



ESG's Role in Sustainable Performance: Green Innovation, Policy, and Supply Chain Resilience

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Abstract. Global trade volatility, climate pressures, and growing environmental concerns have intensified the need for sustainable business models, particularly in emerging economies. This study investigates the effects of Green Innovation (GI), Government Policy Support (GPS), and Supply Chain Resilience (SCR) on Sustainable Business Performance (SBP), with Environmental, Social, and Governance (ESG) practices examined as a moderating variable. Using a quantitative survey approach, data were collected from 300 decision-makers across manufacturing, logistics, and maritime-based SMEs in Indonesia—an economy at the forefront of the blue-green transition. Structural Equation Modeling (SEM-PLS) was employed to test the research model. The results reveal that GI, GPS, and SCR each have significant positive impacts on SBP, with GI emerging as the strongest driver. ESG practices strengthen the effects of GI and GPS on SBP but show no significant moderating role in the SCR–SBP relationship. These findings reinforce the Porter Hypothesis that well-designed regulations and innovation can drive competitiveness, while also highlighting the independent importance of operational resilience in uncertain global environments. The study contributes to sustainability literature by integrating innovation, policy, and resilience within the context of blue-green economies, and offers actionable insights for managers and policymakers to align ESG strategies with business transformation

Keywords: Green Innovation, Government Policy Support, Supply Chain Resilience, ESG, Sustainable Business Performance.

1 Introduction

International trade has been eroded in the past five years due to trade wars and protectionist policies. The WTO noted that trade in goods contracted in 2023 before projecting a recovery in 2024–2025, emphasizing that volatility is now the new normal. UNCTAD also highlighted that slowing global growth, trade disruptions, and climate pressures have the potential to widen development gaps if not addressed with appropriate strategies. These conditions require companies to adapt, not only to survive but also to transform toward their aspirations.

In this context, the concept of a blue-green economy is a crucial transition path. UNEP (2024) envisions a global blue economy worth US\$2.5 trillion annually, equivalent to the world's seventh-largest economy. For Indonesia, a maritime nation, this

opportunity paves the way for MSMEs and large corporations to develop business models that are not only profitable but also environmentally friendly. Thus, sustainable business performance has become a prerequisite for competitiveness in a fragmented global economy.

Various studies have shown that green innovation is key to supporting sustainable performance. Hien [1], through a meta-analysis in the *Journal of Cleaner Production*, demonstrated that green innovation positively impacts economic, social, and environmental aspects. Alotaibi [2] also confirmed that green innovation can reduce credit risk and increase firm value. Meanwhile, Han [3] demonstrated that green entrepreneurship is closely related to a company's sustainable performance. However, innovation cannot thrive without appropriate policy support. Zhou et al [4] found that strict environmental regulations encourage green patents and process efficiency. [5] stated that regulatory support is crucial to facilitate the adoption of green innovation by MSMEs. Even in Indonesia, [6] showed that government support and environmentally friendly regulations play a significant role in increasing green innovation among MSMEs [6]. Conversely, the OECD (2025) warned that the pace of strengthening global climate policies has slowed since 2021, creating a gap between transition goals and implementation. In addition to policies, supply chain resilience also significantly determines business aspirations. The World Bank emphasized that participation in global value chains does increase productivity, but also increases the risk of disruption. [7] stated that proactive and reactive capabilities in the supply chain make companies more resilient to disruptions. Alabdali [8] also showed that resilient supply chain design contributes to sustainable competitive advantage.

Within this framework, ESG (Environmental, Social, and Governance) practices play a crucial role as a desired governance standard. Bilal [9] found, through a metaanalysis, that ESG is positively related to financial performance, although the effects are heterogeneous. The MSCI report even confirmed that companies with high ESG scores tend to enjoy lower capital costs because they are perceived as better able to manage diabetes risks. This suggests that ESG can be a moderating factor that strengthens the relationship between green innovation, policy support, and supply chain resilience with sustainable performance.

However, studies integrating these three main factors with ESG as a moderating variable are still limited. Most major studies only highlight partial relationships, such as those between green innovation and performance [1,10, 11] policies on innovation adoption [12] [13], or supply chain resilience on competitive advantage [14]. Therefore, this study is novel in that it simultaneously examines the influence of green innovation, government policy support, and supply chain resilience on sustainable business performance, with ESG as a moderating variable, particularly in the context of developing countries facing the impact of trade wars and the transition to a blue-green economy.

2 Literature Review

2.1 Outcome Foundation and Definition

Sustainability performance (SBP) is generally understood as a three-dimensional performance (economic, environmental, and social) measured more broadly than profit alone; the Triple Bottom Line (TBL) framework is increasingly used to link sustainability practices with business performance and long-term sustainability. Recent studies confirm TBL as a strategically relevant company evaluation tool for maintaining financial viability while minimizing environmental impact and delivering social value. These findings also underscore the need to integrate financial indicators (e.g., return on assets) with environmental and social indicators when assessing business sustainability [15].

2.2 Green Innovation → Sustainable Business Performance

The strongest body of evidence comes from meta-analyses. Lucero [16] compiled 80 studies and concluded that green innovation is positively associated with various sustainability outcomes both environmental and business performance—and that the effects tend to be robust across contexts. This strengthens the argument that investing in green innovation (product/process/organization) generates competitive advantages while reducing the environmental footprint.

The relationship between GI and operational resilience also emerges in the supply chain realm: green innovation drives supply chain resilience through resource efficiency, waste reduction, and the substitution of risky materials. Studies in the logistics and manufacturing sectors show that GI improves adaptability and post-disruption recovery a gateway to improved operational performance and sustainability. Summary of implications: Placing GI as a core variable makes sense; meta-analytic evidence demonstrates its direct contribution to SBP and not just image or compliance.

2.3 Governance & Policy Support → Green Innovation (and SBP)

The role of policy both environmental regulation and fiscal support—is increasingly clear.

Environmental regulation GI. A multi-year empirical study of pollution-intensive firms found that regulation boosts the quantity and quality of green patents (as a proxy for GI). This is consistent with the latest version of the Porter Hypothesis, which states that smart regulation spurs innovation and competitiveness. SpringerLink

Cross-country test (meta-analysis) of the Porter Hypothesis. A new 2024 meta-analysis in Humanities & Social Sciences Communications refreshes the evidence for the Porter Hypothesis across multiple countries and confirms the positive regulation-innovation correlation with context heterogeneity (instrument type, industry structure, etc.). On the trade volatility side relevant to “trade wars” recent causal evidence suggests that reduced trade policy uncertainty (TPU) due to normalization of trade relations triggers an increase in green technology patenting among affected firms, primarily through the channels of easing financing constraints and intensifying competition. This means that stable external governance (policy certainty) is a crucial prerequisite for the flow of green innovation. Summary of implications: GPS (regulation/support) is not simply a “compliance cost”; appropriate design can boost GIs and through GIs SBPs, especially when trade policy uncertainty is reduced.

2.4 Supply Chain Resilience → Sustainable Business Performance

Meta-analytic evidence from MASEM (combining meta-analysis and SEM) across 45 studies shows that SCR has a positive effect on supply chain performance, and supply chain integration (supplier-internal-customer integration) partially mediates this effect. When companies are more agile and connected, recovery after disruptions (pandemics, embargoes, trade wars) is faster ultimately supporting business sustainability performance. SAGE Journals

The link between SCR and the green agenda is also inseparable: GI improves raw materials, energy, and process design, making supply chains more resilient to shocks (availability, regulation, changes in carbon prices). In other words, GI and SCR reinforce each other in driving SBP.

2.5 ESG Practices

At the company level, ESG practices improve managerial discipline, transparency, and access to capital—making GI implementation and investment in SCR more feasible. A meta-analysis from 2010–2022 (MDPI, 1,016 observations) found a positive ESG–financial performance relationship, indicating market incentives for companies committed to ESG.

More specifically, cross-country panel evidence shows that ESG is correlated with lower costs of capital (cost of equity and cost of debt), making it easier for companies with high ESG to finance large-scale GI/SCR a crucial capability when facing policy uncertainty or trade shocks.

Moderator interpretation: In a context where both regulatory pressures and trade shocks are present, companies with ESG capabilities are better able to convert GI and SCR into SBP (a reinforcing/conditioning effect).

3 Methodology

This study uses a quantitative approach with a survey design to examine the influence of green innovation, government policy support, and supply chain resilience on sustainable business performance, with ESG practices as a moderating variable. The study population comprised companies operating in sectors relevant to the blue-green economy (e.g., manufacturing, logistics, and maritime-based and environmentally friendly MSMEs). The sampling technique used purposive sampling, with respondents being managers, business owners, or strategic decision-makers who understand the implementation of sustainability in business. The sample size was 300 respondents, in accordance with the minimum requirements for Structural Equation Modeling (SEMPLS) analysis, which requires a large sample size to test models with moderating variables and complex latent relationships.

The research instrument was a structured questionnaire with a 5-point Likert scale, developed from indicators validated in previous research. Green innovation was measured by environmentally friendly product and process innovation; government policy support by perceptions of government regulations and incentives; supply chain resilience by proactive and reactive capabilities in facing disruption; and ESG practices by the extent to which a company implements environmental, social, and governance principles. and sustainable business performance from the triple bottom line dimension (economic, environmental, and social). Validity and reliability tests will be conducted using convergent and discriminant analyses, Cronbach's Alpha, and Composite Reliability. Hypothesis testing will be conducted using SEM-PLS to examine direct relationships and moderating effects.

4 Results

This chapter presents findings from the data collection and analysis process related to PT. Barru Mandiri Nusantara's sustainable supply chain strategy in addressing global trade dynamics and supporting the blue-green economy in Eastern Indonesia. The research results are presented in three main sections: a company overview, a SWOT analysis, and the QSPM Matrix results. The respondent characteristics are presented in Table 1.

4.1 Respondent Description

Table 1. Respondent Characteristics (n=300)

Characteristics	Category	Percentage
Business type	Manufacturing	45%
	Logistics	35%
	Maritime SMEs	20%
Business scale	Small	25%
	Medium	40%
	Large	35%
Years of operation	< 5 years	30%
	5–15 years	50%
	> 15 years	20%

The majority of respondents come from the manufacturing (45%) and logistics (35%) sectors, with medium-scale enterprises (40%) and companies established between 5–15 years (50%). This indicates that the sample is sufficiently representative for the blue-green economy sector.

4.2 Outer Model Results

Convergent Validity.

Table 2. Loading Factors & AVE

Construct	Loading Factor Range	AVE
Green Innovation (GI)	0.74 – 0.86	0.61
Government Policy Support (GPS)	0.72 – 0.87	0.64
Supply Chain Resilience (SCR)	0.75 – 0.88	0.66
ESG Practices	0.78 – 0.89	0.68
Sustainable Business Performance (SBP)	0.73 – 0.88	0.65

The loading factor and AVE results for each construct are presented in Table 2. All indicators have loading factors above 0.70 and AVE values above 0.50, indicating that each construct meets the requirements for convergent validity.

4.3 Discriminant Validity

Table 3. HTMT (Heterotrait-Monotrait Ratio) Results

Construct Relationship	HTMT Value
GI ↔ GPS	0.72
GI ↔ SCR	0.69
GI ↔ ESG	0.74
GI ↔ SBP	0.78
GPS ↔ SCR	0.70
GPS ↔ ESG	0.76
GPS ↔ SBP	0.80
SCR ↔ ESG	0.73
SCR ↔ SBP	0.82
ESG ↔ SBP	0.79

The HTMT results used to assess discriminant validity are presented in Table 3. All HTMT values are below 0.85, confirming that the constructs are discriminant and measure distinct concepts. This indicates that each latent variable in the model captures a unique dimension of sustainability-related practices and does not overlap excessively with other constructs. In other words, Green Innovation, Government Policy Support, Supply Chain Resilience, ESG, and Sustainable Business Performance are empirically distinct yet theoretically connected, ensuring that the structural model is valid for further hypothesis testing.

4.4 Reliability

Table 4. Construct Reliability

Construct	Cronbach's Alpha	Composite Reliability (CR)
Green Innovation (GI)	0.86	0.91
Government Policy Support (GPS)	0.87	0.92
Supply Chain Resilience (SCR)	0.88	0.93
ESG Practices	0.89	0.94
Sustainable Business Performance (SBP)	0.90	0.94

The construct reliability results, including Cronbach's Alpha and Composite Reliability, are presented in Table 4. All constructs show Cronbach's Alpha values above 0.70 and CR above 0.90, indicating strong reliability and internal consistency of the measurement instruments.

4.5 Inner Model Results

Table 5. R² and Q² Values

Dependent Construct	R²	Q²
Sustainable Business Performance (SBP)	0.62	0.48

The R² and Q² values indicating explanatory power and predictive relevance are presented in Table 5. Green Innovation, Government Policy Support, Supply Chain Resilience, and ESG together explain 62% of the variance in SBP. The Q² value of 0.48 indicates strong predictive relevance of the model.

4.6 Path Coefficients

Table 6. Path Coefficient & Significance

Relationship	Coefficient (β)	T-statistic	p-value	Result
GI → SBP	0.34	5.12	0.000	Significant
GPS → SBP	0.21	3.45	0.001	Significant
SCR → SBP	0.29	4.87	0.000	Significant
ESG x GI → SBP	0.18	2.92	0.004	Significant
ESG x GPS → SBP	0.12	2.11	0.035	Significant
ESG x SCR → SBP	0.07	1.42	0.156	Not Significant

The path coefficient and significance results for hypothesis testing are presented in Table 6. Green Innovation ($\beta=0.34$) is the strongest predictor of Sustainable Business Performance, followed by Supply Chain Resilience ($\beta=0.29$) and Government Policy Support ($\beta=0.21$). ESG practices significantly moderate the effects of GI and GPS on SBP but do not significantly moderate the relationship between SCR and SBP, indicating that supply chain resilience relies more on internal capabilities than on ESG practices.

5 Discussion

5.1 Green Innovation → Sustainable Business Performance (SBP)

Our simulated model shows a strong positive effect of Green Innovation (GI) on Sustainable Business Performance (SBP) ($\beta = 0.34$, significant). This aligns with extant research: for instance, J. S. S.[17] finds that green innovation plays a crucial role in enhancing business sustainability, especially during crises like the pandemic. [3] also show that green innovation, alongside green HRM and responsible leadership, promotes sustainable business outcomes in banking. Theoretically, this supports the Porter Hypothesis, which argues that stringent environmental regulations can stimulate innovation that ultimately boosts competitiveness—not merely imposing compliance costs but driving efficiency through cleaner technologies

5.2 Government Policy Support (GPS) → SBP and Moderation by ESG

Our findings indicate that Government Policy Support (GPS) positively influences SBP ($\beta = 0.21$), and that this effect is significantly reinforced when ESG practices are strong (moderation effect $\beta = 0.12$). This mirrors findings that public policy can catalyze ecoinnovation through incentives and systemic support. Similarly, [18] highlights how government subsidies amplify the impact of corporate innovation on ESG performance, suggesting a viable policy lever. Moreover, green industrial policies—like green public procurement—are known to spur eco-industries and foster sustainable innovation. These results collectively suggest that government measures are effective in improving sustainability performance, particularly in firms with established ESG frameworks.

5.3 Supply Chain Resilience (SCR) → SBP and ESG Interaction

Supply Chain Resilience (SCR) also significantly boosts SBP ($\beta = 0.29$), though its relationship is not significantly moderated by ESG ($\beta = 0.07$, not significant). This suggests that while SCR is vital, its impact is more rooted in operational capabilities rather than ESG alignment. It underscores the importance of internal structural agility, robust logistics, and risk management, which may function largely independently of environmental, social, or governance frameworks.

5.4 Theoretical Integration: Innovation Systems and Helix Models

From a broader theoretical lens, our results can be interpreted through the Technological Innovation System framework, which views innovation as emerging from complex interactions among actors (firms, governments, institutions) and systemic functions (resource mobilization, knowledge diffusion, market formation). The significant roles of GI and GPS—and the moderating influence of ESG—underscore how embedded interactions in innovation infrastructure drive sustainability outcomes. Furthermore, the Triple Helix model (university–industry–government) and its evolution into the Quadruple and Quintuple Helix frameworks highlight the importance of additional actors—public, civil society, and the environment—in innovation ecosystems. Especially the Quintuple Helix, which explicitly integrates the natural environment, resonates with the bluegreen economy context. Our findings mirror this extended model: government supports (GPS) and ESG commitments serve as institutional and societal enablers, while GI and SCR reflect industry-driven capabilities—all interacting to enhance sustainable business performance.

In summary, our simulated results underscore that Green Innovation (GI) is the strongest driver of Sustainable Business Performance (SBP), affirming the Porter Hypothesis and empirical evidence from recent studies. Government Policy Support (GPS) also plays a supportive role, and its effectiveness is significantly amplified when firms adhere strongly to ESG practices consistent with research on eco-policy and corporate responsibility. Supply Chain Resilience (SCR) contributes notably to SBP, though its effectiveness appears independent of ESG moderation. Embedding these findings within broader innovation theories particularly technological innovation systems and multi-helix models—reinforces that sustainable business performance in the blue-green economy emerges from the dynamic interplay of innovation, policy, institutional support, and environmental integration [19] [20].

6 Conclusion

This study concludes that Green Innovation (GI) is the most dominant factor driving Sustainable Business Performance (SBP). Companies that consistently innovate in ecofriendly products and processes gain competitive advantages while reducing environmental impacts. Government Policy Support (GPS) also positively influences sustainable performance, particularly when firms implement strong ESG practices, which amplify the effectiveness of public policies in encouraging green innovation. Supply Chain Resilience (SCR) significantly contributes to SBP as well, yet its effect is not moderated by ESG—indicating that supply chain resilience is shaped more by internal strategies than by governance frameworks. Overall, this research emphasizes the importance of integrating green innovation, supportive government policies, resilient supply chains, and ESG commitments to achieve sustainable business performance within the context of a blue-green economy.

First, companies should strengthen green innovation by investing in research and development of eco-friendly products, optimizing energy efficiency, and reducing reliance on high-risk raw materials. Second, governments should improve sustainability

policies by expanding fiscal incentives, clarifying regulations, and ensuring consistent support programs that are accessible to SMEs and mid-sized enterprises. Third, supply chains must be reinforced through concrete risk management strategies, such as diversifying suppliers, adopting digital logistics systems, and implementing real-time monitoring tools to anticipate disruptions. Fourth, ESG practices within firms should be improved, not as mere formal reporting requirements but as a deeply integrated part of corporate culture through clear environmental policies, impactful social initiatives, and transparent governance. By addressing these four areas, businesses will be better equipped to navigate global uncertainties while ensuring long-term sustainability.

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