Reconstruction and Validation of Sustainable Supply Chain, Risk Management and Sustainable Performance Using Factor Analysis: Evidence from SMEs in Indonesia

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ABSTRACT

Sustainable Supply Chain Management (SSCM), Supply Chain Risk Management (SCRM), and Sustainable Performance (SP) have largely been conceptualized for large enterprises in developed countries, leaving gaps in implementation for small, and medium-sized enterprises (SMEs) in the context of developing countries. This study aims to reconstruct and validate the core dimensions of SSCM, SCRM, and SP practices in SMEs Indonesia through exploratory factor analysis. Data was collected through a survey of 205 SMEs in various sectors. The analysis identified four key factors: Sustainable Supply Chain Management Practices, Risk Mitigation, Risk Evaluation and Planning, and Sustainable Performance. Notably, SCRM emerged as a multidimensional construct, separating the tactical and strategic aspects from risk management. These findings highlight the contextual specificity of sustainability frameworks in SMEs, emphasizing the need for simplified and adaptable models that reflect the resource constraints and informal structures typical of emerging markets. This research contributes to theoretical refinement and offers practical guidance for SME managers aiming to improve sustainability outcomes.

Keywords: Sustainable Supply Chain Management, Supply Chain Risk Management, Sustainable Performance.

INTRODUCTION

Climate change, social pressures, and global economic uncertainty have further emphasized the urgency of implementing Sustainable Supply Chain Management (SSCM) across various industrial sectors, including small, and medium enterprises (SMEs) in developing countries. SSCM encompasses not only operational aspects but also the integration of environmental, social, and economic dimensions throughout the entire supply chain, aiming to enhance business sustainability and resilience (Zailani et al., 2012; Alzubi & Akkerman, 2022).

Simultaneously, Supply Chain Risk Management (SCRM) has emerged as a crucial strategy for addressing sustainability-related risks such as natural disasters, regulatory uncertainty, and global market volatility (Han & Um, 2024). SCRM is an information-intensive process (Fan et al., 2017), whose success depends on collaboration and coordination between firms and their supplier partners (Kauppi et al., 2016; Li et al., 2015). Proactive risk management is particularly important for SMEs, which typically have limited resources and are more vulnerable to supply chain disruptions.

While several studies have explored the relationships among SSCM, SCRM, and sustainability performance (Raza et al., 2021; Hsieh et al., 2023), the majority of this research has focused on large companies in developed countries. In contrast, studies on SMEs in developing countries remain limited, despite their significant economic contribution and the unique challenges they face in adopting systemic and measurable sustainability practices (Alzubi & Akkerman, 2022).

Moreover, many previous studies have employed structural approaches such as Structural Equation Modelling (SEM) to causally examine relationships between variables. However, relatively few have utilized exploratory techniques, such as factor analysis, to revalidate the constructs of SSCM practices (SSCMP), SCRM, and sustainability performance (SP), especially within the distinct context of SMEs in developing countries.

This study offers both theoretical and practical contributions by reconstructing and validating the core factors of SSCMP, SCRM, and SP through exploratory and confirmatory factor analysis. It focuses specifically on SMEs in developing countries a context that remains underexplored in current SSCM literature. This research also provides empirical validation of items and dimensions relevant to supply chain sustainability practices within SMEs, which may differ significantly from those established for large firms in developed economies. Furthermore, it addresses a critical research gap by examining how sustainability practices and risk management dynamics are shaped by resource limitations, external pressures, and reactive compliance behaviours among SMEs.

Although SSCM and SCRM practices have been widely studied in the context of large firms in developed countries, limited research has revisited the structure of these constructs for SMEs in Indonesia. This raises an important question: are these constructs still valid and applicable in a setting characterized by limited resources and different institutional environments? This study aims to address this question through the application of both exploratory and confirmatory factor analysis.

LITERATURE REVIEW

Sustainable Supply Chain Management

Global trends emphasizing sustainability have led to the evolution of supply chain management beyond mere efficiency and effectiveness in logistics. Today, supply chains are expected to contribute to environmental sustainability, social responsibility, and inclusive economic growth. This holistic approach is referred to as Sustainable Supply Chain Management (SSCM), which is grounded in the Triple Bottom Line (TBL) principle encompassing environmental (planet), social (people), and economic (profit) dimensions (Dyllick & Hockerts, 2002; Seuring & Müller, 2008).

The operationalization of SSCM is manifested through Sustainable Supply Chain Practices (SSCP). The SSCP encompasses a wide range of policies and concrete actions taken by companies to ensure that every supply chain activity pays attention to environmental and social impacts, while maintaining the continuity of economic performance. Common practices include green purchasing, eco-design and sustainable packaging, reverse logistics, energy efficiency, and strengthening relationships with suppliers through collaboration and joint risk management (Zailani et al., 2012; Alzubi & Akkerman, 2022; Raza et al., 2021, Bhatti et al., 2023). In this context, SSCP not only serves as a tool to reduce negative environmental and social impacts, but also contributes to improving the company's economic and operational performance (Paul et al., 2022).

Furthermore, the implementation of SSCP is seen as part of a company's dynamic capabilities, namely the ability to adapt and respond to market changes and environmental risks in an adaptive and innovative manner (Raza et al., 2021). Research shows that the relationship between SSCP practices and sustainability performance is mediated by factors such as Supply Chain Risk Management (SCRM) and Network Capability (NC), as well as moderated by organizational characteristics such as firm size (Raza

et al., 2021). On the other hand, factors for the successful implementation of SSCP such as top management commitments, research and development, and the use of environmentally friendly technologies also play an important role in ensuring the effectiveness of sustainability strategies (Paul et al., 2022).

In the context of Small and Medium-sized Enterprises (SMEs), the adoption of SSCP is becoming increasingly relevant, although these firms often face constraints such as limited resources and low awareness of sustainability issues (Costache et al., 2021). Nonetheless, evidence shows that SSCP implementation among SMEs can enhance both operational and environmental performance, and may foster eco-innovation, which in turn mediates improvements in overall business performance (Bhatti et al., 2023).

Numerous studies have identified specific indicators for evaluating each dimension of SSCP. Table 1 summarizes the key SSCP factors along with their commonly used measurement indicators:

Table 1. SSCP Factors & Measurement Indicators

No	SSCP Factors	Measurement Indicators
1	Sustainable Procurement	Procurement of eco-friendly materials; sustainability criteria in suppliers; Social Audit (Bhatti et al., 2023; Mamun, 2021)
2	Sustainable Manufacturing	Use of renewable energy; waste minimization; Resource Efficiency (Raza et al., 2021; Dubey et al., 2017)
3	Sustainable Distribution	Transportation optimization; the use of environmentally friendly vehicles; Logistics route efficiency (Bhatti et al., 2023; Kot, 2018)
4	Reverse Logistics	Return of used products; Recycling and reuse of materials (Seuring & Müller, 2008; Dubey et al., 2017)
5	Eco-Design	Product design for recycling; minimizing environmental impact from the design stage (Zailani et al., 2012)
6	Green Innovation	Development of environmentally friendly technology; Investing in green innovation (Bhatti et al., 2023; Dubey et al., 2017)
7	Stakeholder Engagement	Local community involvement; Transparency of sustainability information (Meidinger, 2019; Costache et al., 2021)
8	Governance and Monitoring	Environmental performance monitoring of suppliers; Use of certifications (Mamun, 2021; Meidinger, 2019)

Supply Chain Risk Management

Supply Chain Risk Management (SCRM) is a systematic approach aimed at identifying, evaluating, and managing risks that may disrupt the flow of materials, information, and finances across the supply chain (Tummala & Schoenherr, 2011). This approach has evolved in response to increasing market volatility, the globalization of supply chains, and the growing complexity of logistics and consumer demand. SCRM emphasizes the importance of risk mitigation strategies that are not only reactive but also proactive and collaborative (Saglam et al., 2020).

A widely cited framework in the literature is the Supply Chain Risk Management Process (SCRMP) developed by Tummala and Schoenherr (2011). This framework comprises five key stages: risk identification, risk measurement and assessment, risk evaluation, risk mitigation and contingency planning, and risk control and monitoring. It has been extensively adopted in various studies to assess the effectiveness of SCRM practices across multiple industrial sectors (Zhu & Liu, 2023; Saglam et al., 2020; El Baz & Ruel, 2020).

Christopher and Peck (2004) classified supply chain risks into five categories: supply risk, process risk, demand risk, control risk, and environmental risk. Among these, environmental risks, such as climate change, natural disasters, and global pandemics are considered high-impact risks despite their relatively low probability of occurrence. A study by Hsieh et al. (2023) found that such environmental risks can severely disrupt supply chain stability and undermine a company's resilience to shifting market conditions.

The dynamic capability approach introduced by Raza et al. (2021) posits that risk management functions not only as a mitigation mechanism but also as a mediator between sustainable supply chain practices (SSCP) and sustainability performance (SP). In this context, firms that implement SSCP but fail to effectively manage environmental or social risks are unlikely to fully realize the potential benefits of their sustainability initiatives.

Risk management in the context of sustainability entails the early identification of potential disruptions, development of contingency strategies, diversification of supply sources, and stakeholder collaboration to foster adaptive and resilient systems. Raza et al. (2021), in their study of the manufacturing sector in China, observed that firms with strong risk management capabilities were more effective in leveraging SSCP to enhance sustainability performance compared to those that relied solely on reactive measures.

Small and Medium-sized Enterprises (SMEs) often face challenges in identifying and managing supply chain risks due to limited resources and technological capabilities. It is therefore essential for SMEs to strengthen their competencies in risk anticipation and response through training, supply chain digitization, and collaboration with larger business partners. Governments and supporting institutions should promote the development of early warning systems and risk information-sharing platforms to assist SMEs in navigating uncertainty. In light of rising global expectations for transparency and accountability in supply chains, risk management capabilities serve not only as a safeguard against potential losses but also as a source of competitive advantage that can bolster long-term business resilience.

Previous research has shown that the success of SCRM implementation can be measured through various indicators that describe an organization's ability to manage risk as a whole. Table 2 presents a matrix of commonly used SCRM indicators in the literature, along with their reference sources.

Table 2. SCRM Indicator Matrix Based on Previous Research

No	Indicator SCRM	Description	References
1	Identify Risks	Ability to recognize internal and external risks in the supply chain	Tummala & Schoenherr (2011); Zhu & Liu (2023)
2	Risk Assessment	Evaluation of the level of probability and impact of risk	Zhu & Liu (2023); Um & Han (2020)
3	Risk Mitigation Strategy	Preventive measures such as flexibility, diversification, and contingency plans	Saglam et al. (2020); El Baz & Ruel (2020)
4	Supply Chain Resilience	Organizational capabilities in recovering from disruption	El Baz & Ruel (2020); Um & Han (2020)
5	Partner Collaboration and Trust	Degree of cooperation, openness, and trust between supply chain partners	Han & Um (2024); Owuor et al. (2019)
6	Responsiveness to Disruption	Speed of organization in responding to operational disruptions	Saglam et al. (2020); Tummala & Schoenherr (2011)

No	Indicator SCRM	Description	References
7	Risk Monitoring System	Use of information systems for real-time risk detection and reporting	Tummala & Schoenherr (2011); Zhu & Liu (2023)

Sustainable Performance

Sustainable performance in the context of supply chains refers to achieving a balance among the economic, social, and environmental dimensions of business operations. In practice, companies that adopt Sustainable Supply Chain Practices (SSCP) are expected to attain sustainability outcomes across three key areas: (1) Environmental performance, including carbon emission reduction, waste management, and energy efficiency; (2) Social performance, such as workers' rights, occupational health and safety, and contributions to local communities; and (3) Economic performance, including operational efficiency, cost savings, and sustainable revenue growth (Zailani et al., 2012; Raza et al., 2021).

Over the past decades, sustainability performance has emerged as a strategic metric in academic research, particularly within the domain of Sustainable Supply Chain Management (SSCM). Zailani et al. (2012) confirm that integrating sustainability dimensions into supply chains can enhance a company's competitiveness, improve operational performance, and address stakeholders' increasing expectations regarding ethical and environmentally responsible business practices.

Empirical studies also highlight the significant contribution of SSCP to sustainable performance. For instance, Bhatti et al. (2023), in their study of small and medium-sized enterprises (SMEs) in Pakistan, found that sustainable procurement and distribution positively affect four critical performance dimensions: environmental, social, economic, and operational. This impact is further amplified by eco-innovation practices, which serve as mediating mechanisms that integrate sustainability into both products and operational processes. Similar findings were reported by Alzubi and Akkerman (2022) in Jordan, who observed that although SSCP adoption in developing countries remains limited, companies that successfully implement such practices tend to experience improved competitiveness and economic sustainability in the medium to long term.

In the context of SMEs in Indonesia, prioritizing sustainability performance is not merely a form of social responsibility, but also a strategic necessity for surviving in an increasingly competitive market shaped by global sustainability regulations. Common challenges, such as limited access to technology, capital, and knowledge, may be addressed through targeted public policy support, strategic partnerships, and the adoption of circular economy business models and green innovations.

Strong sustainability performance can serve as a key differentiator, enhancing the competitiveness of SMEs in both local and global markets. Therefore, the integration of SSCP, risk management, and sustainability performance measurement constitutes a critical foundation for the adaptive and responsible transformation of supply chains in the era of the green economy.

RESEARCH METHOD

This study adopts an exploratory quantitative approach to reconstruct and revalidate the dimensions of Sustainable Supply Chain Practices (SSCP), Supply Chain Risk Management (SCRM), and Sustainable Performance (SP) within the context of micro, small, and medium enterprises (SMEs) in Indonesia. The exploratory design was chosen to allow the identification of underlying constructs in a context with limited prior empirical validation.

The research began with a qualitative phase involving focus group discussions (FGDs), followed by a quantitative survey. The FGDs involved ten purposively selected participants, comprising academics and SME practitioners from diverse sectors. Participants reviewed indicators based on prior literature

(Zailani et al., 2012; Han & Um, 2024; Raza et al., 2021) and provided feedback on clarity, relevance, and measurability. Several indicators were revised for better comprehension, and Risk Evaluation was suggested as a distinct construct from Risk Mitigation due to differences in field implementation.

A structured questionnaire was developed based on FGD inputs, encompassing the three constructs. Each was operationalized into indicators measured on a 5-point Likert scale. The questionnaire was pilot-tested with 30 SME respondents to assess face and content validity, followed by refinement.

The final survey was distributed to 205 SME respondents across Indonesia using purposive sampling. Inclusion criteria included classification as SMEs under national standards, involvement in supply chain activities (procurement, production, distribution), and willingness to complete the questionnaire. Respondents represented various sectors and regions to ensure diversity.

Descriptive statistics and assumption checks (e.g., normality, multicollinearity) were conducted before applying Exploratory Factor Analysis (EFA), which used Principal Axis Factoring with Varimax rotation. Suitability for factor analysis was verified using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity. Items with loadings below 0.5 or high cross-loadings were removed iteratively to obtain a stable, interpretable model.

Internal consistency was evaluated using Cronbach's Alpha, with a threshold of 0.7. While construct validity is supported through EFA, future validation using Confirmatory Factor Analysis (CFA) is recommended. The EFA output also serves as a foundation for potential Structural Equation Modelling (SEM) in subsequent research phases.

Ethical considerations were addressed through informed consent and confidentiality. Although purposive sampling may limit generalizability, it was appropriate for the exploratory nature of this study and the goal of capturing context-specific SME insights.

RESULTS AND DISCUSSION

This study aims to reconstruct and revalidate the constructs of Sustainable Supply Chain Management Practices (SSCMP), Supply Chain Risk Management (SCRM), and Sustainable Performance (SP) in the context of micro, small, and medium enterprises (SMEs) in developing countries, particularly Indonesia. To analyze the latent structure of these constructs, the Exploratory Factor Analysis (EFA) method was employed, using the Principal Axis Factoring approach with varimax rotation.

Before conducting EFA, the data's suitability was assessed using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity. The KMO value of 0.852 indicates that the sample is adequate for factor analysis. Bartlett's Test yielded a chi-square value of 960.926 with a significant p-value (p < 0.001), indicating that the correlations among variables are sufficient for further analysis, as shown in Table 3.

Table 3. KMO dan Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.852
Bartlett's Test of Sphericity	Approx.Chi-Square	960.926
Df		91
	Sig.	0.000

a. Cronbach's Alpha = 0.857

The EFA results identified four main factors with eigenvalues greater than 1, cumulatively explaining 64.34% of the variance in the data. These findings are supported by a scree plot showing a

clear elbow at the fourth factor, justifying the retention of four components. The rotation process produced a relatively distinct separation of constructs, leading to notable revisions in the initial factor framework of the study.

Table 4. Total Variance Explained

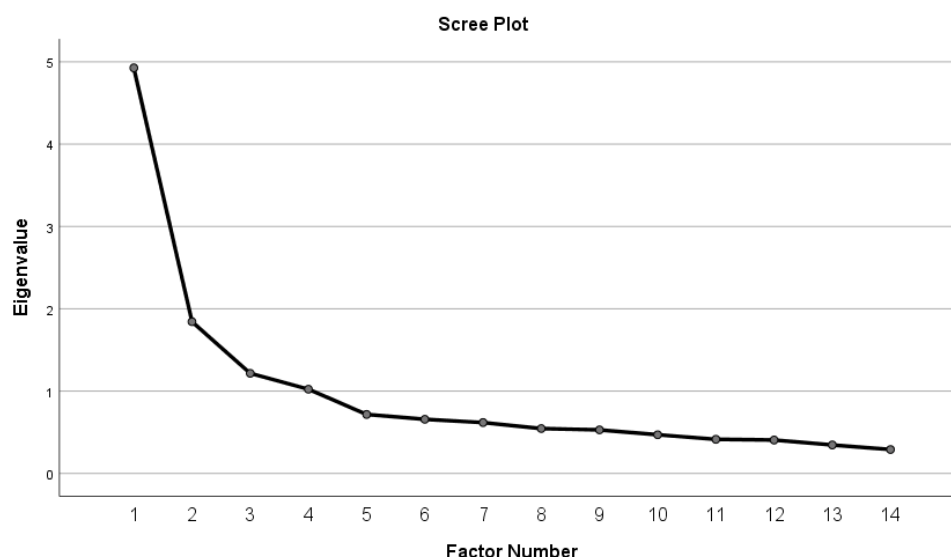|	Total Variance Explained								
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.926	35.188	35.188	4.439	31.708	31.708	1.978	14.126	14.126
2	1.843	13.163	48.351	1.369	9.777	41.485	1.863	13.306	27.432
3	1.216	8.686	57.038	0.716	5.111	46.597	1.619	11.565	38.997
4	1.023	7.306	64.344	0.536	3.83	50.426	1.6	11.429	50.426
5	0.717	5.119	69.462						
6	0.657	4.694	74.156						
7	0.618	4.413	78.569						
8	0.545	3.892	82.462						
9	0.529	3.778	86.239						
10	0.47	3.358	89.597						
11	0.414	2.96	92.557						
12	0.405	2.896	95.454						
13	0.345	2.468	97.922						
14	0.291	2.078	100						

Figure 1. Scree Plot

Following the varimax rotation and the removal of several items, the analysis showed that variables with high factor loadings were well-clustered. Among the remaining 31 variables, 14 were retained: Q2, Q4, Q7, Q8, Q9, Q15, Q16, Q20, Q21, Q22, Q23, Q25, Q27, and Q31. Variables related to SCRM, particularly those concerning mitigation, loaded highly on Factor 1. SSCMP-related variables loaded highly on Factor 2. Variables associated with SP loaded on Factor 3, while SCRM variables focused on evaluation and planning loaded on Factor 4.

Based on the results of the factor rotation shown in Table 5, four main factors were identified that reflect the key dimensions in this study. The first factor, named 'Risk Mitigation', represents activities such as risk data collection, collaboration with supply partners, and early warning systems in the SCRM context. This factor includes items Q20, Q21, Q22, and Q27, all with loading values greater than 0.5. The second factor, 'Sustainable Supply Chain Management Practices', involves practices like sustainable packaging and green supplier selection, consisting of items Q2, Q4, Q8, and Q9. The third factor, 'Sustainable Performance', captures environmental and social sustainability indicators, represented by items Q7, Q15, Q16, and Q9, suggesting integration with SSCMP practices. The fourth factor, 'Risk Evaluation and Planning', focuses on strategic aspects of SCRM, including items Q23, Q25, and Q31. Notably, this fourth factor emerged as distinct from Risk Mitigation, which was previously conceptualized as a single dimension of SCRM.

All extracted factors had Cronbach's alpha values above 0.7, indicating good internal reliability. The RM factor had an alpha of 0.786, SSCMP 0.790, SP 0.732, and REP 0.739. These results reinforce the validity of the constructs and support the feasibility of using these indicators in advanced structural models.

Table 5. Factor Extraction

Factor	Description	Key Items	Cronbach's Alpha
1	Risk Mitigation (RM)	Q20, Q21, Q22, Q27	0.786
2	Sustainable Supply Chain Management Practices (SSCMP)	Q2, Q4, Q8, Q9	0.790
3	Sustainable Performance (SP)	Q7, Q9, Q15, Q16	0.732

Factor	Description	Key Items	Cronbach's Alpha
4	Risk Evaluation & Planning (REP)	Q23, Q25, Q31	0.739

These findings reinforce the argument that the factor structures of SSCMP and SCRM in SMEs are not necessarily identical to those developed for large companies. The most notable difference lies in the decomposition of the SCRM dimension into two distinct components: Risk Mitigation and Risk Evaluation & Planning. This highlights the need to reconstruct the SCRM framework for SMEs in developing countries

The results of this study also indicate that SME actors in Indonesia tend to distinguish between tactical actions (such as direct mitigation of operational risks) and more strategic activities, including evaluation and long-term risk planning. This distinction aligns with previous research by Tummala & Schoenherr (2011) and Yanginlar et al. (2023), which emphasize the importance of two separate stages in risk management. Given the limited resources of SMEs, implementing long-term strategies such as REP concurrently with mitigation efforts is often challenging. Consequently, risk mitigation capacity relies more on day-to-day operational experience than on a systematic and proactive approach. This finding supports Han & Um's (2024) view that reactivity is a defining characteristic of SCRM in small and medium-sized enterprises in developing countries

Furthermore, the emergence of Risk Evaluation & Planning as a distinct factor introduces the potential for its role as a moderating variable in the relationship between SSCMP and SP, as discussed in the literature by Han & Um (2024) and Raza et al. (2021). This represents a significant conceptual contribution to modelling the causal relationship between SSCM, SCRM, and SP in the SME context.

The second factor identified was Sustainable Supply Chain Management Practices (SSCMP), which effectively grouped indicators related to sustainable procurement and eco-friendly packaging design. These findings strengthen the validity of the Environmental Purchasing and Sustainable Packaging constructs, as explained by Zailani et al. (2012), but also reveal that reverse logistics indicators are less prominent in the SME context. This is understandable as reverse logistics practices, such as returning damaged or unused products, require logistics and tracking systems that are often unavailable in locally or informally operated SMEs. These results suggest that the SSCMP dimension in SMEs is more pragmatic, adapting to minimal regulatory pressures and limited market incentives for sustainability. Unlike large companies, SMEs adopt SSCMP primarily due to cost efficiency and local consumer demand, rather than being motivated by intrinsic sustainability values typically emphasized in international markets (Alzubi & Akkerman, 2022).

The third factor, Sustainable Performance (SP), comprises environmental and social sustainability indicators. Notably, certain SP items such as waste efficiency and energy savings appear alongside SSCMP indicators, such as the selection of eco-friendly packaging. This suggests a strong connection between practice and outcomes as perceived by SME actors, where the distinction between practices and performance is not always clearly defined. This condition reinforces the argument that, within the SME context, sustainability is not always conceptually separated into inputs and outputs but is instead viewed as an integral part of daily operations. As demonstrated by Reklitis et al. (2021), SP success in SMEs is more heavily influenced by the integration of core business activities with direct environmental and social considerations, without requiring complex reporting or measurement systems.

These findings have significant implications for the external validity of SSCM and SCRM models developed in the context of developed countries. Previous research has often relied on models that assume formal organizational infrastructure and structured risk governance, whereas in SMEs, these processes are typically informal and based on experience or personal relationships with suppliers.

Therefore, the results of this EFA highlight the urgency of developing context-sensitive models that consider the unique characteristics of SMEs, such as limited resources, low external pressure, and reliance on local social networks. Thus, this study not only confirms the distinct structures of SSCMP and SCRM in Indonesian SMEs, but also highlights the need for reconstructive validation when applying management theories across different contexts.

CONCLUSION AND IMPLICATION

As a conclusion, this study aimed to reconstruct and revalidate the factor structure of Sustainable Supply Chain Practices (SSCP), Supply Chain Risk Management (SCRM), and Sustainable Performance (SP) in the context of micro, small, and medium enterprises (SMEs) in Indonesia. Employing a phased approach comprising Focus Group Discussions (FGD) and Exploratory Factor Analysis (EFA), the study successfully identified four main factors that form a revised conceptual structure for the three constructs.

The results of the EFA reveal that the SCRM structure is not unidimensional, as previously assumed, but rather consists of two distinct dimensions: Risk Mitigation and Risk Evaluation & Planning. These findings suggest a separation of strategic and operational roles in supply chain risk management within the SME sector. Meanwhile, SSCP constructs are clearly associated with green practices, including green supplier selection and sustainable packaging. Sustainable Performance (SP) emerges as a separate dimension, though it practically overlaps with SSCP practices, indicating that SME actors tend to perceive sustainability practices and outcomes as a unified concept. Overall, this study demonstrates that existing SSCM and SCRM models have not fully captured the operational realities of SMEs in developing countries. Therefore, adapting these models to account for resource constraints, external pressures, and informal organizational structures is essential for accurately explaining the dynamics of supply chain sustainability in this sector.

These findings contribute to the development of theories in sustainable supply chain management by demonstrating that: (1) the SCRM construct is multidimensional in the context of SMEs, and the separation between mitigation and risk evaluation should be incorporated into theoretical models; (2) the findings provide an empirical basis for revising and simplifying sustainability constructs to better reflect the realities of small organizations with informal structures and limited resources; (3) this research offers a data-driven and context-sensitive construct validation framework, applicable across sectors and cultural contexts.

From a managerial perspective, this study highlights the need for SMEs to distinguish between reactive approaches (risk mitigation) and strategic approaches (risk planning) in managing supply chain uncertainties. Additionally, strengthening sustainability practices such as the use of environmentally friendly materials and green packaging design can enhance both sustainability performance and cost efficiency. Capacity building in risk planning and environmental impact assessment can be achieved through training that emphasizes systems thinking and basic technical competencies. Therefore, sustainability mentoring and incentive programs for SMEs should be designed with the understanding that sustainability practices and performance are embedded in their daily operations. Governments and support agencies can facilitate the adoption of SSCMP through locally tailored approaches, including the provision of micro-scale eco-friendly packaging, access to simple clean technologies, and streamlined certification processes for green suppliers.

This study has several limitations that should be considered when interpreting the results and generalizing the findings. First, the exploratory quantitative approach is based on self-reported surveys, making the results heavily reliant on respondents' perceptions, which may be influenced by individual understanding and social desirability bias. Second, the sample is limited to SMEs in Indonesia, which although relevant does not capture variations in organizational culture, industry sectors, or levels of

digitalization found in other developing countries. Third, the use of Exploratory Factor Analysis (EFA) does not test causal relationships between constructs. While EFA identified a new factor structure, the model's validity requires further confirmatory testing. Lastly, the cross-sectional design prevents the examination of changes in sustainability dynamics over time.

RECOMMENDATIONS

Future research should employ Confirmatory Factor Analysis (CFA) to test the suitability of the factor model derived from EFA and assess the construct's convergent and discriminant validity. It is also recommended to develop a structural model that examines the causal relationships among SSCP, SCRM, and SP constructs using the Structural Equation Modelling (SEM) approach, including the exploration of mediating and moderating roles of risk factors. Longitudinal studies may be conducted to track changes in sustainability perceptions and practices over time. Additionally, a mixed-methods approach that combines quantitative surveys with in-depth qualitative interviews could offer a more comprehensive understanding of sustainability implementation dynamics in SMEs. Future studies should also consider external influences such as regulatory pressure, access to green financing, and the role of business ecosystem support in fostering the adoption of sustainability practices among SMEs.

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