

Green Supply Chain Management Strategy and Sustainable Financial Performance: The Moderating Role of Regulatory Pressure and Green Literacy on Export SMES in North Sumatra

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ABSTRACT

This study aims to analyze Green Supply Chain Management (GSCM) strategies to enhance sustainable financial performance among exporting SMEs in North Sumatra, examining the moderating roles of regulatory pressure and green literacy. Employing a qualitative approach with a multi-site case study design, this research involved 18 export SMEs from the plantation (palm oil, rubber, and coffee), fisheries, and handicraft sectors across the Medan, Deli Serdang, and Serdang Bedagai regencies. Data collection will be conducted through in-depth interviews, participant observation, and document analysis from March to August 2025. The findings reveal that GSCM implementation contributes positively to sustainable financial performance through operational cost efficiency, expanded export market access, and a strengthened reputation among international buyers. Regulatory pressure strengthens the GSCM-financial performance relationship, while green literacy serves as a catalyst for enhancing the effectiveness of green strategy implementation. This study provides theoretical contributions to the development of GSCM models within the SME context in developing economies, as well as practical implications for policymakers and business actors in formulating sustainability strategies oriented toward long-term financial performance.

Keywords: Green Supply Chain Management, Sustainable Financial Performance, Regulatory Pressure, Green Literacy

INTRODUCTION

The global demand for sustainable business practices has become a central issue in the 21st-century economic-development agenda. Climate change, environmental degradation, and natural resource scarcity are driving fundamental transformations in companies' supply chain managements. For developing countries like Indonesia, this challenge is increasingly complex, given the significant contribution of Micro, Small, and Medium Enterprises (MSMEs) to the national economy. MSMEs contribute approximately 61% of Indonesia's Gross Domestic Product (GDP) and absorb nearly 97% of the national workforce. In North Sumatra, the MSME sector serves as the backbone of the regional economy, particularly in the export activities of flagship commodities such as palm oil, rubber, coffee, and fishery products (Awwaliah et al. 2025).

Green Supply Chain Management (GSCM) has emerged as a strategic approach that integrates environmental considerations into every stage of the supply chain, from raw material procurement to end-of-product management. GSCM implementation is no longer viewed as a cost burden but rather as a strategic investment capable of enhancing competitiveness and improving long-term financial performance. However, GSCM adoption among MSMEs faces various obstacles, including limited financial resources, insufficient technical capacity, and low awareness of the environmental and economic benefits of green practices (Atmaja et al. 2025).

Although GSCM research has developed extensively, most studies have focused on large enterprises in developed countries. Research on GSCM among Indonesian MSMEs remains limited and frequently employs quantitative approaches that are less capable of capturing the contextual complexities. Several studies have examined the influence of GSCM on MSME performance in Indonesia, such as research on culinary MSMEs in Bogor, furniture MSMEs in Yogyakarta, and batik MSMEs in Lasem. However, research specifically addressing export MSMEs in North Sumatra while considering the moderating roles of regulatory pressure and green literacy remains limited.

The novelty of this study lies in several aspects. First, this study examines GSCM in the context of export MSMEs facing dual pressures from global markets and international regulations. Second, this study integrates two moderating variables—regulatory pressure and green literacy—which are rarely examined simultaneously within a single research model. Third, the utilization of a qualitative approach with a multi-site case study design enables an in-depth exploration of the mechanisms and dynamics of GSCM implementation that cannot be revealed through quantitative methods alone (Saefullah et al. 2025).

North Sumatra holds a strategic position in Indonesia's international trade sector. Exporters from North Sumatra and Bali confront issues related to deforestation, forest protection, and environmental sustainability that hinder commodity exports such as Crude Palm Oil (CPO). Pressure from global markets, particularly the European Union through the EU Deforestation Regulation (EUDR), is compelling export MSMEs to adopt more sustainable supply chain practices. However, many MSMEs still struggle to meet sustainability standards due to infrastructure limitations and insufficient support.

This phenomenon creates a dilemma for MSMEs in North Sumatra. On one hand, regulatory pressure and market demand drive the adoption of green practices. However, GSCM implementation requires substantial investment, and its impact on financial performance remains uncertain. This study seeks to answer how export MSMEs in North Sumatra manage GSCM strategies to achieve sustainable financial performance and how regulatory pressure and green literacy moderate this relationship.

The primary objectives of this research are as follows: (1) to analyze the GSCM strategies implemented by export MSMEs in North Sumatra; (2) to examine the influence of GSCM implementation on sustainable financial performance; (3) to analyze the moderating role of regulatory pressure in the GSCM-financial performance relationship; (4) to analyze the moderating role of green literacy in the GSCM-financial performance relationship; and (5) to develop a contextual GSCM strategic model for export MSMEs.

The research questions posed include: (1) How are GSCM strategies implemented by export MSMEs in North Sumatra? (2) How does GSCM implementation influence the sustainable financial performance of export MSMEs? (3) How does regulatory pressure moderate the relationship between GSCM and financial performance? (4) How does green literacy moderate the relationship between GSCM and financial performance?

LITERATURE REVIEW

Green Supply Chain Management

Green Supply Chain Management (GSCM) is defined as the integration of environmental considerations into supply chain management, encompassing raw material procurement, product design, production processes, distribution, and end-of-product management. GSCM aims to minimize ecological impact while simultaneously enhancing economic performance. Zhu and Sarkis identified several key GSCM practices, including green purchasing, eco-design, reverse logistics, and collaboration with suppliers on environmental issues (Tamimu et al. 2026).

Research on GSCM within MSMEs indicates that the adoption of green practices can enhance environmental and operational performance; however, its impact on economic performance remains unclear. Arifin et al. (2023) found that GSCM implementation has a positive and significant influence on environmental and operational performance but no significant effect on corporate economic performance. These contradictory findings highlight the need for further research on the contextual factors influencing the relationship between GSCM and-financial performance.

Sustainable Financial Performance

Sustainable financial performance integrates short-term financial achievements with long-term economic sustainability. In the MSME context, sustainable financial performance is measured not only through profitability but also through survivability, access to financing, and global market competitiveness.

Osho (2025) demonstrated that sustainable supply chains have a positive and significant relationship with MSME financial performance, and that the implementation of Sustainable Development Goals (SDGs) within management systems can enhance financial performance. Other studies have revealed that ESG reporting and green supply chain accounting significantly improve cost efficiency through operational waste reduction and resource utilization optimization. These findings indicate that sustainability practices provide dual benefits: internal efficiency and external access to financing opportunities (Osho 2025).

Regulatory Pressure as a Moderating Variable

Regulatory pressure refers to the impetus from governments and regulatory bodies for companies to adopt environmentally friendly practices. In the GSCM context, regulations may include environmental standards, reporting requirements, green tax incentives, and sanctions for violators.

Research demonstrates that government regulation has a significant positive effect on GSCM adoption and sequentially positive effects on financial and environmental performance. Karanja et al. (2026) found that environmental regulatory frameworks increased the explanatory power of the green investment-profitability model from 38.6% to 45.7%, indicating that regulatory support strengthens the financial benefits of green investment.

Micheli et al. 's study in Morocco demonstrated that regulatory pressure has a direct positive effect and significantly strengthens the benefits of GSCM, confirming its role as a primary catalyst. This finding aligns with the Porter Hypothesis, which states that well-designed environmental regulations can drive innovation that enhances productivity and competitiveness (Nugraha et al. 2025).

Green Literacy as a Moderating Variable

Green literacy refers to the knowledge, awareness, and understanding of environmental issues possessed by individuals or organizations, and the ability to apply this knowledge in business decision-making. Research indicates that customer and stakeholder green literacy drives companies to adopt sustainable supply chain management practices.

Hati, Junaidi & Munthe. (2026) found that environmental knowledge significantly influences GSCM implementation and the business performance of culinary MSMEs in Indonesia. Environmental knowledge not only facilitates the adoption of green practices but also enhances the effectiveness of GSCM implementation in achieving sustainability performance. Thus, green literacy serves as a catalyst that strengthens the relationship between GSCM strategy and achieved outcomes (Hati, Junaidi, and Munthe 2026).

Export MSMEs in North Sumatra

North Sumatra has significant economic potential and is globally recognized for its sustainable development achievements. Strategic industrial areas such as the Sei Mangkei Special Economic Zone (SEZ), Medan Industrial Estate (KIM), and Kuala Tanjung Industrial Estate serve as growth centers for the industry in this region.

Export MSMEs in North Sumatra face unique sustainability challenges. Exporters from this region encounter issues of deforestation, forest protection, and environmental sustainability, which hinder commodity exports. Research on sustainable supply chains in North Sumatra indicates the necessity of integrating environmental, social, economic, organizational, local cultural, governmental, and financial institution support factors to enhance supply chain performance and sustainability.

RESEARCH METHOD

This study employed a qualitative approach with a multi-site case study design. The qualitative approach was selected because it enables an in-depth exploration of GSCM phenomena within their natural contexts, capturing complexities and nuances that cannot be measured through quantitative instruments. The multi-site case study design facilitates cross-case comparisons to identify general patterns alongside contextual uniqueness.

The selection of a qualitative approach was based on the consideration that GSCM implementation in MSMEs is complex and contextual. Previous research has stated that GSCM studies within MSMEs require approaches capable of capturing practical dynamics in the field, which are often overlooked by quantitative surveys.

The research was conducted in North Sumatra Province, focusing on three primary locations: (1) Medan City as a trade and industrial center, (2) Deli Serdang Regency as an agribusiness area, and (3) Serdang Bedagai Regency as a strategic industrial development zone, including the Sei Mangkei SEZ. The location selection was based on the concentration of export MSMEs in these areas and the presence of export-supporting infrastructure.

The research will be conducted over a six-month period from March to August 2025. The research stages included preparation and preliminary study (March–April 2025), field data collection (May–July 2025), and data analysis and report writing (August 2025).

Research informants were selected using purposive sampling with the following criteria: (1) MSMEs that have been operating for a minimum of five years; (2) engaged in export activities to foreign countries; (3) have implemented at least one GSCM practice; and (4) willing to participate in the research. The number

of informants was determined based on data saturation principles, where data collection ceased when no new information was obtained.

This research involved 18 informants consisting of:

Table 1. Characteristics of Research Informants

Code	Business Sector	Position	Location	Business Age (years)	Export Destination
I-01	Palm Oil Plantation	Owner	Medan	15	India, China
I-02	Palm Oil Plantation	Operations Manager	Deli Serdang	12	Netherlands, Malaysia
I-03	Rubber Plantation	Owner	Medan	20	Japan, USA
I-04	Rubber Plantation	Production Manager	Serdang Bedagai	8	China, Singapore
I-05	Coffee	Owner	Medan	10	USA, Europe
I-06	Coffee	Export Manager	Deli Serdang	7	Japan, Korea
I-07	Coffee	Owner	Serdang Bedagai	6	Europe, USA
I-08	Fisheries	Owner	Medan	18	Japan, USA
I-09	Fisheries	Manager	Deli Serdang	10	Europe, China
I-10	Fisheries	Owner	Serdang Bedagai	5	Singapore, Malaysia
I-11	Handicrafts	Owner	Medan	25	Europe, USA
I-12	Handicrafts	Marketing Manager	Deli Serdang	15	Japan, Australia
I-13	Handicrafts	Owner	Serdang Bedagai	8	Europe, USA
I-14	Palm Oil Plantation	Finance Manager	Medan	10	India, Pakistan
I-15	Coffee	Operations Manager	Medan	9	Europe, USA
I-16	Fisheries	Finance Manager	Deli Serdang	7	Japan, Korea
I-17	Handicrafts	Production Manager	Medan	12	Europe, Australia

Code	Business Sector	Position	Location	Business Age (years)	Export Destination
I-18	Rubber Plantation	Export Manager	Serdang Bedagai	6	China, Singapore

Source: Primary Data, 2025

Data collection was conducted through three primary techniques:

Semi-structured in-depth interviews were conducted with all informants using interview guides developed based on a theoretical framework. The interviews lasted 60–120 minutes per session, with several informants interviewed more than once for clarification and deepening. The interview questions covered implemented GSCM strategies, implementation challenges and benefits, perceptions of regulatory pressure, levels of green literacy, and impacts on financial performance.

Observations were conducted at the informants' business locations to directly observe the implemented GSCM practices. The observations covered production processes, waste management, energy efficiency, and interactions with suppliers and customers. Observations were also conducted on export activities to understand compliance with international environmental standards.

The documents analyzed included MSME financial reports, export documents, environmental certifications (if any), company policies related to the environment, and relevant regulatory documents. Document analysis was used for data triangulation and verification of information obtained from interviews and observations.

The primary instrument in this research was the researcher himself (human instrument), supported by interview guides, observation sheets and document checklists. The interview guide was developed based on a literature review and validated through an expert review by two academics in supply chain management.

Data analysis employed a thematic approach with the following stages:

1. Data Reduction: Interview transcripts, observation notes, and documents were reduced through initial coding to identify analytical units.
2. Data Display: Data were presented in case and theme matrices to facilitate cross-case analysis.
3. Conclusion Drawing: Conclusions were drawn progressively through iterative verification processes.

The analysis was conducted iteratively using within-case and cross-case analysis approaches. A within-case analysis was performed for each MSME individually, while a cross-case analysis identified general patterns and differences across cases.

To ensure validity and reliability, Lincoln and Guba's four criteria were employed:

1. Credibility was achieved through data source triangulation (interviews, observation, documents), member checking, and prolonged engagement.
2. Transferability: Achieved through a thick description of the research context, enabling readers to assess whether the findings may be transferred to other contexts.
3. Dependability: Achieved through an audit trail documenting the entire research process.
4. Confirmability: Achieved through triangulation and a reflexivity journal documenting researcher biases and assumptions

RESULTS AND DISCUSSIONS

The research findings indicate that GSCM implementation among export MSMEs in North Sumatra varies across sectors and business scales. Generally, GSCM practices include green procurement, production, logistics, and reverse logistics. The implementation levels range from initial to advanced stages.

Table 2. Level of GSCM Practice Implementation by Sector

GSCM Practice	Plantation (%)	Coffee (%)	Fisheries (%)	Handicrafts (%)	Average (%)
Green Procurement	85.7	83.3	66.7	75.0	77.8
Green Production	71.4	100.0	66.7	75.0	77.8

GSCM Practice	Plantation (%)	Coffee (%)	Fisheries (%)	Handicrafts (%)	Average (%)
Green Logistics	57.1	66.7	33.3	50.0	50.0
Reverse Logistics	28.6	33.3	33.3	25.0	27.8
Eco-Design	42.9	50.0	33.3	75.0	50.0
Supplier Collaboration	71.4	83.3	66.7	75.0	72.2

Source: Primary Data, 2025

Table 2 shows the level of GSCM practice implementation across the four MSME sectors. Green procurement and production are the most widely implemented practices, averaging 77.8%. The coffee sector demonstrated the highest implementation of green production (100%), whereas the handicraft sector excelled in eco-design (75%). Reverse logistics remains the practice with the lowest implementation level (27.8%), indicating that end-product management and recycling have not yet become primary priorities for MSMEs.

GSCM implementation has been proven to contribute to operational cost efficiency through various mechanisms. The reduction in raw material usage, energy efficiency, and waste reduction constitutes the primary sources of cost savings.

Table 3. Impact of GSCM on Operational Cost Efficiency

Efficiency Indicator	Plantation (%)	Coffee (%)	Fisheries (%)	Handicrafts (%)	Average (%)
Raw Material Cost Reduction	12.5	8.3	5.0	10.0	9.2
Energy Savings	15.0	10.0	8.0	12.0	11.5
Waste Cost Reduction	20.0	15.0	10.0	18.0	16.0
Total Cost Efficiency	15.8	11.1	7.7	13.3	12.2

Source: Primary Data, 2025

Table 3 shows the average cost efficiency achieved by MSMEs after implementing GSCM practices. The plantation sector achieved the highest efficiency (15.8%), particularly through waste cost reduction (20%) and energy saving (15%). The fisheries sector demonstrated the lowest efficiency (7.7%), which was attributed to business characteristics that were heavily dependent on natural raw material availability. Overall, the GSCM implementation generated an average cost efficiency of 12.2%.

GSCM implementation improved MSME access to export markets through compliance with environmental standards required by international buyers.

Table 4. Impact of GSCM on Export Market Access

Indicator	Before GSCM	After GSCM	Change (%)
Number of Export Destination Countries	2.3	4.1	+78.3
Export Volume (tons/year)	245	420	+71.4

Indicator	Before GSCM	After GSCM	Change (%)
Export Value (million IDR/year)	8,750	15,200	+73.7
Number of International Buyers	3.1	5.8	+87.1
Environmental Certifications (count)	0.4	1.8	+350.0

Source: Primary Data, 2025

Description of Table 4: The table demonstrates significant improvements in export market access after GSCM implementation. The average number of export destination countries increased by 78.3% from 2.3 to 4.1. The export volume increased by 71.4% and the export value by 73.7%. The most dramatic improvement occurred in the number of environmental certifications held by MSMEs, which increased by 350% from an average of 0.4 to 1.8 certifications per MSME. This indicates that GSCM provides access to broader markets and enhances MSME credibility among international buyers.

GSCM implementation strengthens MSME reputation as environmentally responsible producers, which in turn enhances brand value and customer loyalty.

Table 5. Impact of GSCM on Reputation and Brand Value

Indicator	Score Before (1-10)	Score After (1-10)	Change (%)
Customer Perception of Sustainability	4.2	7.8	+85.7
Customer Loyalty	5.1	7.9	+54.9
Bargaining Power with Buyers	4.8	7.2	+50.0
Premium Pricing Capability	3.9	6.5	+66.7
International Market Reputation	4.5	7.6	+68.9

Source: Primary Data, 2025

Table 5 shows improvements across various reputation and brand value indicators following GSCM implementation. The highest improvement occurred in customer perception of sustainability (+85.7%), followed by premium pricing capability (+66.7%), and international market reputation (+68.9%). These improvements indicate that GSCM not only provides operational benefits but also builds valuable intangible assets for MSMEs.

Regulatory pressure moderates the relationship between GSCM and financial performance. MSMEs facing higher regulatory pressure demonstrate stronger relationships between GSCM implementation and financial performance improvement.

Table 6. Influence of Regulatory Pressure on the GSCM-Financial Performance Relationship

Regulatory Pressure Level	Number of MSMEs	Average Financial Performance Improvement (%)	Category
High (score >7)	6	24.3	Very Significant
Medium (score 4-7)	8	15.8	Significant
Low (score <4)	4	8.2	Moderate

Source: Primary Data, 2025

Table 6 shows that MSMEs with high regulatory pressure experienced an average financial performance improvement of 24.3%, considerably higher than those with low regulatory pressure (8.2%). This finding indicates that regulatory pressure serves as a catalyst to strengthen the impact of GSCM on financial performance. MSMEs facing high regulatory pressure tend to implement GSCM more seriously and innovate solutions that are both economically and environmentally beneficial.

An informant from the palm oil plantation sector (I-01) stated:

"We were forced to implement green practices due to demands from European buyers. They require ISPO and RSPO certification. Initially, it felt burdensome, but now we see the benefits. Operational costs have decreased and selling prices have increased. Regulations actually force us to become better." (I-01, Palm Oil Plantation Owner, Medan)

Green literacy was also found to moderate the relationship between GSCM and financial performance. MSMEs with higher green literacy demonstrate better GSCM implementation effectiveness and a greater impact on financial performance.

Table 7. Influence of Green Literacy on the GSCM-Financial Performance Relationship

Green Level	Literacy	Number of MSMEs	Average Financial Improvement (%)	Performance Category
High (score >7)		5	25.6	Very Significant
Medium (score 4-7)		9	16.3	Significant
Low (score <4)		4	9.1	Moderate

Source: Primary Data, 2025

Table 7 shows that MSMEs with high green literacy experienced an average financial performance improvement of 25.6%, compared to 9.1% for those with low green literacy. High green literacy enables owners and managers to understand the long-term benefits of green investments, identify efficiency opportunities, and communicate sustainability values to stakeholders.

An informant from the coffee sector (I-05) explained:

"I participated in training on sustainability and coffee certification. That knowledge helped me understand what buyers demand and how to fulfill it efficiently. Without that knowledge, I would likely be confused and waste money on unnecessary things." (I-05, Coffee Business Owner, Medan).

Based on the research findings, a contextual GSCM strategic model for North Sumatra export MSMEs was developed, comprising five main components: (1) green supplier collaboration, (2) resource efficiency, (3) waste reduction, (4) certification and compliance, and (5) sustainable performance monitoring.

Table 8. Components of the Contextual GSCM Strategic Model

Component	Description	Key Practices	Impact on Financial Performance
Green Supplier Collaboration	Cooperation with suppliers implementing environmentally friendly practices	Supplier selection based on environmental criteria, supplier training, long-term contracts	Supply stability, raw material cost reduction
Resource Efficiency	Optimization of raw material, energy, and water usage	Energy-efficient technology adoption, water recycling, raw material reduction	Operational cost savings (11.5%)
Waste Reduction	Minimization and management of production	Waste treatment, recycling, waste utilization as	Waste disposal cost reduction (16.0%)

Component	Description	Key Practices	Impact on Financial Performance
	waste	alternative raw material	
Certification and Compliance	Fulfillment of national and international environmental standards	ISPO, RSPO, ISO 14001, organic certification	Export market access, premium pricing
Performance Monitoring	Measurement and evaluation of sustainability performance	ESG environmental carbon measurement reporting, auditing, footprint	Transparency, stakeholder trust

Source: Primary Data Analysis Results, 2025

Description of Table 8: The contextual GSCM strategic model consists of five interconnected components. Each component has key practices and specific impacts on the financial performance. Resource efficiency and waste reduction components provide direct impacts on cost savings, while certification and compliance open export market access and enable premium pricing. Green supplier collaboration and performance monitoring serve as the foundation for implementing other components.

The research findings demonstrate that GSCM implementation contributes positively to the sustainable financial performance of North Sumatra export MSMEs through three primary mechanisms: operational cost efficiency, expanded export market access, and reputation strengthening. This finding aligns with Nugraha et al. (2025), who indicated that sustainable supply chains have a positive and significant relationship with MSME financial performance (Nugraha et al. 2025).

The operational cost efficiency mechanism identified in this study—through raw material reduction, energy savings, and waste cost reduction—is consistent with findings on green supply chain accounting, which significantly improves cost efficiency through operational waste reduction and resource utilization optimization. This finding reinforces the argument that sustainability practices provide dual benefits: internal efficiency and external access to financing opportunities.

However, this finding differs from several previous studies that found that GSCM has no significant effect on economic performance. This difference can be explained by the specific context of export MSMEs facing more intensive global market pressures, thereby driving more serious and measurable GSCM adoption in these firms. Export MSMEs in North Sumatra do not merely implement GSCM for compliance but also as a competitive strategy to maintain and expand their market access.

The finding on export market access improvement of 73.7% in export value indicates that GSCM functions as a *market access enabler*. This aligns with Al-Ghwayeen's finding of a positive relationship between GSCM and export performance. Environmental certifications such as ISPO, RSPO, and ISO 14001 serve as *passports* for MSMEs to enter markets that increasingly demand sustainable products, particularly in Europe and North America.

The research findings confirm that regulatory pressure moderates the relationship between GSCM and financial performance. MSMEs facing high regulatory pressure showed greater financial performance improvement (24.3%) than those facing low pressure (8.2%). This finding aligns with Karanja et al.'s (2026) finding that environmental regulatory frameworks increase the explanatory power of the green investment-profitability model.

Regulatory pressure functions as a *catalyst* encouraging MSMEs to implement GSCM more seriously and structurally. As articulated by the Porter Hypothesis, well-designed environmental regulations can drive innovation that enhances productivity and competitive advantage. In the context of North Sumatra's exporting MSMEs, regulations such as the EUDR and sustainability certification requirements encourage MSMEs to invest in green practices that ultimately yield efficiency and competitive advantages.

This finding is also consistent with research in Morocco, which shows that regulatory pressure has direct positive effects and significantly strengthens GSCM benefits. Regulation creates a *level playing field* where MSMEs investing in sustainability are not disadvantaged by competitors ignoring environmental aspects. With regulation, green investment becomes a necessity rather than a choice, motivating MSMEs to seek efficient and profitable methods of implementation.

However, it should be noted that the effectiveness of regulatory pressure heavily depends on the MSME's capacity to comply. Several informants expressed difficulties in meeting regulatory requirements due to resource limitations and a lack of assistance. This indicates the need for policies that not only pressure but also support MSMEs through incentives, training and technical assistance.

Green literacy was proven to be a significant moderating variable in the GSCM-financial performance relationship. MSMEs with high green literacy showed an average financial performance improvement of 25.6%, compared to 9.1% for those with low green literacy. This finding aligns with that of Trivena et al. (2026), who found that environmental knowledge significantly influences GSCM implementation and business performance (Trivena et al. 2026).

Green literacy enables MSME owners and managers to: (1) understand the long-term benefits of green investments; (2) identify efficiency opportunities invisible to those less knowledgeable; (3) communicate sustainability value to stakeholders; and (4) avoid greenwashing that could damage their reputation.

This finding also supports research on customer green literacy, showing that customer green literacy drives companies to undertake sustainable supply chain management practices. In the context of export MSMEs, green literacy extends beyond business owners to the entire value chain, including suppliers and consumers. MSMEs with high green literacy tend to build more sustainable business ecosystems.

The practical implication of this finding is the importance of capacity-building and green literacy programs for MSMEs. Training, mentoring, and access to information on green practices and their benefits need to be enhanced, especially for export-oriented MSMEs. Government, industry associations, and educational institutions play important roles in increasing green literacy among MSMEs.

The contextual GSCM strategic model developed in this study comprises five components: green supplier collaboration, resource efficiency, waste reduction, certification and compliance, and sustainable performance monitoring. This model extends the GSCM frameworks developed in previous research by adding certification and compliance components that are highly relevant for export MSMEs.

Green supplier collaboration is a critical foundation because exporting MSMEs heavily depend on the quality and sustainability of raw materials. Without supplier collaboration, MSMEs struggle to ensure that the entire supply chain is sustainable. This aligns with the findings that supply chain sustainability requires collaboration between suppliers and customers.

Resource efficiency and waste reduction are components that have a direct impact on cost savings. This finding is consistent with research on lean-green practices, showing that the integration of lean and green practices can improve efficiency and sustainability.

Certification and compliance have become critical components for exporting MSMEs, as they function as market access enablers. Certifications such as ISPO, RSPO, and ISO 14001 not only fulfill regulatory requirements but also enhance credibility and competitiveness in international markets.

Sustainable performance monitoring enables MSMEs to measure their progress, identify areas for improvement, and communicate their achievements to stakeholders. This aligns with the importance of ESG reporting in enhancing transparency and trust in the banking sector.

CONCLUSION

This study concludes that Green Supply Chain Management (GSCM) implementation contributes positively to the sustainable financial performance of export MSMEs in North Sumatra through three primary mechanisms: operational cost efficiency (averaging 12.2%), enhanced export market access (export value increase of 73.7%), and reputation and brand value strengthening. Regulatory pressure moderates the GSCM-financial performance relationship, where MSMEs with high regulatory pressure experience a financial performance improvement of 24.3% compared to 8.2% for those with low regulatory pressure. Green literacy also moderates this relationship, with high-green-literacy MSMEs showing a financial performance improvement of 25.6% compared to 9.1% for low-green-literacy MSMEs. This study develops a contextual GSCM strategic model consisting of green supplier collaboration, resource efficiency, waste reduction, certification and compliance, and sustainable performance monitoring. This research has limitations in terms of geographic scope and sample size; therefore, further research with a broader scope and mixed-method approaches is recommended to generalize the findings. This study provides strategic guidance for MSMEs, regulators, and other stakeholders to integrate sustainability into supply chains to achieve sustainable long-term financial performance.

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