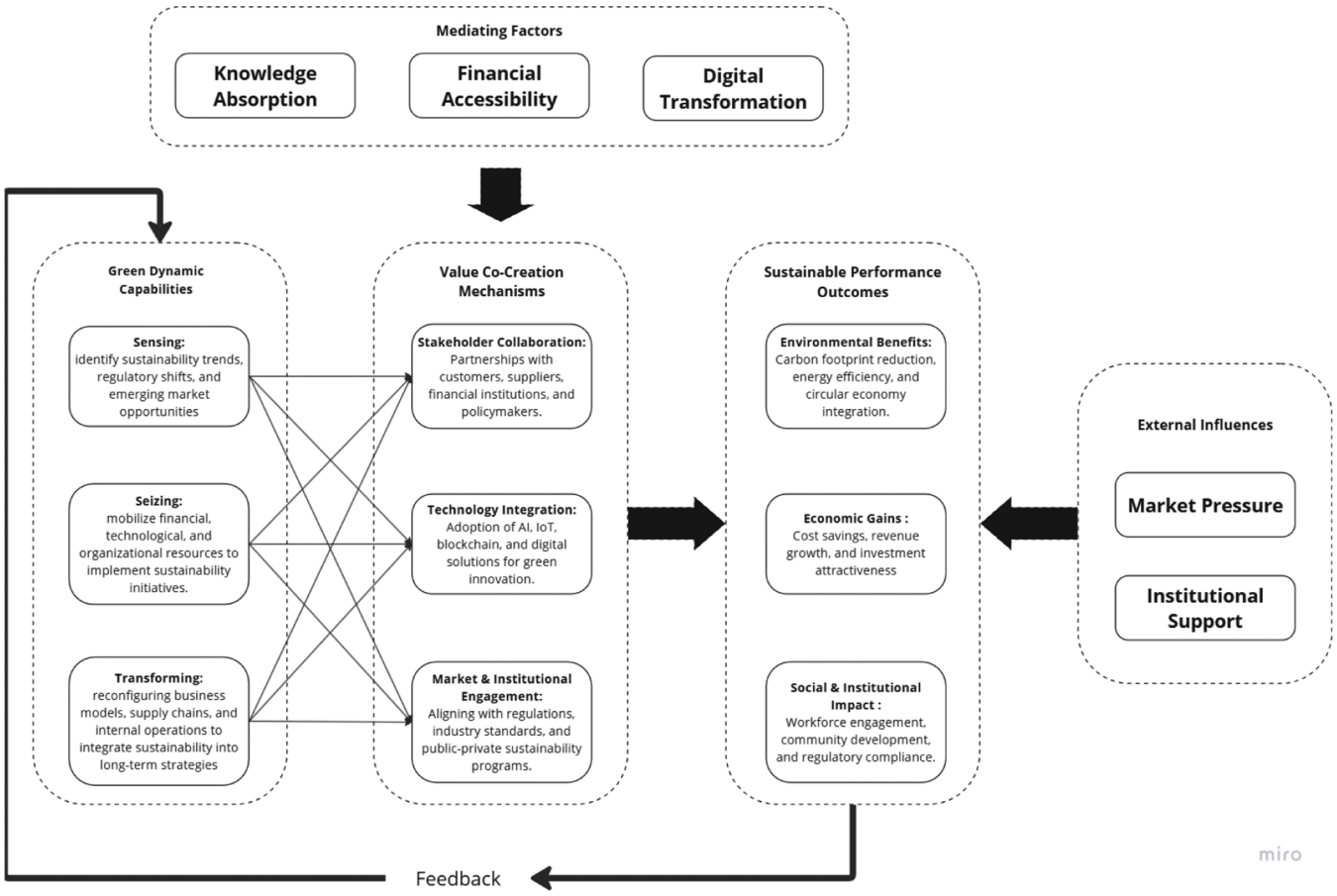

Fig. 4. Green dynamic capabilities and value co-creation framework for SMEs.

6. Conclusion

This study explores how green dynamic capabilities and value co-creation drive SME sustainability through adaptability, innovation, and collaboration, revealing a complex evolutionary journey from compliance-driven approaches to digitally-enabled transformative strategies. SMEs progress through three critical phases—Early Adoption (2011–2014), characterized by regulatory compliance; Growth & Standardization (2015–2019), integrating sustainability as a strategic imperative; and Digital Transformation (2020–2024), leveraging advanced technologies like AI, IoT, and sophisticated green financing mechanisms. Green capabilities develop through sophisticated trend sensing, strategic resource mobilization, and dynamic business model reconfiguration, while value co-creation evolves from minimal regulatory interactions to comprehensive multi-stakeholder collaborations. The research demonstrates that successful SMEs operate across multiple levels—micro (internal process optimization), *meso* (industry network engagement), and macro (ecosystem-wide sustainability alignment)—by integrating green dynamic capabilities with collaborative value creation. Mediating factors such as financial accessibility, digital transformation, and institutional support critically enhance sustainability outcomes, enabling SMEs to achieve measurable environmental benefits (carbon reduction, resource efficiency), economic advantages (cost savings, market expansion), and social impacts (workforce engagement, community development). Ultimately, the study provides a nuanced framework illustrating how SMEs can strategically navigate sustainability transitions, positioning themselves as adaptive, innovative actors in the global movement toward a more sustainable economic landscape.

6.1. Implications for policy and practice

The findings highlight the importance of green dynamic capabilities and value co-creation in driving sustainable SME performance, requiring a balance of internal capability development, external collaboration, and institutional support. SMEs must enhance their ability to sense sustainability trends, seize financial and technological resources, and transform business models, leveraging digital technologies such as AI, IoT, and blockchain to optimize sustainability outcomes. Strategic collaborations with suppliers, customers, financial institutions, and regulators are essential for overcoming resource constraints and scaling green initiatives. Policymakers should facilitate SME sustainability transitions through financial incentives, regulatory frameworks, and public-private partnerships (PPPs), providing access to sustainability-linked loans, carbon credit financing, and green investment incentives while implementing eco-certifications, tax incentives, and capacity-building programs. Industry and financial institutions must also contribute by developing tailored green financing mechanisms, fostering collaborative ecosystems, and encouraging SMEs to engage in green supplier programs, circular economy initiatives, and responsible sourcing partnerships. By aligning policies, financing, and industry collaborations with the conceptual framework, stakeholders can create a scalable, resilient ecosystem that enables SMEs to integrate sustainability into their core strategies effectively.

6.2. Limitations of the research

Several limitations should be acknowledged in this systematic review. First, our search was limited to the Scopus database, which, despite its comprehensive coverage of social sciences literature, may

Table 7
Directions for future research.

Direction	Sample Research Questions and Observations
Continue the level-of-analysis, temporal dynamism, and priority lenses	1. How do individual SME, team, and system dynamics influence green capability development over time? 2. What are the forces across different levels affecting sustainability adoption? 3. How are individual traits and environmental requirements enabling or hindering adoption? 4. When do green capabilities and value co-creation processes align/misalign at individual, team, and system levels? 5. How does the tension between economic priorities and sustainability goals affect implementation? 6. When do various priorities compete with each other, and what is the effective team configuration that eliminates these tensions? 7. How does changing temporal dynamism and priority lenses affect adoption patterns?
Continue the temporal dynamism and priority focus	1. How do changes in error priority over time affect organizational timing and speed? 2. How do competing priorities affect institutional responses? 3. How do specific contextual factors influence implementation effectiveness? 4. How do shifting sustainability priorities help achieve balance between competing goals? 5. How do multilevel priorities work together to achieve balanced outcomes? 6. Does standardization vs. flexibility over time influence sustainability success?
Adopt a balanced view when theorizing and carrying out empirical research	1. Investigate both the costs and benefits of green capability development. 2. Study the relationships between sustainability strategies and performance outcomes. 3. How can research be integrated in a balanced way to eliminate conflicts? 4. How can different priorities be integrated in a balanced approach to drive adoption?
Deal with methodological challenges	1. Better measurement and more accurate ways to assess sustainability outcomes. 2. Development of standardized metrics for green capabilities. 3. Improved methods for evaluating value co-creation effectiveness. 4. Enhanced approaches for measuring latent factors in adoption.

have excluded relevant studies indexed in other academic databases such as Web of Science, PubMed, or discipline-specific repositories. Second, we restricted our analysis to English-language publications, which may have resulted in the exclusion of potentially valuable studies published in other languages, particularly those from non-English speaking regions where SME green economy research might offer different cultural and contextual perspectives. Third, while we employed an expanded search strategy that included multiple terminological variations for small and medium enterprises, there remains the possibility that alternative terms, phrases, or emerging concepts used in the literature were not captured in our Boolean search string, potentially leading to the omission of relevant studies. Fourth, our focus on peer-reviewed journal articles, while ensuring academic rigor, excluded conference proceedings, working papers, and grey literature that might contain valuable insights, particularly regarding recent developments and practical applications in SME green dynamic capabilities. Finally, the systematic screening process, despite following established PRISMA guidelines, involved subjective judgment in relevance evaluation, which could have influenced the final selection of studies included in our analysis.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Aghnia Nadhira Aliya Putri: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Pri Hermawan:** Writing – review & editing, Visualization, Supervision, Conceptualization. **Isti Raafaldini Mirzanti:** Writing – review & editing, Resources, Methodology, Investigation. **Maureen Meadows:** Supervision, Formal analysis, Conceptualization. **Rosie Sadraei:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

The authors declare no conflicts of interest regarding the publication of this paper, Exploring Green Growth in SMEs: Global Trends, Challenges, and Future Directions. The research was conducted independently, and no financial support or personal relationships have influenced the results or interpretation of the data. The authors have no affiliations with organizations or entities that may have an interest in the subject matter discussed in this manuscript.

Data availability

No data was used for the research described in the article.

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