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BLUE BOND FINANCING MODEL FOR ENVIRONMENTAL SOCIAL GOVERNANCE SEAWEED FARMING

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ABSTRAK

Penelitian ini mengkaji potensi obligasi biru sebagai instrumen pembiayaan berbasis Environtment, Social and Governance (ESG) untuk mendukung budidaya rumput laut berkelanjutan dan peningkatan daya saing masyarakat pesisir di Indonesia. Tujuan penelitian ini adalah menganalisis hubungan antara praktik ESG, kepatuhan terhadap pedoman obligasi biru, serta implikasinya terhadap kelayakan proyek dan pengembangan komunitas. Penelitian menggunakan pendekatan metode campuran. Tahap kuantitatif melibatkan survei terhadap 250 responden yang dianalisis menggunakan Partial Least Squares Structural Equation Modeling (PLS-SEM). Tahap kualitatif dilaksanakan melalui wawancara mendalam dan observasi lapangan dengan petani rumput laut, pengelola koperasi, dan pembuat kebijakan. Hasil penelitian menunjukkan bahwa praktik ESG berpengaruh signifikan terhadap kepatuhan pada pedoman obligasi biru dan meningkatkan kelayakan proyek serta daya saing komunitas. Namun, penerapan ESG belum optimal tanpa dukungan pembiayaan yang terjangkau, kapasitas kelembagaan yang memadai, dan koherensi regulasi. Temuan kualitatif mengungkap hambatan berupa keterbatasan akses kredit dan kelemahan tata kelola, sekaligus peluang melalui sertifikasi ESG dan insentif pasar. Penelitian ini menyimpulkan bahwa Blue Bonds berpotensi menjadi instrumen pembiayaan dan pembangunan yang menghubungkan keberlanjutan dengan hasil ekonomi yang inklusif.

Kata kunci: obligasi biru, budidaya rumput laut, daya saing, kelayakan proyek

ABSTRACT

This study investigates the potential of Blue Bonds, grounded in Environmental, Social, and Governance (ESG) principles, as a financing mechanism to advance sustainable seaweed farming and empower coastal communities in Indonesia. Employing a mixed-methods approach, the research examines the interplay between ESG adoption, adherence to Blue Bond guidelines, project feasibility, and local socio-economic outcomes. Quantitative analysis of survey data from 250 respondents using PLS-SEM is complemented by qualitative evidence from stakeholder interviews and field observations. Findings indicate that robust ESG practices foster greater compliance with guidelines, improve project viability, and enhance competitiveness. Nevertheless, the expansion of ESG initiatives is hindered by challenges such as scarce affordable financing, limited institutional capacity, and ambiguous regulatory frameworks. Key obstacles identified include restricted credit access and governance weaknesses, while opportunities exist through ESG certification and emerging market incentives. The study concludes that Blue Bonds hold substantial promise for integrating sustainability objectives with inclusive economic development, offering a pathway for resilient growth among Indonesia's coastal communities.

Key words: blue bonds, seaweed farmers, competitiveness, project feasibility

INTRODUCTION

Indonesia is widely recognized as the world's largest archipelagic nation, endowed with immense maritime potential. It possesses abundant opportunities to foster an ocean-based economy with more than 17,500 islands,

a maritime area of approximately 6.4 million km², and a coastline of 99,083 km (Alamsyah, 2023). However, the contribution of the maritime sector to Indonesia's Gross Domestic Product (GDP) remains relatively modest. Compared with countries such as Norway, Japan, China, and South Korea, which successfully derive more than 30% of their GDP from marine-related activities, Indonesia lags behind in maximizing the benefits of its maritime endowment (Kusumawardhani et al, 2023). The condition underscores the urgency of developing the so-called Blue Economy. It seeks to balance economic growth with ecological sustainability by optimizing and sustainably utilizing marine resources.

One of the most promising subsectors within Indonesia's Blue Economy is seaweed cultivation. According to the Food and Agriculture Organization (FAO, 2024), global seaweed production in 2023 reached 38 million tons (wet weight), 97% of which originated from aquaculture. Indonesia accounted for nearly 25% of global production, as the second-largest producer after China. At the national level, seaweed accounts for approximately 63.45% of total aquaculture output, making it a leading commodity in strengthening coastal economies and supporting non-oil exports (KKP, 2023). Beyond its economic role, seaweed provides significant ecological benefits, including carbon sequestration and contributions to climate change mitigation. In recognition of this dual importance, the Indonesian government has prioritized the seaweed industry through Presidential Regulation No. 33 of 2019, outlining the National Seaweed Roadmap.

Nevertheless, several structural challenges hinder the optimization of this potential. Farmers face limited access to finance, infrastructure for aquaculture remains unevenly distributed. Their technological innovation in cultivation and processing is still insufficient. Indonesia's seaweed industry is largely concentrated on the production of raw materials such as carrageenan, while higher value-added processing is dominated by countries such as China (Langford, 2023). The imbalance results in lost economic opportunities and reduces the sector's contribution to national income and coastal community welfare (Kusumawardhani et al, 2023).

To overcome the challenges, innovative financing mechanisms are required to mobilize resources from both the public and private sectors. Among these, Blue Bonds have emerged as a promising thematic financial instrument (Althalet et al., 2021). Green Bonds are designed to finance projects that promote the sustainable use of marine resources, including ecosystem conservation, sustainable fisheries, and climate adaptation in coastal zones (Thoday, 2023a). Following Seychelles' 2018 issuance of the world's first sovereign Blue Bond, the potential instrument attracted global attention and mobilized capital for ocean sustainability, although challenges in governance, monitoring, and inclusivity persist (March et al., 2024).

The Indonesian Ministry of Finance issued the first Blue Bond in 2023, totaling approximately IDR 2.26 trillion. It was largely allocated to disaster risk reduction infrastructure (63%) and marine ecosystem protection (37%) (Kemenkeu, 2024). While a significant step toward sustainable ocean finance, the allocation did not prioritize seaweed aquaculture, despite its potential contribution to low-carbon transition strategies and coastal economic resilience (Dijkstra et al., 2022b). Seaweed, in fact, can be integrated with other ecosystem-based projects such as mangrove rehabilitation and seagrass restoration. It also supports the development of innovative, value-added products such as bioplastics and bioenergy (Sachs et al., 2019). This highlights the need for a more inclusive approach in channeling Blue Bond financing to sectors that directly support coastal communities. Policymakers and stakeholders should proactively expand Blue Bond allocations to include seaweed aquaculture and similar sectors to maximize benefits for coastal resilience and sustainability.

At the international level, the issuance of Blue Bonds follows the Green Bond Principles

(GBP) established by the International Capital Market Association (ICMA) (Endarto et al, 2024). These principles emphasize adherence to Environmental, Social, and Governance (ESG) standards as a prerequisite to ensure that funded projects deliver not only economic benefits but also social inclusion and environmental protection (Roth, 2019). In Indonesia, however, the seaweed sector has yet to fully meet these standards. Key challenges include the scarcity of bankable projects, high transaction costs, limited institutional capacity, and the lack of harmonized reporting frameworks (Bappenas, 2022).

Against this backdrop, this study addresses four key research questions (Huang, 2021). First, to what extent has Indonesia's seaweed aquaculture sector adopted Environment, Social, and Governance (ESG) principles in line with international standards? Second, how does compliance with Blue Bond guidelines affect the bankability and feasibility of seaweed projects for sustainable financing? Third, what is the role of ESG practices in strengthening coastal communities' competitiveness by improving production quality, expanding international market access, and developing value-added products? Fourth, what strategies support the integration of Blue Bond financing into seaweed aquaculture to promote economic growth, ecological sustainability, and social well-being?

These research questions underscore the need to evaluate the readiness of the seaweed sector to access ESG-based Blue Bond financing. Such an evaluation is crucial, as the implementation of Blue Bonds in Indonesia is still in its infancy and requires empirical evidence to assess its effectiveness in supporting the Blue Economy ((Folqué et al., 2021). Proper application of ESG principles, combined with robust project feasibility, could significantly enhance Indonesia's competitiveness in global markets while simultaneously improving the livelihoods of coastal communities (Brakel et al., 2021).

This study therefore aims to contribute on three levels. Theoretically, it enriches the growing body of literature on sustainable finance, particularly Blue Finance and its applications in aquaculture. Practically, it provides recommendations for policymakers and investors on strategies to design and implement Blue Bond financing that is both effective and inclusive (Shiiba et al., 2022). Socially, it offers a foundation for empowering coastal communities by promoting sustainable production systems and improving access to innovative financing. Ultimately, the study seeks to demonstrate how Blue Bonds can function as a catalyst for closing the financing gap in Indonesia's Blue Economy, while contributing to the achievement of Sustainable Development Goal 14: Life Below Water (Benzaken et al., 2024).

THEORETICAL REVIEW

Blue Economy and Sustainable Finance

The Blue Economy emphasizes the sustainable use of ocean resources to support economic growth, community welfare, and healthy marine ecosystems. In this context, Sustainable Finance is more than a funding tool; it is a theoretical framework that reimagines finance's societal role. Schoenmaker's Grand Theory of Sustainable Finance argues the financial system must evolve beyond shareholder-centric models, which focus on short-term profits, toward stakeholder-oriented models that align financial choices with long-term social and environmental goals (Schoenmaker; Schramade, 2019).

In this perspective, capital markets are not neutral allocators of resources; they actively shape the trajectory of economic and ecological outcomes. By internalizing externalities and incorporating the triple bottom line (people, planet, profit), sustainable finance ensures that investments generate system-wide value rather than isolated financial returns. Blue Bonds exemplify this logic by linking investor returns to measurable marine sustainability

outcomes. As such, they function as dual-purpose instruments: delivering financial yield while simultaneously safeguarding ocean ecosystems and empowering coastal communities.

Applied to the seaweed sector, this theory implies that Blue Bonds can bridge the persistent financing gap by channeling capital toward projects that are both profitable and sustainable. Seaweed aquaculture, which supports carbon sequestration, biodiversity, and rural livelihoods, is an ideal candidate for sustainable finance. In line with Schoenmaker's framework, such projects embody the integration of environmental, social, and financial performance, thereby justifying their inclusion in sustainable investment portfolios and enhancing their attractiveness to global investors.

From this lens, financial markets are not neutral allocators of resources but institutional forces that determine pathways for sustainability. By embedding the triple bottom line, people, planet, and profit, sustainable finance seeks to internalize environmental and social externalities in capital allocation. Blue Bonds operationalize this theoretical shift by linking investor returns to measurable outcomes in marine sustainability (Thoday, 2023b). Thus, they represent dual-purpose instruments: providing yields for investors while safeguarding ecosystems and empowering coastal communities (Roth, 2019). In developing countries such as Indonesia, this becomes especially critical given persistent financing gaps in sectors like seaweed aquaculture, which inherently combine ecological services and socioeconomic value (Dijkstra et al., 2022b).

Seaweed Aquaculture as a Strategic Sector

Seaweed aquaculture serves dual functions. It is a key coastal economic resource and a natural carbon sink that contributes to climate change mitigation (Dijkstra et al., 2022b). Drawing on the theory of comparative advantage, nations with inherent natural endowments in specific commodities can attain global competitiveness provided that production systems are managed effectively. In the Indonesian context, strengthening the seaweed value chain through sustainable financial support is anticipated to improve the country's positioning in international markets. From a value chain development perspective, it is also essential to expand beyond the export of raw materials toward higher-value-added products such as bioplastics, bioenergy, and functional foods, so that coastal communities gain greater benefits and become integrated actors within global supply chains rather than remaining at the lowest tiers of production. Accordingly, seaweed cultivation emerges as a strategic subsector of Indonesia's Blue Economy. With favorable ecological conditions that enable large-scale production, Indonesia has the potential to dominate the global seaweed market if efficient management practices are adopted (KKP, 2023). Consistent with value chain development theory, advancing processing and diversifying into premium products would allow coastal communities to capture greater economic value. In this regard, Blue Bond financing could play a catalytic role in upgrading the seaweed value chain, thereby reinforcing both national development priorities and global market opportunities (Langford, 2023).

ESG Principles, Blue Bond Feasibility, and Community Competitiveness

The adoption of Environmental, Social, and Governance (ESG) principles is fundamental to ensuring that projects qualify for financing through thematic bonds such as Blue Bonds. According to legitimacy theory, organizations or initiatives that adhere to internationally recognized standards such as the Green Bond Principles (GBP) set by the International Capital Market Association (ICMA) are more likely to gain legitimacy in the eyes of global investors (Folqué et al., 2021). Within seaweed aquaculture, the environmental dimension

involves implementing sustainable cultivation methods, the social dimension focuses on community empowerment and equitable benefit distribution, and the governance dimension emphasizes transparency, accountability, and credible monitoring mechanisms. Together, these aspects strengthen project bankability by reducing risk perceptions and enhancing the credibility of impact reporting.

Beyond feasibility, ESG-based Blue Bonds can also act as catalysts for strengthening coastal community competitiveness. Inclusive development theory asserts that economic growth must directly involve marginalized populations, including coastal communities, to ensure broad-based welfare improvements. By channeling resources into seaweed projects, Blue Bonds have the potential to create a multiplier effect: improving production efficiency, supporting value-chain upgrading, expanding international market access, and enhancing social resilience. In line with stakeholder theory, the success of these financial instruments should not be evaluated solely on financial returns but also on the extent to which they generate tangible benefits for local communities and ecosystems (Brakel et al., 2021). Accordingly, integrating ESG principles into Blue Bond financing creates a dual impact, facilitating access to sustainable capital while simultaneously boosting the competitiveness and welfare of coastal communities.

Research Hypotheses and Conceptual Framework

Building upon the theoretical foundations discussed earlier, this study develops a set of hypotheses to empirically examine the role of Blue Bonds as a sustainable financing instrument for seaweed aquaculture projects in Indonesia. The framework integrates Schoenmaker's Grand Theory of Sustainable Finance, which emphasizes the shift from a shareholder-oriented model to a stakeholder-oriented model. It also draws on complementary theories such as legitimacy theory, value chain development, and inclusive development. The conceptual logic begins with the design quality of Blue Bonds. This includes clarity of use of proceeds, selection criteria, fund management, and impact reporting. These features are expected to drive the implementation of Environmental, Social, and Governance (ESG) practices at the project level. In line with legitimacy theory, strong ESG compliance signals credibility to investors and improves project bankability. This, in turn, increases the likelihood of accessing sustainable finance. Once financing is secured, resources can be directed toward value chain upgrading. This enables diversification into high-value-added products and enhanced processing capacity. Ultimately, this upgrading process is theorized to strengthen coastal community competitiveness. The benefits include improved productivity, expanded market access, price premiums, and greater social inclusion.

At the same time, institutional support such as policy clarity, technical assistance, guarantees, and intermediary capacity, including cooperatives, aggregators, and processors, is an important contextual factor. Institutional support is expected to moderate the relationship between ESG implementation and project bankability. Similarly, intermediary capacity is hypothesized to moderate the relationship between financing access and value chain upgrading. This integration reflects the recognition that financial instruments alone are insufficient without supportive institutional frameworks and capable local intermediaries. Based on this reasoning, the following hypotheses are proposed:

Direct Hypotheses

H_1: ESG-based seaweed farming has a positive effect on compliance with Blue Bond Guidelines (Mendes et al., 2024).

H_2: Compliance with Blue Bond Guidelines positively affects project eligibility for sustainable financing (ICMA, 2021).

H_3: ESG-based seaweed farming positively affects project eligibility for financing through Blue Bonds (UNGC, 2022).
H_4: Compliance with Blue Bond Guidelines positively affects the competitiveness of coastal communities (Roth, 2019).
H_5: Project eligibility positively affects the competitiveness of coastal communities (Huang, 2021).
H_6: ESG-based seaweed farming positively influences the competitiveness of coastal communities (FAO, 2024).

Indirect (Mediated) Hypotheses

H_7: ESG-based seaweed farming indirectly influences project eligibility, mediated by compliance with Blue Bond Guidelines.
H_8: ESG-based seaweed farming indirectly affects the competitiveness of coastal communities through mediation mechanisms (compliance with Blue Bond Guidelines and project eligibility) (OECD, 2020).

Figure 1 presents the conceptual framework underlying this research, highlighting the main variables and the proposed causal linkages among them.

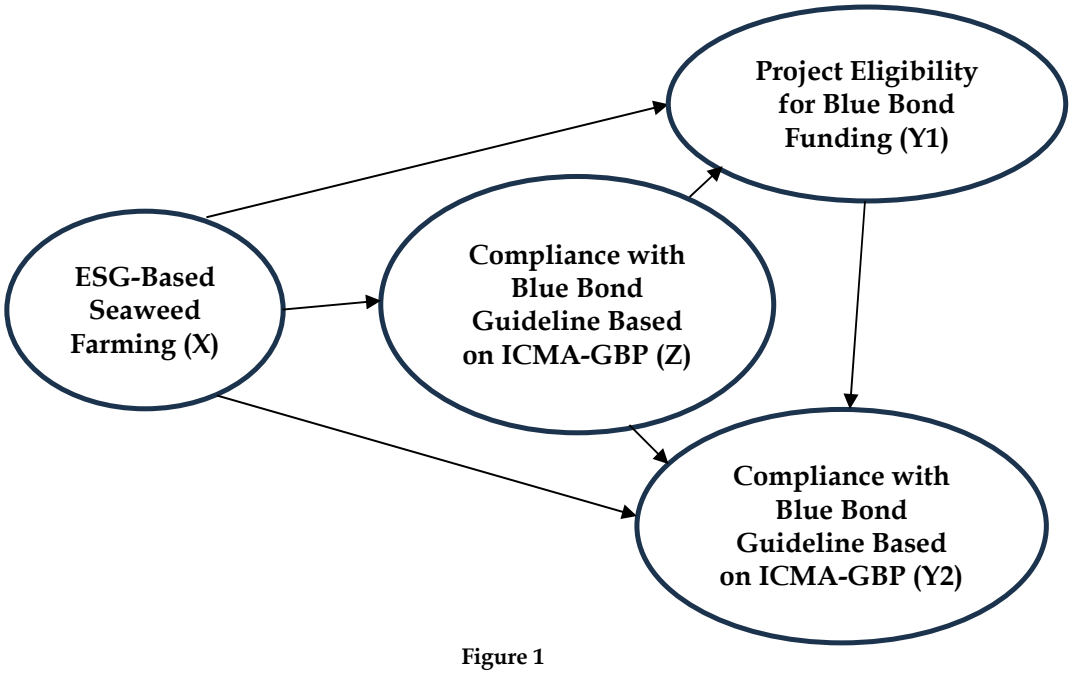

Figure 1
Conceptual Framework
Source: Develop by Authors, 2025

The conceptual framework of this study positions Blue Bond design quality as the starting point of a causal chain that extends to coastal community competitiveness. The model incorporates direct, mediating, and moderating effects. This framework reflects an integrated theoretical perspective that positions Blue Bonds not only as a financial innovation but also as a governance mechanism that can enhance the sustainability and competitiveness of Indonesia's coastal communities.

RESEARCH METHOD

This study employs an Explanatory Sequential Mixed Methods Design, which first collects quantitative data (QUAN) and then qualitative data (qual) (Creswell & Poth,

2018a). Quantitative data involves numerical data, while qualitative data involves non-numerical information, such as interviews. The study integrates these approaches to comprehensively analyze the potential of Blue Bonds, which are sustainability-linked bonds focused on ocean-related projects, as an ESG (Environmental, Social, and Governance)-based financing instrument in the seaweed sector. The quantitative component tests the relationships among ESG-based seaweed farming, Compliance with Blue Bond Guidelines, Project Eligibility, and Increasing Community Competitiveness. This analysis uses Structural Equation Modeling with Partial Least Squares (SEM-PLS), a statistical technique that examines complex relationships among variables, following the measurement and structural model evaluation guidelines of Hair et al. (2017). The qualitative component complements the analysis by providing contextual insights from in-depth interviews and field observations. It addresses challenges and opportunities for implementing Blue Bonds in Indonesia's coastal regions, analyzes them through thematic coding —a process for identifying common themes in qualitative data (Miles, 2014) —and validates them using trustworthiness criteria—steps to ensure the credibility of qualitative findings (Creswell & Poth, 2018).

Population and Sample

In the quantitative phase (QUAN), the population comprised stakeholders directly engaged in the seaweed value chain, including farmers, cooperatives, policy makers from the Ministry of Marine Affairs and Fisheries, and representatives of financial institutions. The study was conducted in three of Indonesia's largest seaweed-producing regions: South Sulawesi, Southeast Sulawesi, and East Nusa Tenggara. A total of 250 respondents were selected using purposive sampling, ensuring their relevance to ESG practices, aquaculture management, and sustainable financing. This sample size meets the minimum requirement for Partial Least Squares Structural Equation Modeling (PLS-SEM), which recommends at least 10 times the number of indicators per construct (J. F. Hair et al., 2017). In the qualitative phase (qual), data were gathered through semi-structured in-depth interviews with farmers, cooperatives, government officials, and representatives of financial institutions to gain deeper insights into opportunities and barriers to Blue Bond implementation. All interviews were recorded, transcribed, and analyzed thematically (Patton, 2015). Data saturation was reached after conducting semi-structured in-depth interviews and field observations with 18 participants (Creswell & Poth, 2018).

Data Collection

In the quantitative phase (QUAN), data were collected using a structured questionnaire with Likert-scale items ranging from 1 (strongly disagree) to 10 (strongly agree). The questionnaire measured variables related to ESG-Based Seaweed Farming, Compliance with Blue Bond Guidelines, Project Eligibility, and Increasing Community Competitiveness. Data were collected between May and July 2025 through direct distribution to seaweed farmers and cooperative members in South Sulawesi, Southeast Sulawesi, and East Nusa Tenggara.

In the qualitative phase (qual), data were gathered through semi-structured in-depth interviews with farmers, cooperatives, government officials, and representatives of financial institutions to gain deeper insights into opportunities and barriers to Blue Bond implementation. All interviews were recorded, transcribed, and analyzed thematically. In addition, non-participant field observations were conducted to capture actual practices and contextual conditions in coastal communities. Field notes were systematically documented and later integrated with interview transcripts. The combination of surveys, interviews, and observations enabled data triangulation, thereby strengthening the credibility and robustness of the findings (Creswell & Poth, 2018a).

Measurement of Variables

This study measured four main constructs: ESG-Based Seaweed Farming, Compliance with Blue Bond Guidelines, Project Eligibility, and Increasing Community Competitiveness. Each construct was operationalized using indicators adapted from prior studies and international frameworks. Environment, Social and Governance (ESG)-Based Seaweed Farming was measured across three dimensions: environmental sustainability (eco-friendly practices, waste management), social inclusion (community empowerment, gender participation), and governance (transparency, accountability). They were adapted from the UNGC (2022) and Klerk (2023). Compliance with Blue Bond Guidelines was assessed by alignment with the International Capital Market Association (ICMA) principles, including the use of proceeds, project evaluation and selection, management of proceeds, and impact reporting (Thoday, 2023b; Bappenas, 2022). Project Eligibility was measured using indicators of financial viability, risk management, technical readiness, and socio-environmental feasibility (Pratama et al., 2022; Roth, 2019). Increasing Community Competitiveness was measured by productivity, market access, value chain upgrading, product innovation, and socioeconomic impacts on coastal households (Huang, 2021; Karman & Savanevičienė, 2021).

All items were measured on a five-point Likert scale ranging from 1 (strongly disagree) to 10 (strongly agree). The measurement model was evaluated for convergent validity, discriminant validity, reliability, and predictive relevance using Partial Least Squares Structural Equation Modeling (PLS-SEM), in accordance with established guidelines (Hair et al., 2019).

Data Analysis

The study used a two-step data analysis approach. First, we analyzed the numbers using SmartPLS 4, a statistical software program. We followed standard steps for this kind of analysis (Hair et al., 2017). Next, the analysis began with a measurement model evaluation, assessing indicator reliability, composite reliability, average variance extracted, and discriminant validity. This was followed by an evaluation of the structural model, which examined path coefficients, mediation effects, and predictive relevance using coefficients of determination and effect sizes, with statistical significance assessed via bootstrapping.

In addition to the quantitative analysis, the qualitative analysis was conducted through inductive coding, including data reduction, data display, and conclusion drawing (Miles, 2014). Interview transcripts and field notes were coded and categorized to identify recurring themes related to ESG implementation, sustainable financing mechanisms, and institutional challenges. To ensure rigor, the study applied trustworthiness criteria, including credibility, dependability, and confirmability (Patton, 2015). Finally, integration of both strands was achieved through connecting, in which quantitative results guided the selection of interview participants, and explaining, in which qualitative findings elaborated and contextualized the statistical outcomes. The integrated results were presented using joint displays that align quantitative outputs with qualitative themes, producing comprehensive meta-inferences (Creswell, 2018).

ANALYSIS AND DISCUSSIONS

Quantitative Analysis

This research used a mixed-methods design. It integrated quantitative and qualitative approaches to provide a comprehensive understanding of the phenomena under study. Quantitatively, Partial Least Squares Structural Equation Modeling (PLS-SEM) examined hypothesized causal relationships among constructs. This followed methodological guidelines of Chin et al. (2020) and Hair et al. (2017). The measurement model showed satisfactory psychometric properties. All outer loadings exceeded the 0.70 threshold, and Average Variance Extracted (AVE) values were above 0.50. This confirmed

convergent validity. Composite Reliability and Cronbach's Alpha values were also above the recommended cutoff of 0.70, indicating strong internal consistency.

Qualitative data were collected using semi-structured interviews and focus group discussions. Key stakeholders included coastal community representatives, investors, and regulatory authorities. This triangulation of methods led to a richer interpretation of the findings. The study established statistically significant pathways and uncovered contextual perceptions, implementation challenges, and enabling conditions for blue bond development as a sustainable financing mechanism. Integrating these methods increased the study's explanatory power. The research provided nuanced insights into both measurable and experiential aspects of ESG-based seaweed farming and its role in supporting coastal community competitiveness.

Table 1 presents the results of the validity measurement test indicate that all constructs meet the required validity criteria.

Table 1
Validity Measurements

Construct	Outer Loading	Cronbach's alpha	Composite reliability	AVE
Seaweed Farming based on ESG (X)	0,749	0,778	0,833	0,506
Project Eligibility for Blue Bond Funding (Y1)	0,755	0,729	0,830	0,551
Increasing Community Competitiveness (Y2)	0,776	0,773	0,854	0,594
Blue Bond Guideline with ICMA - GBP (Z)	0,775	0,761	0,836	0,506

Source: Output SEM-PLS, 2025

Based on the Structural Equation Modeling Partial Least Squares (SEM–PLS) analysis, all constructs in this study demonstrated robust measurement quality. The outer loadings for all indicators exceeded the recommended threshold of ≥ 0.70, indicating that each indicator contributed substantially to explaining its respective latent construct (Hair et al., 2017). The construct ESG-Based Seaweed Farming (X) achieved an average outer loading of 0.749, while Increasing Community Competitiveness (Y2) recorded the highest average value of 0.776. These findings confirm that the selected indicators are both relevant and conceptually appropriate for representing the underlying research constructs. Reliability testing using Cronbach's Alpha showed that all constructs scored above 0.70 (ranging from 0.729 to 0.778), demonstrating acceptable internal consistency consistent with Nunnally and Bernstein's (1994) recommendations. Additionally, the Composite Reliability (CR) values, ranging from 0.830 to 0.854, exceeded the minimum threshold of 0.70, affirming adequate composite reliability and indicating that the constructs would yield stable results under repeated measurements (Chin et al., 2020).

The Average Variance Extracted (AVE) values for all constructs exceeded 0.50. The highest AVE was found for Increasing Community Competitiveness (Y2) at 0.594, while the lowest (0.506) was for ESG-Based Seaweed Farming (X) and Compliance with Blue Bond Guidelines (Z). According to Fornell and Larcker's (1981) criterion, AVE values greater than 0.50 indicate convergent validity. Therefore, the model is suitable for proceeding to the structural model (inner model) analysis to evaluate the causal relationships among latent variables, including the influence of ESG-Based Seaweed Farming (X) on Project Eligibility (Y1), Increasing Community Competitiveness (Y2), and Compliance with Blue Bond Guidelines (Z).

Table 2 presents the HTMT results used to assess discriminant validity among the study constructs. All HTMT values are below the recommended threshold of 0.90, indicating that each construct is empirically distinct and measures a unique conceptual domain.

Table 2
Heterotrait-Monotrait Ratio (HTMT)

Variabel	X	Y1	Y2	Z
Seaweed Farming based on ESG (X)				
Project Eligibility for Blue Bond Funding (Y1)	0,428			
Increasing Community Competitiveness (Y2)	0,226	0,760		
Blue Bond Guideline with ICMA - GBP (Z)	0,588	0,841	0,564	

Source: Output SEM-PLS, 2025

Discriminant validity was assessed using the Heterotrait–Monotrait Ratio (HTMT), a method widely endorsed in PLS-SEM to verify whether latent constructs are conceptually and empirically distinct. In this study, the HTMT values for all construct pairs ranged between 0.564 and 0.841, remaining well below the conservative threshold of 0.90 recommended by Henseler et al. (2015). These outcomes indicate that each latent variable, ESG Practices, Blue Bond Adoption, Project Feasibility, and Community Competitiveness, represents a distinct conceptual domain without substantial overlap.

Confirming discriminant validity is an essential step in evaluating the measurement model within PLS-SEM. The use of the HTMT criterion ensures that constructs are non-redundant and clearly differentiated. For instance, the highest pairwise HTMT value observed, 0.841 for Project Feasibility and Community Competitiveness, still falls within acceptable parameters. Following established guidelines, HTMT values below 0.90 indicate adequate discriminant validity, while values below 0.85 meet a more rigorous standard. Because all observed HTMT values in this analysis meet these requirements, the constructs can be regarded as empirically distinct and theoretically sound. Therefore, the measurement model is considered valid for advancing to the evaluation of structural relationships among the constructs.

Table 3 presents the results of hypothesis testing for the relationships among variables in the research model, including both direct and indirect (mediated) effects.

Table 3
Direct effects and Indirect Effects

Direct Effect	Path Coefficients	Path Coefficients Confidence intervals		f-square	R-square	Q-Square
		Lower	Higher			
H_1 : X => Z	0,508	0,393	0,579	0,356	0,257	0,125
H_2 : Z => Y1	0,644	0,517	0,728	0,602	0,471	0,240
H_3 : X => Y1	0,075	-0,047	0,207	0,014		
H_4 : Z => Y2	0,149	-0,042	0,335	0,241		
H_5 : Y1 => Y2	0,521	0,310	0,678	0,024	0,364	0,197
H_6 : X => Y2	-0,078	-0,199	0,047	0,012		
Indirect Effect						
H_7 : X => Z => Y1	0,326	0,252	0,383			

Direct Effect	Path Coefficients	Path Coefficients Confidence intervals		f-square	R-square	Q-Square
		Lower	Higher			
H_8 : X => Z => Y2	0,076	-0,022	0,175			

Source: Output SEM-PLS, 2025

The findings of this study provide strong empirical support for the theoretical argument. Environmental, social, and governance (ESG)-based aquaculture practices play a crucial role in determining compliance with Blue Bond Guidelines. The positive, significant effect of ESG-based seaweed farming on compliance (H_1) underscores the importance of sustainable farming practices. These practices must integrate environmental stewardship, social inclusiveness, and transparency in governance. All are essential prerequisites for aligning aquaculture projects with international financing standards, such as those established by the International Capital Market Association (ICMA, 2024). This result reinforces prior studies (UNEP, 2021) that emphasize how sustainability-driven aquaculture enhances credibility and increases access to innovative financing instruments.

The results also show that compliance with Blue Bond Guidelines exerts a strong and significant influence on project eligibility (H_2), whereas the direct effect of ESG practices on project feasibility (H_3) is not statistically significant. This pattern suggests that ESG adoption, while important, does not automatically translate into financial eligibility unless it is validated through recognized financing frameworks. In other words, Blue Bond compliance serves as a critical mediating mechanism that transforms sustainability-oriented practices into quantifiable eligibility criteria demanded by investors. This finding is consistent with FAO (2024), which argues that aquaculture projects must conform to global financing norms to secure long-term investment.

Project eligibility emerged as a pivotal determinant of community competitiveness (H_5). The significant relationship indicates that feasible projects not only attract financing but also deliver tangible socio-economic benefits, including enhanced productivity, improved market access, and integration into global value chains. Conversely, the direct effect of compliance on competitiveness (H_4) and of ESG-based farming on competitiveness (H_6) were both insignificant. It implies that compliance with financial standards and ESG adoption alone are insufficient to immediately strengthen the socio-economic fabric of coastal communities. Their impact is fully realized only when projects successfully pass eligibility thresholds and are translated into operational investments that directly benefit local communities.

The mediation analysis further confirms this chain mechanism. ESG-based seaweed farming indirectly influences project eligibility through compliance with the Blue Bond Guidelines (H_7), demonstrating a full mediation effect. This pathway underscores the importance of financing standards in linking sustainability practices with financial feasibility. However, the indirect effect of ESG-based seaweed farming on community competitiveness (H_8) was weak and statistically marginal, suggesting that coastal community competitiveness is driven more by project feasibility than by ESG adoption alone. This finding refines the conceptual model by revealing that sustainability initiatives require not only alignment with ESG norms but also institutional validation through recognized financing instruments before they can generate significant socio-economic outcomes.

These findings highlight several theoretical and practical implications. Theoretically, the results extend the literature on sustainable finance by demonstrating that the impact of ESG adoption on socio-economic competitiveness is predominantly indirect, mediated by financial standards and project feasibility (Hair et al., 2019). Practically, the study provides actionable insights for

policymakers, financial institutions, and coastal communities. For policymakers, the evidence suggests that regulatory support for ESG compliance and the establishment of Blue Bond frameworks are essential to unlock sustainable financing. For financial institutions, the results emphasize that project eligibility should be the primary criterion for funding allocation, ensuring that financed projects deliver measurable economic and social benefits. For coastal communities, the findings underscore that adopting ESG practices is necessary but not sufficient—projects must also demonstrate compliance with financing principles to achieve long-term competitiveness.

Qualitative Analysis

To complement the structural relationships revealed by the PLS-SEM analysis, qualitative data were collected through five focus group discussions (FGDs) involving 18 participants across five stakeholder sectors: government institutions, financial market actors, cooperative management, marine conservation authorities, and local aquaculture administrators. Participants were selected using purposive sampling to ensure sectoral and institutional representation relevant to ESG implementation and Blue Bond governance. Of the five FGDs conducted, two were held online due to national-level geographical constraints, while three were conducted face-to-face in South Sulawesi and East Nusa Tenggara. It is important to note that the FGD participants were distinct from the 250 survey respondents to avoid sample overlap and strengthen methodological triangulation. Further detail on the sectoral composition and institutional positions of the 18 participants can be found in Table 4. In addition to focus group discussions, field observations conducted during the on-site discussions further enriched the contextual understanding of local governance structures and operational dynamics. Building on these data sources, thematic analysis identified three dominant themes: (1) limited access to sustainable financing, (2) governance and institutional barriers, and (3) market opportunities through ESG compliance. Together, these themes illuminate the mechanisms underlying the relationships observed in the PLS-SEM model.

Table 4
Demographic Profile of Gorup Discussion

Sector	Position	Province
Government Official Ministry of Finance (KEMENKEU)	Manager of Market Staff	Jakarta - Indonesia
Private Official PT Indonesian Central Securities Depository (KSEI)	Corporate Secretary Head of Marketing Services	Jakarta - Indonesia
Government Official Maritime Affairs and Fisheries Service (DKP Sulsel)	Head of General Affairs Head of Cultivation Program Program Staff Program Staff Program Staff Program Staff Program Staff Program Staff	South Sulawesi
Government Official National Marine Conservation Area Center (BKKPN Kupang)	Head of Division Junior Expert Field Staff Field Assistant	East Nusa Tenggara

Sector	Position	Province
	Field Assistant	
Private Official Indonesian Independent Workers Union Cooperative (Kospermindo)	General Manager	South Sulawesi

Source: Recapitulation of informants by the author, 2025

Mechanism and Policy Framework for Blue Bond Issuance in Indonesia

Insights derived from the Focus Group Discussion (FGD) involving officials from the Ministry of Finance (KEMENKEU) indicate that Indonesia's Blue Bond is embedded within a broader green and sustainable finance architecture aligned with the national blue economy strategy. Participants emphasized that prior to the Blue Bond issuance, Indonesia had established credibility in sustainable sovereign financing through the issuance of green sukuk in 2018 and SDG bonds in 2021, culminating in the inaugural yen-denominated Blue Bond (Samurai Bond) in 2023. The FGD discussions clarified that the issuance mechanism follows three main phases: pre-issuance, issuance, and post-issuance. The pre-issuance phase involves developing the Sustainable Government Securities Framework, budget-tagging eligible expenditures, and identifying qualifying blue economy activities. The issuance phase includes the appointment of joint lead managers, preparation of macroeconomic and policy disclosure documents, and investor roadshows. The post-issuance phase requires the publication of allocation and impact reports, typically subject to independent verification.

Importantly, FGD participants stressed that Blue Bond proceeds are managed under a general treasury financing scheme. Funds are pooled into the central government account and used to support the national budget deficit, rather than being directly allocated to specific ministries. Consequently, line ministries such as the Ministry of Marine Affairs and Fisheries (KKP) must proactively align programs, such as seaweed farming and mangrove rehabilitation, with budget tagging mechanisms to qualify as eligible underlying activities. This finding confirms that Blue Bonds function primarily as fiscal policy instruments and signaling tools rather than direct project-based financing channels.

Cooperative Roles and ESG Implementation at the Ground Level

The FGD cluster involving cooperative representatives, particularly Kospermindo, revealed that cooperatives serve as critical intermediaries between grassroots producers and external financing institutions. While government assistance (APBN) often bypasses cooperatives and flows directly to farmers, cooperatives play a strategic role in capacity building, production aggregation, and market linkage.

FGD discussions highlighted that Kospermindo has begun integrating Environmental, Social, and Governance (ESG) principles into operational practices. One example includes the replacement of plastic bottle buoys with more durable PVC pipes developed in collaboration with international partners. This innovation reduces marine plastic waste while allowing cultivation in deeper offshore zones, thereby increasing productivity and resilience.

Another key theme emerging from the FGD relates to data governance. Participants identified discrepancies between data from BPS, KKP, and industry associations as a structural barrier to policy coherence. In response, cooperative actors have initiated the development of a single-data digital system to enhance traceability and transparency. Such data integrity was repeatedly emphasized as a prerequisite for aligning seaweed production with Blue Bond eligibility criteria, particularly in meeting ESG reporting standards.

Technical and Socio-Economic Conditions Among Seaweed Farmers

FGDs conducted with farmer groups in East Nusa Tenggara and South Sulawesi revealed a mixed landscape of opportunity and vulnerability. The production cycle for seaweed averages 45 days, allowing up to six harvests annually. However, participants reported recurring disruptions due to ice-ice disease, seasonal tidal fluctuations, and declining seed quality. Farmers continue to rely on aged seed stock dating back to the late 1990s, with limited success in adopting tissue culture alternatives.

Price volatility emerged as a dominant concern. Participants noted that regional regulations, including the 2022 Governor's Decree in East Nusa Tenggara restricting inter-regional trade, have unintentionally reduced bargaining power. Reported prices declined significantly compared to previous years, constraining household income stability.

Access to capital remains limited. Initial investment requirements of approximately IDR 7 million are often financed through micro-credit schemes, yet repayment conditions remain burdensome. FGDs also revealed institutional weaknesses in local cooperatives, particularly in financial management and price stabilization mechanisms.

Despite these challenges, seaweed farming has transformed local economies, enabling families to finance education and household needs. A clear gender-based division of labor is evident: women are responsible for seeding, while men handle offshore cultivation and harvesting. However, environmental risks persist, particularly from the continued use of single-use plastic buoys. Though alternatives such as PVC pipes and waste banks have been introduced, adoption remains inconsistent, necessitating further awareness campaigns and stronger regulatory enforcement.

Community Readiness and Perceptions of Blue Bond Mechanisms

Discussions with government officials clarified the fiscal structure of Blue Bonds. Cooperative actors focused on how institutions can work together. However, FGDs with farmer groups showed another issue: readiness at the grassroots level. Most participants liked the idea of innovative financing, such as Blue Bonds. Their acceptance was conditional. Farmers wanted technical guidance, transparent financial procedures, and assured market access before joining. These concerns show that being open to the idea does not mean they are ready or eligible.

FGD findings showed that business management, financial literacy, and ESG documentation need improvement. These gaps mean that improving the environment alone is not enough to meet Blue Bond guidelines. Building governance capacity and supporting aggregation through cooperatives are needed to link fiscal tools and farm-level work. These discussions suggest that without better alignment between design and grassroots skills, Blue Bonds might serve only as signals at a macro level rather than real change for producers.

Synthesis and Implications

The integrated FGD findings demonstrate that Blue Bonds in Indonesia operate primarily as macro-fiscal instruments that enhance policy credibility and enable budget allocation rather than functioning as direct project-level funding mechanisms. While ESG compliance enhances the formal eligibility of seaweed projects, project feasibility ultimately depends on cooperative capacity, governance quality, access to financing, and data transparency.

Cooperatives emerge as pivotal intermediaries capable of translating ESG principles into operational practices. However, their transformative potential remains constrained by managerial limitations and technological gaps. Market-driven sustainability requirements from international buyers create additional incentives for ESG adoption, thereby strengthening the competitiveness pathway identified in the quantitative model.

The findings suggest that localizing Blue Bond frameworks needs a multi-level

approach. This includes fiscal policy design, institutional strength, empowering cooperatives, and building grassroots capacity. Without these conditions, Blue Bonds may remain only symbolic policies with little real impact on coastal livelihoods.

Discussion

This study aimed to examine how ESG-based seaweed farming can be transformed into investment-ready projects through Blue Bond financing, ultimately enhancing coastal community competitiveness. By integrating the structural relationships identified through PLS-SEM with qualitative insights from stakeholder-based FGDs and field observations, the findings provide a multi-level explanation of how sustainability practices translate into economic outcomes within Indonesia's blue economy framework.

ESG Practices: Necessary but Structurally Dependent

The results confirm that ESG-based seaweed farming positively influences compliance with Blue Bond guidelines (H_1). However, ESG practices do not directly or independently enhance community competitiveness (H_6). Instead, their contribution to community competitiveness occurs indirectly: ESG practices promote greater compliance with Blue Bond guidelines and enhance project feasibility, which, in turn, strengthens competitiveness.

This finding suggests that ESG implementation at the grassroots level, while foundational, remains structurally dependent on institutional and financial mediation. FGDs with farmers and cooperative representatives revealed awareness of environmental sustainability and social inclusion principles. Nevertheless, limitations in financial access, documentation capacity, and governance systems constrain the translation of ESG practices into bankable projects. These observations align with arguments (FAO, 2024; UNEP, 2021) that the sustainability commitments must be embedded within enabling financing ecosystems and coherent policy environments to generate tangible economic returns.

The Blue Bond as an Institutional Translation Mechanism

The significant relationship between compliance with Blue Bond guidelines and project feasibility (H_2) indicates that the Blue Bond framework functions as a translation mechanism rather than merely a financing label. It formalizes ESG criteria into standardized reporting, governance, and accountability requirements that enhance investor confidence.

Qualitative findings reinforce this interpretation. Government officials clarified that Blue Bonds operate under a general treasury scheme, while cooperatives must align programs through budget tagging and documentation systems to qualify as eligible activities. This institutional filtering mechanism explains why compliance improves feasibility: it reducs information asymmetry and strengthens credibility in the eyes of investors.

However, FGDs also revealed that cooperative capacity remains uneven. Weak financial reporting systems and limited ESG auditing capabilities can weaken the compliance–feasibility pathway (H_3), even when environmental practices are in place. These results support prior research emphasizing institutional readiness as a determinant of sustainable finance effectiveness (ICMA, 2024; OECD, 2020).

Governance and Market Alignment as Dual Drivers

The study highlights governance quality and market orientation as complementary drivers of project viability. On the governance side, institutional fragmentation, inconsistent data systems, and limited managerial capacity undermine project eligibility. On the market side, international buyers increasingly demand traceability and ESG certification, creating economic incentives for compliance.

FGDs suggest that when ESG practices are linked to traceable supply chains and

potential price premiums, farmers perceive clearer economic benefits. This dynamic strengthens the pathway from project feasibility to competitiveness (H_5). Therefore, Blue Bond effectiveness depends not solely on public policy design, but on the alignment between regulatory frameworks, cooperative governance, and market-based sustainability incentives.

Chain Mediation and Systemic Interaction

A central contribution of this study is the confirmation of a chain mediation effect: ESG practices enhance compliance with institutional rules (H_1), compliance with rules improves project feasibility, meaning the likelihood that projects can be successfully completed (H_2), and feasibility strengthens a community's ability to compete for resources and opportunities, referred to as competitiveness (H_4, H_7, H_8). This sequential pathway demonstrates that sustainability-driven competitiveness develops over time through connected steps, rather than producing immediate effects.

The model's substantial explanatory power for project feasibility ($R^2 = 0.650$) and competitiveness ($R^2 = 0.801$) indicates that following institutional rules and ensuring financial preparedness are crucial steps connecting environmental practices to positive social and economic results. Qualitative findings further clarify that achieving this chain requires coordination between local communities, cooperatives, and national organizations (vertical coordination), as well as cooperation between different government departments and regulatory areas (horizontal policy integration).

Reframing Blue Bonds Within Development Strategy

Indonesia's Blue Bond now acts mainly as a macro-fiscal tool in the national budget. However, its community impact depends on how ready institutions are. Focus group participants showed some openness but said they would engage only if there is sufficient technical support, clear procedures, and fair access to funding.

Building on these findings, it becomes apparent that Blue Bonds' effectiveness in supporting ESG-based seaweed farming is mediated by cooperative capacity, governance quality, and market integration. Without sufficient institutional alignment, the instrument's impact may remain concentrated at the policy level rather than fully transmitted to grassroots producers (World Bank, 2023).

Theoretical and Practical Implications
Theoretical Contribution

This study tests a chain-mediated model linking ESG implementation, Blue Bond compliance, project feasibility, and community competitiveness. The findings show that ESG adoption alone does not guarantee economic gains; sustainability outcomes require institutional structures that enable financial results. The study brings together sustainable finance theory and cooperative governance in the aquaculture sector to expand the Blue Economy Financing Framework. It shows that financial tools must work within multi-level governance to yield socioeconomic impact.

From a policy perspective, the key recommendations are: (1) strengthen cooperative governance capacity, with a focus on financial reporting, ESG documentation, and project preparation; (2) build robust institutional capability to ensure Blue Bond framework compliance translates into project eligibility; and (3) enhance data transparency and traceability systems, providing credible, harmonized production data to reduce information asymmetry and improve investor confidence.

Additionally, the study recommends designing blended finance mechanisms that combine public and concessional capital to reduce entry barriers for small-scale producers. It also suggests that because coastal communities face limited financial literacy and access to capital, relying solely on market-based debt instruments may not ensure inclusive participation. Finally, the study advises regulatory harmonization across

aquaculture, conservation, and regional trade policies to prevent administrative bottlenecks that can delay ESG-compliant initiatives.

The study also recommends facilitating stronger market integration for ESG-compliant producers within traceable global value chains. It suggests linking sustainability standards directly to improved market access and price incentives, making ESG adoption economically rational rather than just a matter of regulatory compliance. The institutional, financial, and market-oriented adjustments can help ensure that Blue Bond–aligned initiatives generate not only fiscal credibility at the national level but also tangible and inclusive development outcomes within coastal communities.

CONCLUSIONS AND SUGGESTIONS

This study assessed the viability of Blue Bonds as a financing tool for ESG-based seaweed farming and improving coastal community competitiveness in Indonesia. By combining Partial Least Squares Structural Equation Modeling (PLS-SEM) with qualitative thematic analysis, the research delivers empirical evidence and context for how sustainability practices affect socioeconomic outcomes.

The findings confirm that ESG-based seaweed farming significantly enhances compliance with Blue Bond guidelines, thereby improving project feasibility and, ultimately, community competitiveness. The results demonstrate that sustainability practices improve competitiveness not directly, but through the influence of institutional and financial mechanisms. Thus, ESG implementation yields economic gains only when supported by strong governance, accessible financing, and regulatory alignment.

The observed chain-mediation effect shows the need for integrated institutional design. Sustainability principles must be embedded in clear financial frameworks and organizational readiness. Qualitative findings indicate that limitations in cooperative governance, restricted credit access, and fragmented data systems shape this pathway. At the same time, stakeholder discussions show that coastal actors are willing to adopt ESG standards if they get technical support, transparent processes, and reliable market access.

Overall, this study contributes to the Blue Economy Financing Framework by empirically validating the cumulative mechanisms linking ESG adoption, financial eligibility, and competitiveness outcomes. From a practical standpoint, the findings suggest strengthening cooperative governance, enhancing data transparency, improving access to blended financing schemes, and harmonizing regulatory policies across marine sectors. Such measures can help ensure that Blue Bond–aligned initiatives generate not only fiscal credibility at the national level but also inclusive and sustainable development at the community level.

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