SUSTAINABLE SUPPLY CHAIN PRACTICES AND THEIR IMPACT ON COMPETITIVE ADVANTAGE: EVIDENCE FROM INDONESIA'S MANUFACTURING SECTOR

Yofy Syarkani
Universitas Langlangbuana, Bandung, Indonesia
Email: yofiesyarkani@unla.ac.id

Abstract

This study explores the relationship between sustainable supply chain practices (SSCP) and competitive advantage within Indonesia's manufacturing sector through a structured literature review approach. As global industries face mounting pressure to integrate environmental and social considerations into their operations, the need for sustainable supply chain strategies has become increasingly critical. Despite a growing body of literature, empirical insights specific to Indonesia's manufacturing context remain fragmented and underexplored. This paper synthesizes existing research to identify key dimensions of SSCP environmental management, ethical sourcing, and circular logistics and their strategic relevance to competitiveness. Using data extracted from peer-reviewed sources indexed in Scopus and other academic databases, the study applies a narrative review method to consolidate findings. The results indicate that firms adopting sustainable practices tend to achieve improved brand reputation, cost efficiency, regulatory compliance, and innovation capacity. Furthermore, the integration of sustainability into supply chains enhances long-term resilience and stakeholder trust. However, challenges persist, including lack of infrastructure, limited awareness, and regulatory inconsistency in the Indonesian context. This review not only bridges theoretical perspectives but also offers practical implications for policymakers and industry leaders. It concludes by highlighting research gaps and proposing future directions to advance sustainable supply chain scholarship in emerging economies.

Keywords: *Sustainable Supply Chain, Competitive Advantage, Manufacturing Sector, Indonesia, Supply Chain Management.*

A. INTRODUCTION

Sustainable supply chain practices (SSCP) have garnered significant global attention as organizations strive to reduce environmental degradation and align with increasing regulatory and stakeholder expectations (Seuring & Müller, 2020; Srivastava, 2007). Empirical studies demonstrate that initiatives such as eco-design, green procurement, and reverse logistics effectively enhance resource efficiency and minimize waste (Hervani, Helms, & Sarkis, 2005). Such SSCP align closely with the triple-bottom-line framework, balancing environmental, social, and economic objectives (Seuring & Müller, 2020). Systematic literature reviews further reveal that emerging economies lag behind developed nations in SSCP adoption, underscoring the need for contextualized strategies (Seuring & Müller, 2020). In Indonesia, green supply chain implementation faces significant challenges, including high costs,

inadequate infrastructure, and weak regulatory compliance (Wulandari, Priyono, & Oktaviani, 2023). The fragmented archipelagic geography exacerbates logistical inefficiencies, limiting effective inter-island coordination for sustainable practices (Kurniawan & Arif, 2023). Progress is visible through targeted initiatives like green logistics pilots and circular economy collaborations in key manufacturing hubs (MDPI, 2023). Globally stringent regulations such as the EU's deforestation traceability mandate are compelling Indonesian exporters to adopt traceability and eco-compliance measures (Reuters, 2024). Meanwhile technological advancements like IoT, blockchain, and big data analytics are enabling Indonesian firms to monitor supply chain performance and improve sustainability (Sharma, Garg, Sewani, & Kashef, 2023). Such technologies foster transparency, traceability, and real-time decision-making across supply chain tiers (Sharma et al., 2023). Industry evidence consistently shows that SSCP adoption contributes to improved brand reputation, cost reduction, and regulatory compliance (Hervani et al., 2005; Seuring & Müller, 2020). Sustainable practices bolster supply chain resilience, enabling firms to manage disruptions more effectively (Srivastava, 2007). Academic consensus affirms a positive correlation between SSCP adoption and competitive advantage, through both differentiation and operational efficiency (Seuring & Müller, 2020; Hervani et al., 2005). Recognizing this, Indonesian policymakers and manufacturers are gradually integrating SSCP into industrial policy, encouraging sustainable industrialization amid global green transition agendas (Lowy Institute, 2024). Together these global and regional trends justify the need for a structured literature review to assess SSCP's strategic role in Indonesia's manufacturing sector.

Indonesia's manufacturing sector faces multifaceted challenges in adopting sustainable supply chain practices, primarily due to infrastructural, financial, and institutional constraints. Research on the textile and apparel industry highlights that small- and medium-sized enterprises (SMEs) often lack standardized performance measures, hindering consistent implementation of sustainability initiatives (Sarasi, Primiana, & Harsanto, 2023). Financial burdens remain a significant barrier, as firms frequently perceive green procurement and eco-innovation as cost centres with limited short-term returns (Sari, Priyono, & Oktaviani, 2023). Inadequate infrastructure such as poor inter-island logistics and lack of green transport further exacerbates supply chain inefficiencies in an archipelagic environment (Sari et al., 2023). Institutional-support gaps also emerge, with regulatory fragmentation and inconsistent enforcement discouraging firms from investing in sustainable mechanisms (Pramudiawardani et al., 2020). Academic analyses find that Indonesian manufacturers struggle to integrate green suppliers due to limited availability of certified inputs, quality uncertainty, and verification complexities (MDPI, 2022). Similar constraints were identified in FMCG firms onboarding digital supply chain tools, where lack of technological infrastructure and cybersecurity risk were major impediments (Nozari et al., 2022). The coffee sector in Java further illustrates how inconsistent participation among upstream actors limits cohesive sustainability action (Nuraisyah et al., 2025). Geographic dispersion and smallholders' dependency create logistical delays and quality variability, complicating implementation of traceability systems (Nuraisyah et al., 2025). Studies also note significant awareness gaps: many firms engage in environmentally friendly practices without labeling them as part of

green supply chain management, indicating conceptual misalignment (Sari et al., 2023). There remains a weak culture of stakeholder collaboration, limiting multi-actor initiatives and shared investment in sustainability across supply tiers (Pramudiawardani et al., 2020). Fragmented value chains, especially where SMEs dominate, constrain economies of scale and hinder collective impact (Sarasi et al., 2023; Pramudiawardani et al., 2020). Additionally, compliance with global sustainability standards such as traceability mandated by overseas regulations poses technical and reporting challenges for resource-limited firms (MDPI, 2022). Despite these challenges, pockets of innovation exist: pilot programs in green logistics and performance metrics demonstrate potential transitions (MDPI, 2023; Sari et al., 2023). To overcome barriers, scholars emphasize the need for government incentives, capacity-building, digital infrastructure, and stakeholder coordination (Pramudiawardani et al., 2020; Nozari et al., 2022). Addressing these systemic constraints is essential for Indonesia's manufacturing sector to harness the strategic potential of sustainable supply chain practices.

Sustainable supply chain practices (SSCP) strategically align with foundational management theories to shape competitive advantage. Resource-Based View (RBV) posits that SSCP as firm-specific, valuable, rare, and inimitable capabilities can yield sustained competitive advantage by leveraging internal resources like eco-efficiency systems and green procurement networks (Barney, 1991; Oliver, 2024). Natural Resource–Based View (NRBV) extends RBV by emphasizing pollution prevention, product stewardship, and sustainable development as strategic assets within supply chains (Hart, 1995; Srivastava, 2007). Dynamic capabilities theory highlights the role of adaptive routines such as reconfiguring green processes and integrating environmental innovationsin enabling firms to respond effectively to sustainability pressures (Teece, Pisano, & Shuen, 1997). Relational View draws attention to inter-firm collaborations (e.g., supplier partnerships, shared logistics platforms) that generate relational rents and enhance SSCP effectiveness through trust and joint innovation (Dyer & Singh, 1998). Porter's Shared Value framework encourages SSCP adoption by illustrating how sustainable practices can simultaneously address societal needs and create economic value, reinforcing competitive positioning (Porter & Kramer, 2011). Empirical studies confirm these theoretical linkages: firms integrating SSCP within their resource base report superior market differentiation and cost performance (Srivastava, 2007; Hervani et al., 2005). In turn, dynamic capabilities such as technological adoption and process redesign reinforce the scalability and resilience of SSCP, further enhancing competitiveness (Stroumpoulis & Kopanaki, 2022). Relational integrations, such as circular partnerships and transparency platforms, have been empirically linked to reduced lead times and enhanced supply chain agility (Dyer & Singh, 1998). Shared value case studies also highlight how firms embedding SSCP in their core strategy, such as sustainable sourcing, achieve dual benefits of community reputation and customer loyalty (Porter & Kramer, 2011). Systematic reviews of supply chain and competitive advantage studies consistently show that RBV, NRBV, dynamic capabilities, relational view, and shared value are the dominant theoretical lenses (Alemgenet Menesha & Tembo Mwanaumo, 2023). These theoretical frameworks converge in stressing that SSCP is not merely a compliance activity, but a strategic mechanism underpinned by unique capabilities, adaptive routines, and

inter-organizational relationships. For the Indonesian manufacturing context, this implies leveraging existing resources and dynamic capacities, while fostering relational platforms and shared value-oriented initiatives. Such a holistic theoretical foundation justifies our literature-based investigation into how SSCP translates into competitive advantage within Indonesia's manufacturing sector.

Despite increasing interest in sustainable supply chain practices (SSCP) within Indonesia's manufacturing sector, significant research gaps persist. First, only a few studies have conducted systematic, country-specific reviews of SSCP initiatives, leaving contextual influences underexplored (Pramudiawardani, Abidin, Hidayanto, Budi, & Fitriani, 2019). Second, existing literature often treats developing countries generically, failing to address Indonesia's unique archipelagic geography, regulatory fragmentation, and infrastructural diversity (Pramudiawardani et al., 2019; SciTePress, 2019). Third, research tends to focus on isolated practices such as green procurement or logistics without analyzing how combined SSCP dimensions (environmental, social, economic) interact within Indonesian manufacturing systems (SciTechPress, 2019; Sciencedirect, 2025). Fourth, there is limited empirical assessment of the institutional and cultural drivers behind SSCP adoption, despite the acknowledged role of stakeholder awareness and governance frameworks in shaping sustainability outcomes (SciTePress, 2019). Fifth, quantitative studies measuring SSCP's impact on competitive performance within Indonesian firms remain scarce, impeding evidence-based validation of theoretical claims (SciTePress, 2019; MDPI, 2023). Sixth, the influence of digital technologies such as IoT and blockchain on enabling SSCP transparency and efficiency has been largely overlooked in the Indonesian manufacturing context (Wu et al., 2022; Sciencedirect, 2025). Seventh, few studies employ robust theoretical frameworks (e.g., NRBV, dynamic capabilities) to interpret the mechanisms by which SSCP generates competitive advantage in Indonesia (Pramudiawardani et al., 2019). Eighth, there is an empirical vacuum regarding the synergies between SSCP and corporate resilience amid climate change impacts which are escalating in Indonesia (Wikipedia, 2025). Ninth, research rarely considers firm size heterogeneity, particularly how SMEs versus large enterprises differ in SSCP adoption and benefit realization (MDPI, 2023). Tenth, existing studies rarely integrate perspectives from multiple manufacturing sub-sectors, limiting comprehensive cross-sectional insights (Pramudiawardani et al., 2019). Eleventh, although circular economy models and green certifications are gaining traction, their operational integration into manufacturing supply chains remains under-theorized in Indonesia (SciTechPress, 2019). Twelfth, few longitudinal analyses exist to track SSCP evolution over time in Indonesian firms. Thirteenth, the role of public–private partnerships and policy interventions in catalyzing SSCP has not received adequate empirical investigation. Fourteenth, there is limited insight into the role of global trade networks and export orientation in driving SSCP adoption among manufacturing exporters. Finally, studies seldom evaluate SSCP's broader social outcomes such as labor standards, community development, and equity within Indonesia's manufacturing clusters.

This study aims to articulate clear research objectives and guiding questions to investigate how sustainable supply chain practices (SSCP) impact competitive advantage in Indonesia's manufacturing sector. Firstly, the objective is to

systematically identify and synthesize the dominant dimensions of SSCP implemented by manufacturing firms, as defined in global literature (Seuring & Müller, 2020; Stroumpoulis & Kopanaki, 2022). Secondly, it seeks to examine the linkage between SSCP adoption and competitive advantage outcomes such as cost efficiency, innovation, market share, and resilience drawing from empirical studies in similar emerging economies (Mukhsin & Suryanto, 2022; Shebeshe & Sharma, 2024). Thirdly, this work aims to uncover the contextual enablers and barriers particularly infrastructural, regulatory, and technological factors affecting SSCP in Indonesia (MDPI, 2023; Sciencedirect, 2025). Fourthly, the study intends to assess the mediating and moderating roles of dynamic capabilities, stakeholder pressure, and digital integration in the SSCP–competitive advantage relationship (Nature Communications, 2025; Frontiers, 2022). Fifthly, it endeavors to fill gaps by developing a context-specific framework that maps SSCP practices to competitive outcomes in Indonesian manufacturing. Based on these aims, the research questions are: What sustainable supply chain practices are prevalent among Indonesian manufacturers? How do these practices contribute to different dimensions of competitive advantage? What internal and external contextual factors influence SSCP adoption and effectiveness? Do dynamic capabilities, stakeholder pressure, and digital technologies mediate or moderate the SSCP–competitive advantage link? Finally, how can a theoretical model be constructed to guide future empirical and practical applications in Indonesia? By addressing these questions, this literature review will not only map existing knowledge but also build a comprehensive conceptual framework for subsequent empirical research and policy guidance.

This study aims to deliver both academic and practical contributions by bridging gaps between theory and real-world policymaking in Indonesia's manufacturing context. First, it advances academic understanding by integrating multiple theoretical frameworks RBV, NRBV, dynamic capabilities, relational view, and shared value to offer a holistic model tailored to SSCP and competitive advantage linkages (Barney, 1991; Hart, 1995; Dyer & Singh, 1998; Porter & Kramer, 2011; Stroumpoulis & Kopanaki, 2022). Second, it will generate a comprehensive conceptual framework that maps SSCP dimensions (environmental, social, economic) to specific competitive outcomes, thereby offering a structured lens for future empirical validation across diverse industries (Seuring & Müller, 2020; Mukhsin & Suryanto, 2022). Third, through a systematic review of Indonesian manufacturing literature, this work tackles context-specific barriers such as infrastructural, regulatory, and cultural nuances providing grounded insights often overlooked in generic global studies (MDPI, 2023; Sari et al., 2023). Fourth, it highlights the role of emerging digital technologies IoT, blockchain, analytics in enabling SSCP effectiveness, adding to the nascent literature on digital-sustainable integration in emerging markets (Stroumpoulis & Kopanaki, 2022; Nature Communications, 2025). Fifth, the study offers practical value by identifying actionable strategies for manufacturers, including green procurement guidelines, supplier development roadmaps, and performance metrics tailored to Indonesian conditions (Mukhsin & Suryanto, 2022; Sari et al., 2023). Sixth, it serves policymakers by pinpointing how infrastructure investments, regulatory harmonization, and public–private partnerships can accelerate SSCP adoption (Frontiers, 2022; MDPI, 2023). Seventh, it addresses broader sustainability

agendas by linking SSCP to long-term industrial resilience and Indonesia's commitment to global climate and SDG targets (Seuring & Müller, 2020). Eighth, the integrated framework will support academics and practitioners in identifying leverage points and benchmarking interventions. Ninth, the proposed model emphasizes stakeholder engagement and capacity-building key levers for sustainable transitions in manufacturing ecosystems. Tenth, insights from this review will guide curriculum updates and training programs in supply chain management education. Eleventh, by synthesizing heterogeneous evidence, the study offers clarity to firms confused by fragmented practices and mixed outcomes. Twelfth, it underscores the strategic importance of sustainability, shifting perception from cost burden to value creation. Thirteenth, it cultivates a research agenda encouraging mixed-method follow-ups, longitudinal studies, and case-based investigations. Fourteenth, the study sets a precedent for cross-sectoral comparisons across FMCG, automotive, and electronics clusters. Finally, by articulating both theoretical and policy pathways, this work contributes to the sustainability discourse, empowering Indonesia's manufacturing sector to competitively thrive in the global green economy.

B. METHOD

This study adopts a structured literature review approach to explore the link between sustainable supply chain practices and competitive advantage within Indonesia's manufacturing sector. The review method is chosen due to its effectiveness in synthesizing diverse theoretical and empirical insights across multiple disciplines. A comprehensive search was conducted using academic databases including Scopus, ScienceDirect, Emerald Insight, and Wiley Online Library. Keywords such as "sustainable supply chain," "competitive advantage," "manufacturing," and "Indonesia" were used in various Boolean combinations.

The search covered articles published between 2013 and 2025 to capture both foundational frameworks and recent developments. Only peer-reviewed journal articles published in English were included to ensure scholarly rigor. Duplicates, conference papers, and non-peer-reviewed sources were excluded to maintain quality. The selection process followed a multi-stage procedure involving identification, screening, eligibility, and inclusion. Articles were initially assessed by title and abstract to filter out irrelevant content. Full-text reviews were then conducted to confirm the relevance of each article to the study's objectives. Studies that focused exclusively on environmental sustainability without supply chain relevance were excluded. The final pool of literature was categorized based on thematic areas, such as environmental practices, social responsibility, digital integration, and regulatory factors.

The review process also identified and mapped theoretical frameworks, including resource-based perspectives, dynamic capabilities, and stakeholder engagement. Each selected article was analyzed for its methodological design, key findings, and relevance to the Indonesian context. Both qualitative and quantitative studies were included to ensure a balanced view. The synthesis involved comparing results across studies, identifying consistencies, contradictions, and gaps. Attention was given to studies that addressed barriers and enablers specific to emerging economies. The data extraction matrix included authorship, publication year,

geographical focus, and main variables studied. The review also aimed to identify empirical trends, conceptual advancements, and practical implications. This structured method provides a robust foundation for developing a conceptual model that links sustainable supply chain practices with competitive advantage in Indonesia's manufacturing sector.

C. RESULTS AND DISCUSSION

Indonesian manufacturing firms increasingly adopt environmental and digital sustainability practices as core components of their supply chain strategies. These practices reflect a growing awareness of the need to balance operational efficiency with environmental responsibility. Companies implement waste minimization programs and energy-saving initiatives across production and logistics. Many manufacturers invest in green packaging, eco-friendly materials, and low-emission transportation systems. They embed environmental criteria into supplier selection and procurement processes.

These actions demonstrate a strategic shift from reactive compliance to proactive sustainability integration. In parallel, digital technologies play a transformative role in enabling transparency and real-time monitoring. Firms deploy Internet of Things (IoT) devices to track energy use, emissions, and inventory movement. Some manufacturers utilize blockchain to ensure traceability and authenticity across supply chain tiers. Data analytics systems support predictive maintenance and optimize material flow. These digital tools enhance visibility, reduce inefficiencies, and improve decision-making accuracy. Larger firms lead in adopting these innovations, while smaller enterprises gradually follow through government support or partnerships. Environmental management systems and digital platforms increasingly serve as strategic tools rather than auxiliary functions. Companies that institutionalize such practices demonstrate a higher commitment to sustainability at the corporate level. This pattern suggests a structural evolution in how Indonesian manufacturers perceive and operationalize sustainability. Environmental and digital practices thus emerge as the most dominant and measurable dimensions of sustainable supply chain adoption within the sector

Sustainable supply chain practices directly strengthen the competitive positioning of Indonesian manufacturing firms. Companies that implement integrated sustainability measures often experience increased cost efficiency through resource optimization and waste reduction. They redesign processes to minimize material usage and streamline logistics, resulting in lower operational expenses. Many firms enhance innovation capacity by adopting green technologies and developing eco-friendly products. These initiatives enable companies to enter new markets and respond to environmentally conscious consumer demands.

Sustainability practices also elevate brand reputation, helping firms build trust with stakeholders and attract ethical investors. Companies establish sustainability reporting systems to demonstrate transparency and accountability. By doing so, they gain reputational capital that reinforces long-term customer loyalty. Competitive advantage also emerges from improved risk management, as sustainable operations

reduce exposure to regulatory penalties and supply disruptions. Some firms achieve differentiation by marketing sustainability as a core value proposition. Others attain first-mover advantages in adopting green standards required by international buyers.

These outcomes create both tangible and intangible benefits, reinforcing a firm's ability to outperform competitors. Sustainable practices also support operational agility, enabling firms to adapt quickly to environmental or market shifts. As a result, sustainability becomes not merely a moral obligation but a strategic asset. Firms that embed these practices deeply within their operations often outperform those that treat sustainability as an external add-on. This evidence positions sustainable supply chain practices as a credible and effective driver of competitive advantage in the manufacturing sector.

Indonesian manufacturers face significant institutional and infrastructural challenges in implementing sustainable supply chain practices. Many firms operate within a fragmented regulatory environment that lacks consistency and clarity. Government policies often vary across regions, creating confusion for companies attempting to comply with sustainability standards. Manufacturers struggle to access green-certified raw materials due to limited supplier availability. Inconsistent enforcement of environmental regulations discourages proactive investment in sustainability initiatives. Firms frequently encounter bureaucratic delays when seeking permits for eco-friendly upgrades or new technologies. Infrastructure limitations such as unreliable electricity, poor transport connectivity, and port inefficiencies hinder efficient implementation of green logistics. Smaller enterprises in particular face difficulties due to high upfront costs associated with sustainability adoption. Financial constraints prevent them from investing in renewable energy, digital tracking systems, or waste management facilities. Many manufacturers also lack access to skilled labor capable of managing sustainability systems or interpreting performance metrics.

Communication gaps between industry and government reduce opportunities for technical assistance or incentive alignment. Firms often operate in isolation without sufficient stakeholder collaboration or industry-wide platforms. Some business owners view sustainability as a cost burden rather than a strategic necessity. The absence of standardized guidelines for sustainability reporting further complicates implementation. These conditions create a fragmented landscape where commitment to sustainability varies widely across firms. Institutional and infrastructural challenges therefore represent systemic barriers that significantly impede the broader adoption of sustainable supply chain practices in Indonesia.

Dynamic capabilities and stakeholder engagement play a pivotal role in enabling the successful adoption of sustainable supply chain practices. Firms actively develop internal routines that allow them to sense, seize, and reconfigure resources in response to sustainability demands. They invest in training programs to build employee competence in environmental management and digital systems. Companies reengineer their workflows to accommodate circular production models and closed-loop logistics. Many organizations form sustainability teams to monitor performance indicators and propose continuous improvements.

These internal capabilities enhance the firm's ability to integrate green practices with minimal disruption. At the same time, external engagement with stakeholders

strengthens implementation efforts. Companies collaborate with suppliers to ensure responsible sourcing and consistent compliance across the value chain. Manufacturers also engage with customers by offering transparency through labeling, certifications, and open sustainability reports. Industry associations and government programs often serve as platforms for knowledge sharing and capacity building. Firms that partner with NGOs or academic institutions benefit from research insights and technical guidance. Some companies form strategic alliances to co-develop eco-innovations or invest in shared green infrastructure. Active stakeholder dialogue helps firms align their sustainability strategies with evolving societal expectations.

These partnerships foster trust, reduce resistance, and accelerate adoption at scale. Internal capabilities and external relationships work in synergy to create adaptive, resilient, and sustainable supply chains. Organizations that nurture both elements position themselves to leverage sustainability not only as compliance but as a competitive differentiator. Dynamic capabilities and stakeholder collaboration thus emerge as essential enablers in the transition toward sustainable manufacturing in Indonesia

The current body of research and industry practice reveals a notable gap in measuring long-term outcomes of sustainable supply chain practices across Indonesia's manufacturing sub-sectors. Most existing evaluations emphasize short-term environmental indicators such as emission reduction or energy savings. Few studies assess how sustainability initiatives influence long-term competitiveness, resilience, or social impact. Researchers often overlook sectoral diversity, treating the manufacturing industry as a homogeneous entity. This tendency limits the depth and relevance of findings for sub-sectors such as automotive, electronics, textiles, or food processing. Companies rarely track how sustainability investments affect supply chain adaptability or crisis recovery capacity over time. Monitoring systems often fail to capture improvements in labor conditions, community engagement, or equitable value distribution. Firms lack robust tools to assess how SSCP influences innovation trajectories or strategic renewal. The absence of longitudinal data hinders the ability to draw causal inferences between sustainability and firm growth. Researchers and practitioners frequently use fragmented metrics that vary widely across case studies and industries. Without a unified measurement framework, cross-sectoral benchmarking remains difficult.

Smaller firms in particular face challenges in documenting sustainability progress due to resource limitations. Public reports often underrepresent performance from local firms, focusing instead on multinational enterprises. Limited academic attention to social sustainability dimensions creates blind spots in understanding the broader impact of SSCP. Indonesia's export-oriented industries require tailored models that reflect sector-specific dynamics and global buyer expectations. Addressing these measurement gaps is essential for building a comprehensive understanding of how sustainability shapes competitive advantage in diverse manufacturing settings.

The prominence of environmental and digital sustainability practices among Indonesian manufacturers mirrors trends documented in global supply chain studies. Research demonstrates that firms deploying IoT, RFID, and blockchain achieve enhanced traceability, real-time monitoring, and disruption resilience compared to

traditional setups (Garcia-Sánchez et al., 2020; Queiroz & Wamba, 2023). Scholars emphasize that integrating blockchain with IoT specifically boosts transparency, reduces inefficiencies, and strengthens environmental performance in manufacturing contexts (Khanfar et al., 2021; Shatta, 2023). Comparative analyses show that industries using these technologies experience measurable improvements in logistics capabilities and waste control, outperforming peer firms that rely solely on conventional systems (Md. N. Shatta, 2024; Qiu & Zhou, 2022).

Furthermore, studies on blockchain-IoT architectures confirm that such digital integration establishes trust among supply chain actors, a prerequisite for upscaling green initiatives (Khanfar et al., 2021; Moudoud et al., 2022). These findings align with the observed pattern in Indonesia, where larger manufacturers prioritize energy efficiency and digital tracking while SMEs gradually follow. The consistency between findings suggests that Indonesian firms are following a global path in leveraging digital tools as a gateway to sustainable supply chains. By actively investing in eco-design and digital platforms, these firms position themselves to capture environmental and competitive gains earlier than lagging peers. This reinforces the notion that the observed dominance of environmental and digital SSCP dimensions in Indonesia reflects mature global practices underpinned by advanced technology adoption.

Manufacturers in emerging economies often realize concrete competitive benefits following the implementation of sustainable supply chain practices. Multinational corporations in Southeast Asia have reported tangible cost savings through waste reduction and eco-efficient logistics, mirroring our findings on Indonesian firms (Lam et al., 2021; Sarkis et al., 2019). Academic models show that green innovation such as eco-friendly product design drives market differentiation and customer loyalty in global supply chains (Chen et al., 2020; Stevens & Johnson, 2022). Companies that integrate sustainability into their core processes also experience enhanced operational agility against market volatility (Bai et al., 2023). In Latin American manufacturing, similar strategies led to both lower cost-per-unit and premium product positioning, reinforcing the concept of dual advantage (González-Benito et al., 2020).

These cross-regional comparisons affirm that sustainability can act as a value creasing mechanism rather than a cost center. Indonesian firms reflect these global trends, as they harness resource efficiencies and innovation to strengthen brand equity. Moreover, green credentials help Indonesian manufacturers access export markets that enforce sustainability standards echoing the experience of firms in Turkey and Brazil (Ulucak & Khan, 2022). The observed link between sustainability and competitive advantage thus aligns with robust empirical evidence from various emerging contexts. This analysis supports the conclusion that Indonesian manufacturing's strategic shift toward sustainable supply chains yields both operational and reputational dividends, consistent with broader international patterns.

Many studies confirm that institutional and infrastructural barriers significantly hinder the implementation of sustainable supply chain practices in emerging economies, echoing our findings in the Indonesian manufacturing context. Scholars identify inconsistent regulations and weak enforcement as primary obstacles

that diminish firm motivation to invest in green initiatives (Ghisellini et al., 2022; Zhao et al., 2021). Infrastructural limitations including unreliable energy, poorly maintained transport systems, and inadequate digital connectivity directly raise implementing costs and disrupt sustainable logistics efforts (Jabbour et al., 2020; Govindan et al., 2022). SMEs face particularly acute challenges due to their limited financial reserves and lower economies of scale compared to larger firms, which results in slower adoption of sustainability tools and platforms (Rana et al., 2023; Prajogo & Hobbs, 2022).

Comparative research in Southeast Asia shows that inconsistent policy frameworks between regions produce compliance fatigue among firms, reducing the impact of government support efforts (Do et al., 2021). Studies also evidence that the absence of green supplier networks exacerbates raw material shortages, increasing supply chain fragmentation (Cheng & Wu, 2023). Researchers observe that companies operating in fragmented value chains struggle to mobilize stakeholders and achieve traceable procurement (Upadhyay et al., 2021). Public–private partnership models in contexts like Bangladesh and India illustrate that bundled infrastructure and policy incentives can mitigate such institutional failures (Khan et al., 2022). Our findings align with this literature: Indonesian firms confront both policy incoherence and weak infrastructure that stymie holistic SSCP adoption. This comparative evidence validates the identification of systemic barriers and underscores the need for integrated interventions targeting policy harmonization, infrastructure investment, and SME capacity-building to enable sustainable supply chain transitions.

Firms in developing contexts often leverage dynamic capabilities and stakeholder engagement to scale sustainable supply chain practices, aligning closely with our findings. Scholars have shown that organizations effectively sensing market demands and reconfiguring resources such as processes and technologies achieve higher environmental effectiveness and competitive differentiation (Rialti et al., 2022; Wang & Bansal, 2012). Organizations that develop specialized capabilities, including sustainability project teams and cross-functional coordination routines, demonstrate stronger ability to implement green innovations (Eisenhardt & Martin, 2000; Searle & Bunker, 2021). Studies highlight that stakeholder engagement with suppliers, customers, NGOs, and regulators catalyzes adoption of sustainable practices by sharing knowledge and reducing uncertainty (Dibb & Simkin, 2021; Pagell & Shevchenko, 2014). Empirical evidence further confirms that co-created sustainability frameworks such as joint waste reduction programs improve supply chain performance through trust-based relationships (Hervani et al., 2005; Pagell & Shevchenko, 2014).

Firms that integrate stakeholder inputs into green strategy planning outperform peers in both eco-efficiency and innovation capacity (Gligor & Holcomb, 2013; Rialti et al., 2022). Comparative case studies across emerging economies show that stakeholder collaboration compensates for weak institutional support by enhancing resource mobilization (Jones et al., 2020). These observations echo in the Indonesian context, where firms establish sustainability councils and engage multi-party platforms to foster green innovation. Through continuous stakeholder dialogue, firms align internal processes with external expectations and regulatory trends. Active stakeholder engagement also contributes to organizational legitimacy and market

credibility. Dynamic capabilities work in tandem with stakeholder networks to amplify the impact and scalability of sustainable supply chain initiatives. This synergy underscores why Indonesian firms that deliberately cultivate both internal capabilities and external partnerships achieve more substantial sustainability outcomes.

The observed gap in measuring long-term outcomes of sustainable supply chain practices aligns with broader scholarly concerns regarding fragmented performance evaluation frameworks. Existing studies critique the lack of longitudinal research tracking environmental, social, and resilience effects of SSCP over extended periods (Martínez-Pérez et al., 2021; Zhu et al., 2022). Authors emphasize that most metrics focus on immediate emissions or cost reduction, leaving strategic dimensions like innovation growth and social equity underexplored (Zhu et al., 2022; Köhler et al., 2023). Scholars underscore the need for multi-dimensional performance tools that include social and resilience indicators, particularly for diverse industrial contexts (Seele & Lock, 2017). Comparative analyses in the automotive and electronics sectors demonstrate that robust measurement systems enhance firms' understanding of sustainability ROI and inform strategic decision-making (Garcia-Quevedo et al., 2020; Li et al., 2023). SMEs are particularly affected by this shortcoming, as they seldom have access to standardized performance frameworks and rely on ad hoc indicators (Williams et al., 2021).

Research also identifies that sectoral differences significantly influence which sustainability outcomes firms choose to monitor, reinforcing the need for contextualized models (Martínez-Pérez et al., 2021; Li et al., 2023). The lack of longitudinal data creates challenges in assessing the causal links between SSCP investments and firm adaptability, crisis recovery, or market expansion. In response, scholars recommend establishing industry-wide benchmark initiatives to promote data comparability across sub-sectors (Williams et al., 2021). These initiatives also encourage alignment with global reporting standards, enhancing credibility and stakeholder trust. Our finding in Indonesia resonates with these insights, highlighting that without systematic, long-term measurement, firms and researchers cannot fully assess SSCP's strategic impact. Future frameworks should integrate time-bound and sector-specific indicators to address this evidence gap and guide sustainable manufacturing practice across Indonesia's diverse industrial landscape.

D. CONCLUSION

This study concludes that sustainable supply chain practices (SSCP) serve as critical strategic instruments for achieving competitive advantage in Indonesia's manufacturing sector. Firms actively adopt environmental and digital initiatives to enhance transparency, reduce waste, and optimize resource efficiency. They incorporate IoT, blockchain, and analytics to gain real-time visibility and improve operational agility. Manufacturers invest in green logistics, energy-saving technologies, and supplier compliance systems to meet both domestic and international standards. Companies that embed sustainability into their core operations experience improved innovation, cost performance, and brand positioning. They also benefit from enhanced stakeholder trust and access to environmentally conscious markets. However, widespread implementation of SSCP remains uneven due to persistent institutional and infrastructural barriers. Regulatory

inconsistencies, fragmented supply chains, and weak infrastructure limit firms' ability to fully integrate sustainability. Smaller firms, in particular, struggle with the financial and technical requirements of green transformation. Internal capabilities and stakeholder collaboration emerge as decisive enablers of successful SSCP adoption. Organizations that build adaptive routines and engage suppliers, customers, and government bodies navigate sustainability transitions more effectively. Multi-stakeholder partnerships accelerate learning, reduce resistance, and scale best practices across the value chain. Despite this progress, significant research and practice gaps remain. Most companies lack tools to measure long-term SSCP outcomes beyond short-term environmental indicators. Sector-specific insights and longitudinal frameworks are necessary to evaluate social impact, resilience, and innovation capacity. The absence of standardized benchmarks makes it difficult to assess SSCP maturity across diverse manufacturing sub-sectors. Firms must also address underdeveloped digital infrastructure to unlock the full potential of technology-enabled sustainability. Moving forward, a holistic strategy that combines internal innovation, stakeholder alignment, and contextual policy support is essential. By integrating sustainability into strategic planning, Indonesian manufacturers can gain a competitive edge while contributing to national and global development goals.

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