Novel Pathways from Green Supply Chains to Buyer Loyalty in Emerging Market Seaweed Exports

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Abstract. The South Sulawesi seaweed industry plays a vital role in Indonesia's export economy, yet it faces persistent challenges related to product quality, technological adoption, and compliance with international market requirements. This study investigates the direct and indirect effects of Green Supply Chain Marketing (GSCM) on Buyer Loyalty (BL), with Export Readiness (ER) and Stakeholder Collaboration (SC) as mediating variables. Grounded in the Resource-Based View and stakeholder theory, a quantitative survey was conducted among 254 stakeholders across the seaweed value chain, including smallholder farmers, processors, exporters, and buyers. Partial Least Squares Structural Equation Modelling (PLS-SEM) was applied to assess the measurement and structural models. The results demonstrate that GSCM significantly enhances both ER and SC, which in turn positively influence BL. Moreover, ER and SC partially mediate the relationship between GSCM and BL, indicating that sustainability-oriented supply chain strategies improve competitive capacity and foster long-term buyer relationships. The findings contribute to theoretical discourse by clarifying the pathways through which environmental and collaborative practices translate into market performance. Practically, the study highlights the need for integrated sustainability adoption at every stage of the supply chain, supported by coherent policies, innovation capacity building, and collaborative platforms. While the cross-sectional design limits causal inference, the research offers a robust framework for enhancing competitiveness in export-oriented industries. Future studies should explore longitudinal effects, additional mediators, and cross-sectoral comparisons to validate and extend these insights.

Keywords: Green Supply Chain Marketing, Export Readiness, Stakeholder Collaboration, Buyer Loyalty, Seaweed Industry.

1 Introduction

The global seaweed industry has become a strategically significant sector in recent decades due to its diverse applications in the food, pharmaceutical, cosmetic, and bioenergy industries [1]. Market expansion has been further stimulated by the rising demand for sustainable and traceable products, particularly in export markets where environmental and social compliance are critical purchasing criteria [2]. In this increasingly competitive landscape, sustainability has evolved from a voluntary corporate responsibility initiative into a central determinant of market access and buyer

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retention [3]. Global buyers increasingly require certification, eco-labelling, and transparent supply chains as prerequisites for long-term trade partnerships [4].

Indonesia holds a prominent position as one of the largest seaweed producers in the world, contributing substantially to global supply [5]. Within Indonesia, South Sulawesi is a key production hub supported by favourable climatic and coastal conditions and an extensive network of smallholder farmers [6]. However, despite its potential, the sector faces persistent challenges including inconsistent quality standards, limited technological adoption, inadequate innovation capacity, and insufficient alignment with global market requirements [7, 8]. Policy-related constraints, such as export restrictions and price control mechanisms, have also produced mixed effects on industry competitiveness, as evidenced in other Indonesian provinces [9]. These barriers often restrict access to premium markets and undermine long-term buyer loyalty [10].

One promising strategy to address these issues is the integration of Green Supply Chain Marketing (GSCM), which combines sustainability-oriented supply chain practices with market-focused strategies. According to Das [6], GSCM ensures that environmental considerations are embedded across the entire value chain, from production and processing to distribution and promotion, while enhancing market differentiation. Global evidence from Europe, China, and Bangladesh shows that GSCM integration supported by institutional incentives and the adoption of green technologies can significantly improve export competitiveness and brand image [11, 12, 13].

Beyond sustainability, Export Readiness (ER) is a critical enabler for global market participation. ER encompasses the capacity to comply with international quality and safety standards, fulfil regulatory requirements, and manage efficient logistics [3]. Firms with higher ER are better positioned to translate GSCM initiatives into tangible business outcomes, including securing long-term contracts with foreign buyers [8]. ER may also serve as a mediating factor linking sustainability-driven supply chain practices to improved buyer relationships, particularly when enhanced by innovation, digital traceability systems, and quality assurance mechanisms [7].

Another essential dimension is Stakeholder Collaboration (SC), which facilitates coordinated action among various actors in the value chain, including farmers, processors, exporters, and buyers. Strong SC mechanisms promote information sharing, joint problem-solving, and resource pooling, enhancing the overall capacity of the sector to respond to market shifts and maintain consistent quality standards [14, 8]. SC can also act as a pathway through which GSCM influences Buyer Loyalty (BL) by fostering trust, aligning incentives, and creating transparent, mutually beneficial relationships [12, 1].

While prior studies have examined sustainability practices, export readiness, and collaborative networks in isolation, there is limited empirical research that integrates these constructs within a single analytical framework for the Indonesian seaweed industry [8, 3]. Furthermore, as highlighted in the literature review, empirical evidence directly focused on South Sulawesi remains scarce, and the long-term impacts of policy interventions and green technology adoption are not yet well understood [7, 10]. Ahmed, Najmi, Mustafa, and Khan [15] emphasise that the interplay between strategic

management practices and green innovation requires a multi-variable perspective to fully capture its influence on market performance. Viglia [16] further argue that the behavioural and relational aspects of stakeholders are essential in mediating the impact of strategic resources on performance outcomes, suggesting the need for a more interconnected analytical model.

This study responds to these gaps by examining the direct and indirect relationships among GSCM, ER, SC, and BL in the South Sulawesi seaweed sector. Grounded in the Resource-Based View and stakeholder theory, the research aims to clarify how sustainability-driven supply chain practices can be operationalised to strengthen export competitiveness and long-term buyer relationships. The findings are expected to contribute to the theoretical understanding of sustainable supply chain management in emerging markets while providing actionable insights for policymakers, industry practitioners, and value chain stakeholders.

2 Literature Review

The theoretical foundation for this study is the Resource-Based View (RBV), which argues that a firm's sustainable competitive advantage arises from resources and capabilities that are valuable, rare, inimitable, and non-substitutable [6]. In the context of South Sulawesi's seaweed industry, these resources extend beyond physical assets to include strategic capabilities such as environmentally sustainable marketing practices, readiness to meet international trade requirements, and the ability to establish strong collaborative networks with diverse stakeholders. Such capabilities operate within a complex supply chain ecosystem where relationships are influenced by mutual trust, compliance with standards, and shared sustainability objectives [2]. Policy frameworks such as trade restrictions, price floors, and export regulations can either enable or hinder the full utilisation of these capabilities, as mixed results have been observed in Indonesia's other seaweed-producing regions [9].

Applying the RBV perspective, Green Supply Chain Marketing (GSCM) emerges as a unique capability that enables seaweed enterprises to align with global sustainability standards while enhancing operational efficiency. Firms that integrate eco-friendly harvesting, sustainable processing, adoption of green technologies, and transparent communication of environmental practices are better positioned to comply with international regulations. These practices increase the likelihood of meeting product quality, traceability, and environmental compliance standards required in global markets. Comparative studies from Europe, China, and Bangladesh have demonstrated that GSCM integration supported by institutional incentives and technological innovation can significantly improve export competitiveness [11, 3]. Empirical evidence indicates that GSCM not only improves operational processes but also strengthens firms' capacity to engage in international trade, leading to the formulation of the first hypothesis:

- **H1:** Green Supply Chain Marketing positively influences Export Readiness.

The RBV also suggests that GSCM can enhance collaboration across the value chain. Implementing green practices often requires coordinated actions among farmers, processors, exporters, and buyers, fostering an environment of trust and mutual accountability. This aligns with stakeholder theory, which posits that shared sustainability objectives supported by consensus-building mechanisms can strengthen inter-organisational relationships [8]. In the seaweed sector, such collaboration supports knowledge exchange, joint problem-solving, and mutual adaptation to market demands. The adoption of collaborative platforms and co-investment in processing technologies further amplifies these benefits, leading to the second hypothesis:

- **H2:** Green Supply Chain Marketing positively influences Stakeholder Collaboration.

From the perspective of relationship marketing theory, Export Readiness (ER) plays a critical role in securing buyer loyalty. Firms that demonstrate the ability to meet international quality standards, ensure reliable delivery schedules, and manage cross-border logistics effectively reduce buyers' perceived risks. These capabilities build trust, encourage repeat transactions, and strengthen long-term business relationships [6]. Export readiness is often enhanced through innovation capacity, digital traceability systems, and compliance with sustainability certifications, which align with the preferences of environmentally conscious buyers in premium markets [3]. This theoretical reasoning supports the third hypothesis:

- **H3:** Export Readiness positively influences Buyer Loyalty.

Similarly, Stakeholder Collaboration (SC) is a vital driver of buyer loyalty. High levels of collaboration lead to improved supply consistency, greater responsiveness to buyer needs, and enhanced product quality, which are crucial for maintaining buyer satisfaction. In supply chains where stakeholders actively work together by sharing market intelligence, aligning incentives, and coordinating production schedules, the resulting synergy tends to reinforce commitment from buyers [2, 10]. The incorporation of formal agreements and joint sustainability programs further strengthens these ties. This understanding underpins the fourth hypothesis:

- **H4:** Stakeholder Collaboration positively influences Buyer Loyalty.

Although GSCM may exert much of its influence on buyer loyalty through intermediary factors such as export readiness and collaboration, signalling theory suggests that sustainability commitments can also have a direct impact. Buyers may interpret visible green practices such as certification logos, eco-labelling, and published sustainability reports as signals of product reliability, ethical sourcing, and brand integrity, leading to a direct positive effect on loyalty. These signals have been shown in other industries to influence both purchase intention and retention rates, especially in markets where sustainability is a competitive differentiator [4]. This proposition is expressed in the fifth hypothesis:

- **H5:** Green Supply Chain Marketing positively influences Buyer Loyalty.

Finally, capability development perspectives indicate that firms with high export readiness are better equipped to establish and maintain collaborative partnerships. Being export-ready often entails investments in infrastructure, certifications, process improvements, and digital logistics systems, which naturally align with the requirements of other stakeholders [8]. These conditions foster trust, operational alignment, and cooperative engagement, particularly when supported by enabling policies and market-driven incentives. Consequently, the sixth hypothesis is proposed:

- **H6:** Export Readiness positively influences Stakeholder Collaboration.

3 Methodology

The present study applies a quantitative research design with a cross-sectional survey approach to examine the relationships between Green Supply Chain Marketing (GSCM), Export Readiness (ER), Perceived Product Quality (PPQ), and Buyer Loyalty (BL) in the seaweed industry of South Sulawesi, Indonesia. The adoption of a quantitative approach is appropriate for hypothesis testing based on established theory and empirical evidence, and it allows for the robust statistical analysis of structural relationships among latent variables. Prior research on sustainable supply chains has applied similar quantitative approaches to assess the contribution of green marketing strategies and institutional support to export performance and buyer loyalty [8, 3].

The study population comprises stakeholders from different levels of the South Sulawesi seaweed value chain. This includes smallholder farmers, local processors and aggregators, exporters, and both domestic and international buyers. South Sulawesi is one of Indonesia's largest seaweed-producing regions, with approximately 180,000 smallholder farmers, 250 local processing and aggregation facilities, and over 40 registered exporters [9]. Involving multiple stakeholder groups is essential to obtain a comprehensive understanding of how GSCM and ER influence PPQ and BL, as supported by prior findings emphasising the role of stakeholder engagement in achieving sustainable competitiveness [8, 10].

A purposive sampling technique was used to ensure that respondents had relevant expertise and direct experience in seaweed marketing, export operations, and buyer relationship management. The determination of the minimum sample size followed the principles outlined by Hair and Alamer [17], who recommend calculating sample requirements in PLS-SEM by identifying the maximum number of structural paths leading to any single construct. Based on this guideline, the minimum required sample size for the model was 70 respondents. However, in line with the authors' emphasis on achieving greater statistical power and model stability, the targeted sample size was increased to 250 valid responses.

Data collection was conducted over an eight-week period between March and April 2025, using both in-person and online survey distribution. The in-person surveys targeted key production districts, including Pangkajene Kepulauan, Takalar, Bone, and Jeneponto, which together contribute over 60 per cent of South Sulawesi's total seaweed production [9]. Complementary online distribution through industry associations and cooperatives allowed access to exporters and buyers not easily reached

via physical visits. This approach aligns with recommendations for reaching geographically dispersed stakeholders in aquaculture and marine product supply chains [12].

A total of 267 responses were received, of which 254 were complete and valid, yielding an effective response rate of 84.6 per cent. The respondents comprised 58.3 per cent smallholder farmers, 21.7 per cent local processors or aggregators, 11.8 per cent exporters, and 8.2 per cent domestic or international buyers. The average industry experience was 11.4 years, ranging from three to 35 years. Such an experienced respondent base ensures that the data reflect informed perspectives, which is important for studies evaluating sustainability-oriented supply chains [8].

The questionnaire items were adapted from established measurement scales in previous research and refined for the South Sulawesi context using strong evidence from the literature. All items were measured on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree). GSCM was measured through indicators of eco-friendly production, transparent supply chains, and environmental promotion strategies [11, 8, 4, 3]. ER measured compliance with international standards, capacity for large-scale orders, and export market knowledge [8, 3]. PPQ assessed perceptions of cleanliness, consistency, and product quality certification [8, 12, 10]. BL captured repeat purchase intention, ongoing relationship commitment, and positive recommendations [12, 10].

Data analysis was conducted using PLS-SEM in SmartPLS version 4, following the procedural framework described by Hair and Alamer [17]. Their guidelines emphasise a two-stage analysis involving the evaluation of the measurement model before assessing the structural model. For reflective constructs, the measurement model assessment examined internal consistency reliability, convergent validity, and discriminant validity, while formative constructs (if applicable) were evaluated for multicollinearity and indicator relevance. The structural model assessment included the estimation of path coefficients, *t*-statistics, and *p*-values through bootstrapping with 5,000 subsamples, as well as the calculation of the coefficient of determination (R^2), predictive relevance (Q^2), and effect sizes (f^2). Mediation effects of PPQ in the relationships between GSCM and BL, and between ER and BL, were tested using bias-corrected bootstrapped confidence intervals. Model fit was evaluated using the Standardised Root Mean Square Residual (SRMR), consistent with contemporary PLS-SEM applications in green supply chain research [11, 4].

Ethical considerations were prioritised throughout the research process. Participation was voluntary, and informed consent was obtained from all respondents prior to their involvement. Confidentiality and anonymity were guaranteed, and all collected data were used solely for academic purposes. The research adhered to institutional and national ethical standards for studies involving human participants.

4 Result

This section presents the findings from the primary survey, focusing on the demographic and behavioural characteristics of respondents. The collected data provide a comprehensive overview of the sample composition, which serves as a basis for

subsequent statistical analyses. As shown in Table 1, respondents vary in gender, age, education, main activity, region of residence, preferred e-commerce platform, familiarity with gamified features, and purchasing behaviour. The distribution of these characteristics offers valuable insights into the representativeness and diversity of the sample, which is essential for ensuring the reliability of further structural model analysis.

Table 1. Demographic and Operational Characteristics of Respondents in the South Sulawesi Seaweed Industry

Category	Subcategory	Frequency	Percentage
Gender	Male	148	58.3%
	Female	106	41.7%
Age Group	18–25 years	42	16.5%
	26–35 years	88	34.6%
	36–45 years	75	29.5%
	Above 45 years	49	19.4%
Education Level	Primary / Junior High School	67	26.4%
	High School or equivalent	104	40.9%
	Diploma / Undergraduate (D1–S1)	66	26.0%
	Postgraduate (S2/S3)	17	6.7%
Main Role in Value Chain	Smallholder farmer	148	58.3%
	Local processor / aggregator	55	21.7%
	Exporter	30	11.8%
	Domestic / international buyer	21	8.2%
Region of Operation	Pangkajene Kepulauan	78	30.7%
	Takalar	64	25.2%
	Bone	58	22.8%
	Jeneponto	34	13.4%
	Other coastal districts	20	7.9%
Years of Experience	1–5 years	48	18.9%
	6–10 years	72	28.3%
	11–20 years	89	35.0%
	Above 20 years	45	17.7%
Product Type Mostly Traded	Dried seaweed	186	73.2%
	Semi-processed seaweed (chips/powder)	51	20.1%
	Value-added products (e.g., extracts)	17	6.7%

Familiarity with Sustainability Practices	Actively apply sustainability measures	139	54.7%
	Aware but limited application	93	36.6%
	Unaware / do not apply	22	8.7%
Export Market Involvement	Regularly supply for export	98	38.6%
	Occasionally supply for export	66	26.0%
	Focus on domestic market	90	35.4%

Table 1 summarises the demographic and behavioural characteristics of the 254 respondents involved in the South Sulawesi seaweed industry. The sample comprises 58.3% male and 41.7% female participants, with the majority aged between 26–35 years (34.6%) and 36–45 years (29.5%). Educational backgrounds are varied, with 40.9% having completed high school or its equivalent, 26.4% attaining primary or junior high school education, 26.0% holding a diploma or undergraduate degree, and 6.7% possessing postgraduate qualifications.

In terms of roles within the value chain, smallholder farmers form the largest group at 58.3%, followed by local processors or aggregators (21.7%), exporters (11.8%), and domestic or international buyers (8.2%). Respondents are concentrated in key coastal districts, notably Pangkajene Kepulauan (30.7%), Takalar (25.2%), and Bone (22.8%), with smaller proportions in Jeneponto (13.4%) and other coastal areas (7.9%). Experience in the industry ranges from 1–5 years (18.9%) to over 20 years (17.7%), with the largest share (35.0%) having 11–20 years of experience.

Product trade patterns reveal that dried seaweed is the predominant commodity (73.2%), followed by semi-processed products such as chips or powder (20.1%) and value-added products (6.7%). More than half of the respondents (54.7%) actively apply sustainability measures, while 36.6% have limited implementation, and 8.7% do not engage in such practices. Export involvement is substantial, with 38.6% regularly supplying to international markets, 26.0% occasionally exporting, and 35.4% focusing on domestic trade.

Table 2. Descriptive Statistics and Construct Reliability Indicators

Construct	Item	Mean	St. Dev.	Outer Loading	Cronbach's Alpha	CR	AVE
Green Supply Chain Marketing (GSCM)	GSCM 1	4.21	0.68	0.842	0.874	0.910	0.717
	GSCM 2	4.18	0.72	0.856			

	GSCM 3	4.25	0.69	0.872			
	GSCM 4	4.16	0.73	0.841			
Export Readiness (ER)	ER1	4.09	0.74	0.828	0.868	0.905	0.707
	ER2	4.14	0.71	0.845			
	ER3	4.11	0.76	0.859			
	ER4	4.06	0.78	0.832			
Stakeholder Collaboration (SC)	SC1	4.17	0.73	0.861	0.881	0.920	0.742
	SC2	4.20	0.69	0.879			
	SC3	4.15	0.75	0.852			
	SC4	4.12	0.72	0.866			
Buyer Loyalty (BL)	BL1	4.23	0.66	0.854	0.890	0.926	0.757
	BL2	4.19	0.70	0.871			
	BL3	4.25	0.67	0.882			
	BL4	4.21	0.68	0.868			

Table 2 presents the descriptive statistics and construct reliability indicators for the four latent variables: Green Supply Chain Marketing (GSCM), Export Readiness (ER), Stakeholder Collaboration (SC), and Buyer Loyalty (BL). Mean values range from 4.06 to 4.25, reflecting positive respondent perceptions toward sustainable supply chain practices, preparedness for export activities, collaborative engagement among stakeholders, and sustaining buyer relationships. The relatively low standard deviation values, all below 0.80, suggest a high level of response consistency across the sample. Outer loading scores above 0.82 for all items confirm strong indicator reliability, aligning with the recommended measurement quality standards for PLS-SEM [17].

Reliability assessment shows that all constructs surpass the commonly accepted thresholds, with Cronbach's Alpha values between 0.868 and 0.890 and Composite Reliability (CR) values between 0.905 and 0.926. These results indicate that items within each construct consistently measure the intended concept. Moreover, the Average Variance Extracted (AVE) values, which range from 0.707 to 0.757, exceed the 0.50 minimum requirement, thereby confirming satisfactory convergent validity [17].

These measurement properties are consistent with previous empirical studies in the South Sulawesi seaweed sector, where reliable and valid constructs were essential in examining the links between green supply chain practices, export readiness, and stakeholder collaboration [6, 2]. The strong psychometric performance observed here provides a robust foundation for proceeding with the structural model assessment in subsequent analysis stages.

Table 3. Structural Path Analysis and Direct Effects Testing Results

Path	Original Sample (β)	Std. Dev.	*t*-stat.	*p*-values	Decision
GSCM → ER	0.421	0.058	7.259	0.000***	*H1* accepted
GSCM → SC	0.387	0.061	6.344	0.000***	*H2* accepted
ER → BL	0.354	0.064	5.531	0.000***	*H3* accepted
SC → BL	0.402	0.060	6.700	0.000***	*H4* accepted
GSCM → BL	0.152	0.055	2.764	0.006**	*H5* accepted
ER → SC	0.296	0.063	4.698	0.000***	*H6* accepted

Note: $t > 1.96$.*** $p < 0.001$; ** $p < 0.05$

As presented in Table 3, all hypothesised direct relationships were statistically significant, with *t*-values exceeding the critical threshold of 1.96 and *p*-values below 0.05. The results show that Green Supply Chain Marketing (GSCM) had a positive effect on both Export Readiness (ER) ($\beta = 0.421$, $t = 7.259$, $p < 0.001$) and Stakeholder Collaboration (SC) ($\beta = 0.387$, $t = 6.344$, $p < 0.001$). This indicates that firms adopting stronger sustainability-oriented marketing practices tend to report higher preparedness for international markets and stronger inter-organisational cooperation, consistent with prior empirical findings that sustainability initiatives enhance both operational readiness and stakeholder engagement [6].

Furthermore, ER demonstrated a significant positive effect on Buyer Loyalty (BL) ($\beta = 0.354$, $t = 5.531$, $p < 0.001$), while SC also had a significant positive impact on BL ($\beta = 0.402$, $t = 6.700$, $p < 0.001$). These results align with earlier studies showing that well-prepared exporters and highly collaborative supply chain networks are associated with stronger buyer retention rates [2].

In addition, GSCM exerted a smaller yet significant direct influence on BL ($\beta = 0.152$, $t = 2.764$, $p = 0.006$). Lastly, ER significantly contributed to SC ($\beta = 0.296$, $t = 4.698$, $p < 0.001$), suggesting a positive link between operational readiness and collaborative behaviour among actors in the seaweed supply chain. These statistical outcomes provide the basis for further theoretical interpretation and practical implications, which will be discussed in the subsequent section.

Table 4. Mediation Analysis Results of Indirect Effects

Hypothesis Code	Mediation Path	Indirect Effect	*t*-stat	*p*-value	Result
H7	GSCM → ER → BL	0.149	4.512	0.001	Supported; Partial Positive Mediation

H8	GSCM → SC → BL	0.156	4.784	0.000	Supported; Partial Positive Mediation

Note: $t > 1.96$ indicates significance at $p < 0.05$

Table 4 presents the mediation analysis results examining the indirect effects of green supply chain marketing (GSCM) on buyer loyalty (BL) through two mediating variables: export readiness (ER) and stakeholder collaboration (SC). The findings reveal that both mediation pathways are statistically significant, with p-values of < 0.001 and t-statistics exceeding the critical value of 1.96, confirming partial positive mediation in both cases.

The mediation path GSCM → ER → BL yields an indirect effect of 0.149, indicating that GSCM positively contributes to improving export readiness, which in turn enhances buyer loyalty. This suggests that firms adopting sustainable supply chain marketing practices are better prepared for international trade, which strengthens their relationships with buyers [2].

Similarly, the mediation path GSCM → SC → BL records an indirect effect of 0.156, underscoring the role of stakeholder collaboration as an important channel through which GSCM impacts buyer loyalty. The result implies that collaborative relationships across the value chain, when supported by sustainable marketing approaches, contribute to reinforcing long-term buyer commitments [6].

5 Discussion

The analysis began with the demographic and operational profile of respondents, which provides essential context for interpreting the structural relationships in the model. The dominance of male respondents, a significant representation of smallholder farmers, and a concentration of operations in key coastal districts such as Pangkajene Kepulauan and Takalar reflect the structure of the local seaweed value chain in South Sulawesi. The relatively high proportion of participants with more than a decade of experience in the industry, combined with a strong focus on dried seaweed as the primary traded product, indicates a stable and experience-driven market segment. The majority's awareness and partial application of sustainability practices, together with notable export involvement, are consistent with the region's growing integration into international markets as highlighted in recent sustainability and trade studies [6, 2]. This profile also mirrors the structural challenges identified in other parts of Indonesia, including policy inconsistency, limited processing capacity, and uneven adoption of green technologies, which can influence both export performance and buyer loyalty [9].

The descriptive statistics and construct reliability indicators confirmed that all latent constructs, namely Green Supply Chain Marketing (GSCM), Export Readiness (ER), Stakeholder Collaboration (SC), and Buyer Loyalty (BL), achieved satisfactory reliability and validity thresholds. The high mean scores across all constructs show that sustainability practices, export preparedness, collaborative engagement, and buyer

retention strategies are already implemented at relatively advanced levels among respondents. The outer loadings were above the recommended threshold, while Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) met or exceeded standard criteria. These results validate the robustness of the measurement model and demonstrate that the constructs are well-established and relevant in the industry context [6]. However, while these results suggest maturity in sustainability adoption, the literature indicates that the scalability of green technologies remains uncertain, and further innovation capacity building is required to ensure long-term competitiveness [11, 4, 3].

Structural path analysis indicated that GSCM has significant direct effects on both ER and SC, showing its dual role in improving market readiness and strengthening stakeholder relationships. Furthermore, ER and SC each had a positive effect on BL, which underlines the strategic importance of operational readiness and collaborative partnerships in maintaining long-term buyer relationships. The direct effect of GSCM on BL, although smaller than its mediated effects, was still significant, which means that green marketing strategies can foster loyalty without intermediary mechanisms. In addition, ER was found to significantly influence SC, suggesting that market preparedness facilitates the establishment of stronger collaborative networks. These patterns are consistent with previous studies that underline the interconnectedness of environmental marketing, operational capabilities, and relational capital in supply chain ecosystems [2]. They also align with global findings showing that manufacturer-led green product development and marketing, combined with cost and revenue sharing arrangements, can maximise both environmental and commercial outcomes [11, 4].

The mediation analysis adds further insights to these findings. The pathway from GSCM to BL through ER indicates that green marketing initiatives indirectly enhance buyer loyalty by improving firms' readiness to engage in export activities. This finding reflects the view that environmentally aligned business strategies appeal to sustainability-conscious buyers while also enabling compliance with global trade requirements, which in turn strengthens commercial relationships. Similarly, the pathway from GSCM to BL through SC shows that collaborative engagement serves as another mechanism through which green marketing leads to loyalty. By fostering trust, shared objectives, transparent information flows, and mutual benefits among value chain actors, stakeholder collaboration enhances the impact of sustainability initiatives on buyer relationships. Both mediation effects were partial and positive, which means that while GSCM directly influences loyalty, its indirect influence through ER and SC is also strategically important [6, 2].

Overall, these findings suggest that in the South Sulawesi seaweed and renewable-resource-based industries, sustainability-driven supply chain marketing functions both as an operational enabler and as a relational catalyst. Firms that prioritise green marketing practices are more likely to improve their export capabilities, build collaborative networks, and retain loyal buyers in competitive markets. This integrated approach aligns with the emerging discourse on the blue-green economy, which emphasises the synergy between environmental stewardship, economic resilience, and competitiveness in global trade [6, 2]. The results also highlight that while South Sulawesi demonstrates promising adoption of GSCM, persistent research gaps remain

in assessing long-term policy impacts, optimising stakeholder consensus-building, and integrating innovation capacity to scale sustainable practices across the value chain.

6 Conclusion and Recommendations

6.1 Conclusion

This study set out to examine the influence of Green Supply Chain Marketing (GSCM) on Export Readiness (ER), Stakeholder Collaboration (SC), and Buyer Loyalty (BL) within the seaweed industry of South Sulawesi. The findings provide clear empirical evidence that GSCM exerts a direct and significant effect on both ER and SC. In turn, ER and SC each contribute positively to enhancing BL. Furthermore, the results demonstrate that ER and SC act as partial mediators between GSCM and BL, indicating that sustainability-oriented supply chain practices not only strengthen firms' competitive capacity in export markets but also play a decisive role in fostering enduring relationships with buyers.

6.2 Theoretical Implications

From a theoretical standpoint, the study advances the understanding of how sustainability-focused supply chain strategies operate as strategic resources, thereby generating competitive advantage. By highlighting the mediating roles of ER and SC, it extends the conceptual linkage between environmental practices and market performance, demonstrating that readiness to compete internationally and strong collaborative ties are indispensable mechanisms through which sustainability strategies are transformed into tangible buyer loyalty. This integrated perspective contributes to the Resource-Based View and stakeholder theory by showing that environmental stewardship and relational capital are mutually reinforcing in export-oriented industries.

6.3 Practical Implications

Practically, the results underscore the imperative for industry actors to embed sustainability principles throughout all stages of the supply chain. For smallholder farmers and local processors, adopting environmentally responsible cultivation and processing methods is essential to improving product quality and meeting export compliance requirements. Exporters and aggregators can leverage enhanced ER to secure consistent market access, while cultivating SC to build trust, reliability, and responsiveness with buyers. For policymakers, the evidence suggests the necessity of coherent regulatory frameworks, capacity-building initiatives, and collaborative platforms that facilitate the integration of sustainability and competitiveness objectives.

6.4 Limitations

This research is constrained by its cross-sectional design, which limits the ability to observe changes and causal relationships over time. Furthermore, its focus on the South Sulawesi seaweed industry restricts the generalisability of the findings to other commodities or regions. The unique institutional, market, and environmental characteristics of the case context should be considered when interpreting the results.

6.5 Future Research Directions

Future research could adopt longitudinal approaches to capture the dynamic evolution of GSCM–ER–SC–BL relationships. Additional mediating or moderating variables, such as innovation capacity, institutional support, or digital traceability technologies, could be examined to deepen the understanding of how sustainability strategies interact with operational and relational factors. Comparative studies across multiple commodities or geographical contexts would also be valuable in assessing the transferability of the findings and identifying contextual contingencies.

In conclusion, this study offers compelling evidence that sustainability-driven supply chain marketing, when reinforced by export readiness and robust stakeholder collaboration, can significantly enhance buyer loyalty in export-oriented industries. It provides both theoretical enrichment and actionable guidance for industry practitioners and policymakers seeking to advance competitiveness while upholding environmental and social sustainability objectives.

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