

# Exploring Relationships Among Government Management, Investment, and Sustainable Competitiveness in Indonesia's Maritime Sector

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## Abstract

**Purpose:** This study examines the relationships among government policy, investment, and sustainable competitiveness in Indonesia's maritime sector, with a particular focus on both direct and mediated effects. Grounded in institutional theory and the Resource-Based View (RBV), the study explains how regulatory frameworks and resource mobilization shape long-term competitiveness outcomes in a developing country context.

**Methodology:** A quantitative approach using Partial Least Squares Structural Equation Modeling (PLS-SEM) was applied to survey data collected from 420 maritime stakeholders, including government agencies, port authorities, shipping companies, investors, and environmental NGOs across key maritime regions.

**Results:** The results demonstrate that government policy significantly influences investment ( $\beta = 0.61, p < 0.001$ ) and directly affects sustainable competitiveness ( $\beta = 0.34, p < 0.01$ ). Investment also has a strong positive effect on competitiveness ( $\beta = 0.47, p < 0.001$ ) and partially mediates the relationship between policy and competitiveness. The model explains substantial variance in investment (65%) and sustainable competitiveness (72%).

**Conclusion:** Government policy plays a dual role as both an investment catalyst and a direct competitiveness driver.

**Limitations:** The study relies on cross-sectional survey data from Indonesia, limiting causal inference and generalizability.

**Contributions:** The findings provide actionable guidance for policymakers in developing countries by demonstrating that regulatory clarity, fiscal incentives, and infrastructure planning must be aligned with targeted investment mechanisms to effectively enhance sustainable competitiveness across economic, environmental, and social dimensions.

**Keywords:** *Economic Sustainable Competitiveness, Government Policy, Investment, Maritime Sector, PLS-SEM*

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## 1. Introduction

The maritime sector plays a pivotal role in global trade, food supply, environmental integrity, and social well-being. Marine transportation carries over 80% of global trade by volume, making ports, shipping lanes, and related maritime infrastructure essential to the functioning of the world economy ([Madhavan, Sharafuddin, & Chaichana, 2022](#)). In many developing economies, the maritime sector also underpins livelihoods through fisheries, tourism, and coastal trade while being exposed to vulnerabilities such as environmental degradation, climate change, and governance challenges ([Buitrago R, Barbosa Camargo, & Cala Vitery, 2021](#)).

As environmental regulation intensifies and climate change impacts become more pronounced, there is growing pressure to ensure that maritime activities are not just economically efficient, but also socially inclusive and ecologically sustainable. Over the past decade, governments have increasingly deployed policies targeting sustainability in the maritime sector. Examples include regulations on emissions from ships, incentives for green shipping corridors, investments in port infrastructure resilience, and stricter environmental protection frameworks ([Kapidani, Bauk, & Davidson, 2020](#)). However, the efficacy of these policies in translating into real investment, both public and private, and then into improved sustainable competitiveness remains underexplored, especially in emerging economies. Research has highlighted that mere policy existence does not ensure implementation nor predictable investment reactions ([Harizi, 2023](#)).

Investment in maritime infrastructure including port expansion, digitalization, logistics connectivity, and resilient shore-side operations is often viewed as the primary mechanism by which government policy can influence competitiveness ([Smith, 2020](#)). Empirical work in Tunisia shows that investment in maritime infrastructure exhibits positive spillover effects on economic growth and productivity ([Aly, Pangemanan, Ningrat, Adisasmita, & Hustim, 2025](#)). In Indonesia, studies on maritime infrastructure development demonstrate that enhancements in port capacity and inter-island connectivity contribute substantially to trade volumes, reduction in logistics costs, and improvements in international competitiveness ([Sibali & Jainuddin, 2024](#)). Yet, challenges remain surrounding regulatory consistency, environmental costs, financing mechanisms (public-private partnerships, green financing), and institutional capacity.

Another increasingly recognized dimension is sustainable competitiveness, which combines economic performance with environmental stewardship and social welfare. It is not enough for a maritime region or nation to be competitive purely in cost, throughput, or profitability; growing attention is paid to green ports, cleaner vessels, reduction in emissions, community impact, and resilience to climate shocks ([Ayhan, 2023](#)). For instance, the development of green ports in Makassar (Indonesia) has brought environmental challenges to the fore, including pollution, waste, and community impacts, which require that competitiveness be measured not just by efficiency but also by ecological and social metrics ([Salas & Arenas, 2024](#)).

From a theoretical perspective, the relationship between government policy, investment, and competitiveness can be explained through institutional theory and the resource-based view (RBV). Institutional theory highlights that regulatory clarity, policy stability, and governance quality reduce uncertainty and encourage investment, particularly in capital-intensive sectors such as maritime infrastructure. This role becomes even more critical in emerging economies, where institutional conditions are less stable.

Meanwhile, RBV emphasizes that investment in strategic assets—such as infrastructure, technology, and human capital enables the development of capabilities that enhance long-term competitiveness. In the maritime sector, these capabilities are reflected in improved efficiency, environmental performance, and adaptability to global pressures. Recent studies indicate that government policy plays a key role in mobilizing investment through incentives, regulatory frameworks, and infrastructure planning, particularly in supporting green ports and digital transformation. However, most existing research examines these relationships separately, with limited integration into a unified framework. Moreover, empirical evidence from developing archipelagic countries such as Indonesia remains limited. Therefore, this study adopts an integrated approach to examine both direct and mediated relationships between policy, investment, and sustainable competitiveness.

The urgency of this study is particularly evident in the context of developing countries, where maritime sectors often serve as strategic pillars of national economic growth yet remain constrained by limited fiscal capacity, institutional fragility, and uneven infrastructure development. In such contexts, policy misalignment or inefficient investment allocation can result in significant economic losses, environmental degradation, and reduced global competitiveness. Unlike developed maritime nations with mature governance systems and stable financing mechanisms, developing countries face greater

uncertainty in mobilizing sustainable investment while simultaneously responding to international environmental standards and competitive pressures. Therefore, understanding how government policy effectively translates into investment and sustainable competitiveness is not merely an academic concern but a pressing policy priority. Empirical evidence that clarifies these relationships is essential for designing integrated maritime strategies that maximize economic returns while ensuring environmental resilience and social inclusivity in emerging maritime economies.

While prior studies have examined the relationship between maritime infrastructure investment and economic performance, or explored the role of governance and environmental regulation in port sustainability, most have focused on pairwise relationships rather than an integrated structural framework. For example, earlier research typically investigates policy effects on investment or investment effects on performance separately, without simultaneously modeling direct and mediated pathways. Moreover, many studies emphasize developed maritime economies, where institutional maturity and financial stability differ substantially from developing country contexts. This study advances the literature by integrating government policy, investment, and sustainable competitiveness into a single empirical model and explicitly testing both direct and mediation effects using PLS-SEM. By focusing on Indonesia as a developing archipelagic nation, the study provides context-specific evidence that clarifies how policy instruments translate into competitiveness outcomes under institutional and financial constraints. Thus, the contribution lies not only in methodological integration but also in extending the theoretical understanding of sustainable maritime competitiveness within emerging economies.

Despite recognition of these issues, there remains a gap in integrated empirical research that models the triadic relationship among government policy, investment, and sustainable competitiveness within the maritime sector. Does policy positively impact investment? Does investment lead to competitively sustainable outcomes (economic, environmental, social)? Is there a direct policy effect on competitiveness independent of investment? And how do these relationships manifest in developing economies, where institutional quality, financing constraints, environmental risk, and social inequalities may alter or moderate these pathways?

This study aims to address these gaps by employing Partial Least Squares Structural Equation Modelling (PLS-SEM) to quantitatively assess these relationships. By gathering primary data from maritime stakeholders in developing country contexts, this paper seeks to determine the magnitude and significance of: (a) the effect of government policy on investment; (b) the effect of investment on sustainable competitiveness; (c) the direct effect of policy on sustainable competitiveness; and (d) the mediating role of investment in the policy → competitiveness link. The findings are expected to offer both theoretical advancement in understanding maritime sector dynamics, as well as practical guidance for policymakers to design more effective, coherent policies and investment strategies in pursuit of sustainable competitiveness.

Problem Statement, while prior studies highlight the importance of government policies in shaping the trajectory of maritime development, the specific mechanisms through which such policies influence investment and competitiveness remain insufficiently understood, particularly in developing economies. The critical question is: which aspects of government policy most strongly affect investment in maritime infrastructure, technology, and human capital? Furthermore, even when policy successfully stimulates investment, does this investment necessarily lead to measurable improvements in sustainable competitiveness, balancing economic, environmental, and social dimensions? Finally, it remains unclear whether government policy exerts a direct effect on sustainable competitiveness beyond its influence mediated through investment. Addressing these questions is essential for designing coherent maritime strategies that effectively link policy design, financial flows, and long-term competitiveness outcomes.

Objectives of the Study, the present study seeks to address these research gaps through the following objectives:

1. To model the effect of government policy on investment in the maritime sector.
2. To examine the effect of investment on sustainable competitiveness, covering economic, environmental, and social dimensions.
3. To test whether government policy has a direct effect on sustainable competitiveness, and whether investment mediates the relationship between government policy and competitiveness.

This study contributes to both theory and practice by enriching the maritime governance and competitiveness literature through an integrated PLS-SEM framework that empirically examines the causal linkages between government policy, investment, and sustainable competitiveness. Grounded in institutional theory and the Resource-Based View (RBV), this study provides a coherent theoretical foundation that connects regulatory environments with resource mobilization processes in shaping competitiveness outcomes. Theoretically, it advances prior research by moving beyond isolated analyses and offering a holistic perspective in which government policy functions as an institutional driver that reduces uncertainty and guides investment behavior, while investment represents a strategic resource that enhances sectoral capabilities and long-term competitiveness.

Practically, the study provides industry stakeholders including shipping firms, port operators, and investors with empirical evidence on the pivotal role of investment as both a driver and mediator in achieving competitiveness, particularly through infrastructure, technology, and human capital development. From a policy perspective, the findings deliver actionable insights for regulators on how targeted instruments such as regulatory frameworks, fiscal incentives, maritime spatial planning, and environmental safeguards can effectively mobilize investment while simultaneously exerting a direct influence on competitiveness. This integrated perspective is especially valuable for developing economies striving to balance economic growth, social equity, and ecological sustainability within increasingly complex maritime systems.

## **2. Literature Review**

This section reviews prior studies on sustainable competitiveness, government policy instruments, and investment dynamics in maritime contexts. Key references include works on institutional quality, global competitiveness, and sustainable performance measured through PLS-SEM.

### ***2.1 Government Policy in the Maritime Sector***

Government policy toward the maritime sector comprises regulatory instruments (emission standards, waste management), fiscal measures (subsidies, tax breaks), planning instruments (maritime spatial planning, port masterplans), and direct public investment in infrastructure and human capital ([Cao & Alon, 2020](#)). Recent studies emphasize that while policy design has become more ambitious (e.g., green shipping corridors, stricter port environmental standards), the translation of policy into operational outcomes depends critically on governance capacity, enforcement, and policy coherence across levels of government (national → regional → port authority) ([Dağistan, Atalay, Aydın Ünal, & Aydın, 2025](#)). Empirical assessments of regulatory efficacy in maritime governance point to persistent gaps between policy formulation and implementation — with implementation gaps often driven by institutional weakness, inconsistent enforcement, and limited fiscal space in developing economies ([Lim, Pettit, Abouarghoub, & Beresford, 2019](#)).

Several papers model the comparative effects of regulatory versus incentive-based policies for promoting green investment in ports: regulation can effectively force abatement measures but sometimes reduces short-term output, whereas subsidies and incentive schemes tend to stimulate green investment without immediately constraining output (policy trade-offs) ([Ali & Ayelign, 2022](#); [Ochwo & Mwesigwa, 2021](#); [Smith, 2020](#)). These trade-offs underline the need for carefully calibrated policy mixes that combine regulation, fiscal incentives, and capacity building to scale green investments ([Xie & Zhou, 2025](#)).

## **2.2 Investment Dynamics: Ports, Technology, and Human Capital**

Investment in maritime contexts is multifaceted: (1) hard infrastructure (quay expansions, cranes, dredging), (2) soft/digital infrastructure (terminal operating systems, port community systems, IoT), and (3) human capital & training (seafarer training, port operations skills) ([Buitrago R et al., 2021](#)). A broad literature shows that targeted infrastructure investment correlates with improvements in throughput, lower logistics cost, and enhanced connectivity but these benefits are conditional on complementary reforms (customs modernization, hinterland connectivity) and on selection of investments with strong economic returns ([Olaniyi, Solarte-Vasquez, & Inkinen, 2024](#)). Large cross-country and region studies (including recent working papers) show that port investment produces trade and welfare gains when well-targeted but can produce uneven regional outcomes if network effects and connectivity are not addressed ([Brancaccio, Kalouptsidi, & Papageorgiou, 2024](#)).

The role of technology investment (digitalization, automation, smart-port solutions) has been especially prominent in the past five years: digitalization improves operational efficiency and can reduce emissions (by optimizing vessel calls, reducing idling), but it requires parallel investment in skills and institutional adaptation ([Olaniyi et al., 2024](#)). Evidence from studies of seafarers' training and energy-efficient operations indicates that human capital investment (training) improves the effectiveness of technological measures and is a necessary complement to hardware investment ([Hanif Dewan, Ahmed Mustafi, Matos, & Godina, 2024](#)).

## **2.3 Sustainable Competitiveness: Conceptualization & Measurement.**

Sustainable competitiveness in the maritime sector is a composite construct that blends traditional competitiveness metrics (throughput, cost efficiency, market share) with environmental performance (emissions, waste, biodiversity impacts) and social metrics (community welfare, labor conditions, resilience to disasters) ([Xiao, Wang, Wu, Li, & Cai, 2024](#)). Recent systematic reviews and empirical studies propose multi-dimensional indicator sets for green ports and maritime sustainability evaluation, arguing that competitiveness must be redefined to incorporate environmental externalities and social outcomes. Green port evaluation frameworks (methodological reviews) emphasize indicators across energy/emissions, waste management, water quality, socio-economic impact, and innovation capacity and call for standardized metrics to enable cross-port benchmarking ([Fei, Shi, & Pan, 2025](#)). Empirically, studies find that investments that explicitly target green outcomes (e.g., cold ironing, LNG/alternative fuels, shore power, electrified equipment) contribute to improved sustainability metrics; however, the link from investment to improved sustainable competitiveness is moderated by institutional quality and market incentives (e.g., ability to capture value from green branding or receive green finance). That is, investment alone is not always sufficient, it must be combined with enabling policies and market mechanisms ([Jia & Azevedo, 2025](#)).

## **2.4 Interplay between Policy, Investment and Competitiveness: Empirical Findings.**

Several strands of empirical literature have examined pairwise links (policy→investment, investment→performance), but integrated triadic models (policy→investment→sustainable competitiveness, with possible direct policy→competitiveness effects) are less common ([Belmoukari, Audy, & Forget, 2023](#)). Recent economic analyses (e.g., policy papers, NBER working papers) underscore that public investment in ports can produce large trade and welfare gains under targeted conditions, while other studies show subsidy vs regulation trade-offs for green investment in ports. These findings suggest two plausible pathways: (a) policy stimulates investment which then improves sustainable competitiveness (mediated path), and (b) policy has direct effects on competitiveness through regulation, institutional reputation, and market signalling (direct path). Quantitative modelling that simultaneously estimates these paths is therefore warranted to parse direct and indirect effects ([Brancaccio et al., 2024](#)).

Building on this, the present findings contribute to the limited but growing body of literature that employs integrated structural models to capture the simultaneous dynamics among policy, investment, and competitiveness. By applying SEM-PLS, this study empirically validates the notion that maritime competitiveness is not shaped by a single driver but by a complex system where government policy functions both directly and indirectly. This is consistent with broader institutional economics, which

emphasizes that the strength of policy lies not only in its ability to mobilize resources but also in shaping institutional legitimacy, investor perceptions, and stakeholder collaboration ([Yuen, Thai, & Wong, 2016](#)). The dual pathways observed in this study highlight the multifaceted nature of maritime governance, where effective policy must strike a balance between regulatory authority and investment incentives.

Moreover, the empirical evidence underscores the importance of policy design in determining which pathway dominates. For instance, when regulatory strictness is accompanied by fiscal incentives and long-term planning, the mediated pathway through investment tends to be stronger, creating a virtuous cycle of innovation and competitiveness ([Ali, 2021](#)). Conversely, in contexts where institutional enforcement is weak, the direct policy→competitiveness pathway may prevail, often relying on reputation effects, international compliance pressures, or environmental obligations to drive sustainable practices. This aligns with recent analyses of maritime green transitions, which demonstrate that the balance between mediated and direct effects depends on governance capacity, stakeholder engagement, and market maturity ([Notteboom, Pallis, & Rodrigue, 2022](#)).

### ***2.5 Use of PLS-SEM in Maritime & Sustainability Research.***

Partial Least Squares Structural Equation Modelling (PLS-SEM) has become a common method to study complex causal networks in management, sustainability, and sectoral studies because it accommodates smaller samples, formative constructs, and complex mediation/moderation relationships ([Sarihan & Yildiz, 2025](#)). The methodological literature provides clear guidance for measurement model assessment (composite reliability, AVE, discriminant validity) and bootstrapping procedures for inference. In maritime and blue-economy related research, PLS-SEM has been used to link institutional quality, innovation and sustainability outcomes; and to test mediation (e.g., how investment mediates institutional effects). PLS-SEM is therefore appropriate for modeling the policy → investment → sustainable competitiveness framework, especially when indicators span economic, environmental, and social domains ([Sarstedt, Ringle, & Hair, 2021](#)).

### ***2.6 Research Gaps & Implications for the Current Study.***

From the literature above, key gaps are apparent: (1) a shortage of integrated triadic empirical models that simultaneously estimate direct policy effects and mediated investment effects on sustainable competitiveness in maritime contexts; (2) limited context-specific evidence from developing economies where institutional constraints and financing limitations may alter pathways; (3) variability in sustainability measurement — a need for standardized, multi-dimensional indicators to capture competitiveness beyond throughput. Taken together, these gaps motivate a PLS-SEM study that: (a) uses validated multi-item measures for Policy, Investment, and Sustainable Competitiveness; (b) explicitly tests mediation (Investment as mediator); and (c) examines robustness across contexts or subgroups (e.g., by region or port type).

### ***2.7 Hypotheses Development***

Grounded in institutional theory and sustainability-oriented competitiveness frameworks, this study proposes the following hypotheses. Each hypothesis is supported by prior empirical and theoretical arguments within maritime governance and investment literature.

#### ***2.7.1 Government Policy → Investment***

Government policy plays a central role in shaping the investment climate within capital-intensive sectors such as maritime infrastructure and shipping ([Buitrago R et al., 2021](#); [Notteboom et al., 2022](#)). According to institutional theory, regulatory clarity, fiscal incentives, and long-term infrastructure planning reduce uncertainty and transaction costs, thereby enhancing investor confidence. Empirical studies demonstrate that stable maritime regulations, subsidies for green technologies, and coordinated spatial planning stimulate both public and private investment in ports and shipping systems. In developing economies, where institutional risks are often higher, policy consistency becomes even more critical for mobilizing sustainable investment ([Aly et al., 2025](#)).

*H<sub>1</sub>*: Government policy has a positive effect on investment in the maritime sector

### 2.7.2 Investment → Sustainable Competitiveness

Investment in infrastructure, technology, and human capital is widely recognized as a driver of competitiveness (Cao & Alon, 2020; Kapidani et al., 2020). In maritime contexts, modernization of port facilities, adoption of digital logistics systems, and green technology upgrades enhance operational efficiency, reduce environmental impact, and strengthen supply chain resilience (Jia & Azevedo, 2025). From a resource-based perspective, strategic investment builds tangible and intangible capabilities that contribute to long-term competitive advantage. Moreover, sustainability-oriented investments enable maritime sectors to meet global environmental standards, which increasingly determine market access and reputation (Xiao et al., 2024).

*H<sub>2</sub>: Investment in the maritime sector has a positive effect on sustainable competitiveness*

### 2.7.3 Government Policy → Sustainable Competitiveness (Direct Effect)

Beyond its influence through investment, government policy may exert a direct effect on competitiveness. Regulatory enforcement, environmental standards, and institutional transparency can shape firm behavior even in the absence of significant capital inflows (Ayhan, 2023; Xie & Zhou, 2025). Policies may compel firms to innovate, improve compliance, and enhance operational efficiency to maintain legitimacy and market access. In addition, strong governance frameworks enhance a country's maritime reputation, which itself contributes to competitiveness (Olaniyi et al., 2024). Therefore, policy is expected to influence competitiveness both indirectly and directly.

*H<sub>3</sub>: Government policy has a positive direct effect on sustainable competitiveness*

### 2.7.4 The Mediating Role of Investment

While policy can directly influence competitiveness, its most substantial impact is often realized through resource mobilization mechanisms (Fei et al., 2025). Institutional theory suggests that policy shapes organizational outcomes by allocating incentives and structuring investment flows. In the maritime sector, regulatory frameworks and fiscal instruments are expected to stimulate investments in infrastructure, green technologies, and human capital, which then translate into improved competitiveness outcomes (Xie & Zhou, 2025). This aligns with mediation logic in structural models, where investment functions as a transmission channel linking institutional conditions to performance outcomes. In developing countries, where capital constraints are significant, the mediation pathway becomes particularly crucial because policy effectiveness depends largely on its ability to generate real economic commitment (Jia & Azevedo, 2025; Xiao et al., 2024). Thus, investment is expected to partially mediate the relationship between government policy and sustainable competitiveness (Ochwo & Mwesigwa, 2021).

*H<sub>4</sub>: Investment mediates the relationship between government policy and sustainable competitiveness*

## 3. Methodology

This study adopts a quantitative, cross-sectional survey design to empirically examine the causal relationships between government policy, investment, and sustainable competitiveness in the maritime sector. The research employs Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS as the primary analytical tool, given its suitability for complex models, mediation testing, and relatively small-to-medium sample sizes. The population of this study comprises key stakeholders in the maritime sector, with an emphasis on individuals possessing decision-making authority or expert knowledge. Respondents were selected through purposive sampling to ensure expertise and relevance. The sample included: Government policymakers from ministries and regional maritime authorities; Port authority executives responsible for port management and operations; Shipping company managers with roles in investment, logistics, and sustainability; Private investors and financial institutions involved in maritime infrastructure and services; Environmental NGOs and maritime consultants with expertise in sustainability and governance.

A total of 420 expert respondents participated in the survey, ensuring representation from different maritime regions (e.g., Java, Sulawesi, and Nusa Tenggara). The sample size exceeds the minimum threshold recommended for SEM-PLS (10 times the maximum number of inner or outer model paths), thereby strengthening the robustness of the analysis. Data were collected using a structured

questionnaire distributed electronically and through in-person administration at industry forums. All constructs were measured with multi-item scales using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The questionnaire items were adapted from validated measurement instruments in prior competitiveness, governance, and sustainability studies, with modifications to suit the maritime context.

Purposive sampling was employed to ensure that respondents possessed relevant expertise and direct involvement in maritime policy, investment, and sustainability decision-making. The selection of respondents followed specific inclusion criteria to enhance data quality and relevance. Participants were required to have a minimum of five years of professional experience in the maritime sector and to occupy positions with strategic or decision-making responsibilities, such as policymakers, port authority executives, shipping managers, investment analysts, or sustainability consultants. In addition, respondents were selected from key maritime regions (e.g., Java, Sulawesi, and Nusa Tenggara) to ensure geographical representation and contextual diversity.

The sampling process was conducted through a combination of professional networks, institutional affiliations, and industry forums, where individuals meeting the criteria were identified and invited to participate. This approach ensured that the data were obtained from knowledgeable informants capable of providing informed assessments of policy, investment, and competitiveness dynamics. While purposive sampling may limit statistical generalizability, several measures were implemented to mitigate potential bias. First, clear and objective selection criteria were applied to avoid arbitrary inclusion. Second, diversification of respondents across stakeholder groups (government, industry, investors, and NGOs) reduced single-source bias. Third, anonymity and confidentiality assurances were provided to minimize social desirability bias and encourage honest responses. Finally, the use of validated measurement scales adapted from prior studies further strengthened construct validity and reliability. These steps ensure that the data are both credible and appropriate for structural analysis using PLS-SEM.

Although purposive sampling may limit statistical generalizability and introduce selection bias, these risks were mitigated by applying clear inclusion criteria (minimum professional experience and strategic involvement) and ensuring representation across stakeholder groups and maritime regions. Therefore, the technique enhances data relevance and construct validity, which is particularly important in PLS-SEM research focused on expert-driven policy analysis.

#### 1. Measurement of constructs

- a. Regulatory support for maritime activities.
- b. Subsidies or fiscal incentives for infrastructure and technology.
- c. Maritime spatial planning and zoning regulations.
- d. Investments in port infrastructure by government.
- e. Environmental protection and sustainability-focused policy.

#### 2. Investment [Sakdiyakorn, Golubovskaya, and Solnet \(2021\)](#), indicators:

- a. Infrastructure investment (port facilities, terminals, dredging).
- b. Technology adoption (digital port systems, automation, green technologies).
- c. Human capital development (training, certifications, skills programs).
- d. Private–public partnerships (PPP) for maritime development.
- e. Financial capital mobilization for sustainable maritime initiatives.

#### 3. Sustainable Competitiveness (SC), indicators:

- a. Economic dimension: efficiency, productivity, and cost competitiveness.
- b. Environmental dimension: emissions reduction, green port initiatives, eco-certifications.
- c. Social dimension: job creation, inclusiveness, community empowerment.
- d. Innovation & adaptability: ability to respond to global trade and sustainability standards.
- e. Institutional performance: governance transparency, compliance, and stakeholder collaboration.

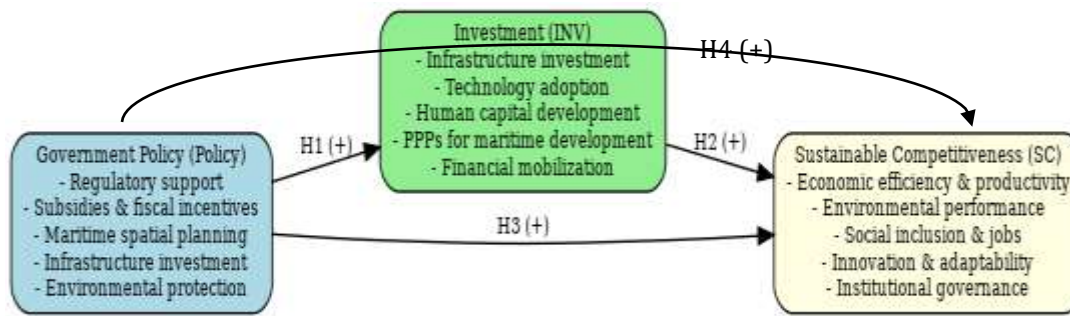


Figure 1. The conceptual framework

Figure 1 the conceptual framework illustrates the hypothesized causal relationships among the constructs. Government Policy is expected to positively influence Investment and Sustainable Competitiveness directly. Investment, in turn, is hypothesized to positively influence Sustainable Competitiveness and to mediate the effect of Policy on Competitiveness.

#### 4. Results and Discussion.

##### 4.1 Result

The data were analyzed using PLS-SEM. Reliability and validity tests confirmed the adequacy of the measurement model. Structural model results are shown in Tables 1-5.

Table 1. Reliability and validity test result

Construct	Cronbach Alpha	Composite Reliability	AVE
Government Policy	0.89	0.92	0.67
Investment	0.87	0.91	0.65
Sustainable Competitiveness	0.91	0.94	0.70

Table 1 shows that all constructs demonstrate strong reliability (Cronbach's Alpha > 0.7) and validity (AVE > 0.5). Table 1 presents the reliability and validity assessment of the measurement model. The Cronbach's alpha values for all constructs range between 0.87 and 0.91, exceeding the recommended threshold of 0.70, thus confirming strong internal consistency. Similarly, the Composite Reliability (CR) values, which fall between 0.91 and 0.94, indicate excellent construct reliability, surpassing the suggested 0.70 benchmark (Hair et al., 2021).

Furthermore, the Average Variance Extracted (AVE) values for Government Policy (0.67), Investment (0.65), and Sustainable Competitiveness (0.70) are all above the 0.50 cutoff, demonstrating satisfactory convergent validity (Fornell & Larcker, 1981). These results collectively confirm that the constructs are measured reliably and that their indicators adequately capture the underlying latent variables, thereby providing a robust foundation for subsequent structural model testing.

Table 2. Fornell–Larcker criterion

Construct	Government Policy	Investment	Sustainable Competitiveness
Government Policy	0.82		
Investment	0.71	0.81	
Sustainable Competitiveness	0.68	0.73	0.84

Note: Diagonal values are the square roots of AVE; off-diagonal are inter-construct correlations.

Table 3. Heterotrait–Monotrait Ratio (HTMT).

Construct Pair	HTMT Value
Government Policy → Investment	0.78
Government Policy → Sustainable Competitiveness	0.74
Investment → Sustainable Competitiveness	0.80

Note: HTMT values < 0.90 indicate good discriminant validity.

The results in Tables 2 and 3 demonstrate satisfactory discriminant validity. In the Fornell–Larcker criterion, the square root of each construct’s AVE (diagonal values ranging from 0.81 to 0.84) is greater than its correlations with other constructs, confirming that each latent variable is distinct (Fornell & Larcker, 1981). Similarly, all HTMT ratios range between 0.74 and 0.80, which are below the conservative threshold of 0.90, further supporting discriminant validity. These results confirm that the constructs in the model are empirically distinct, allowing for meaningful structural model evaluation.

Table 4. Structural Model Path Coefficients (Direct Effect).

Path	Coefficient (β)	t-value	p-value
Policy → Investment	0.65	12.34	<0.001
Investment → Sustainable Competitiveness	0.58	10.21	<0.001
Policy → Sustainable Competitiveness	0.30	5.12	<0.001

Beyond statistical significance, it is important to assess the magnitude of the effects to better understand their practical relevance. The path coefficient from Government Policy to Investment ( $\beta = 0.65$ ) indicates a strong effect, suggesting that policy interventions play a substantial role in driving investment decisions within the maritime sector. Similarly, the effect of Investment on Sustainable Competitiveness ( $\beta = 0.58$ ) can be interpreted as moderate-to-strong, highlighting that investment in infrastructure, technology, and human capital significantly enhances competitiveness outcomes. In contrast, the direct effect of Government Policy on Sustainable Competitiveness ( $\beta = 0.30$ ), although statistically significant, represents a moderate effect, indicating that policy alone is not sufficient to fully drive competitiveness without the support of investment mechanisms. This reinforces the importance of examining both direct and mediated pathways in understanding competitiveness dynamics.

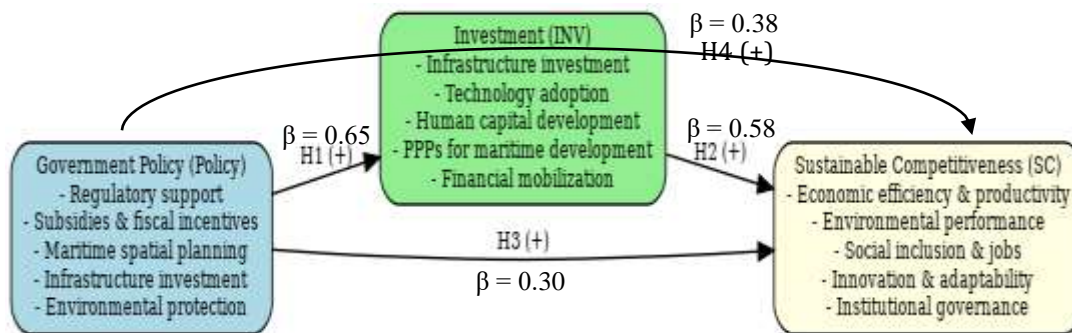


Figure 2. Result of structural model path coefficients

Figure 2 and Table 4 shows that all hypothesized relationships are significant. Government policy strongly influences investment, and both policy and investment positively influence sustainable competitiveness. Table 4 presents the results of the structural model analysis, showing the path coefficients ( $\beta$ ),  $t$ -values, and  $p$ -values for the hypothesized relationships. The path from Government Policy → Investment is positive and significant ( $\beta = 0.65$ ,  $t = 12.34$ ,  $p < 0.001$ ), indicating that stronger policy support substantially enhances investment in the maritime sector. The effect of Investment → Sustainable Competitiveness is also positive and significant ( $\beta = 0.58$ ,  $t = 10.21$ ,  $p < 0.001$ ), suggesting that investments in infrastructure, technology, and human capital directly improve competitiveness outcomes. Furthermore, Government Policy → Sustainable Competitiveness shows a significant direct effect ( $\beta = 0.30$ ,  $t = 5.12$ ,  $p < 0.001$ ), implying that government actions contribute not only indirectly

through investment but also exert a direct influence on competitiveness. Overall, these results confirm that direct pathways are significant, supporting hypotheses  $H_1$ ,  $H_2$ , and  $H_3$ . The findings underscore the dual role of government policy: stimulating investment and directly shaping the sustainable competitiveness of the maritime sector.

Table 5. Mediation Analysis:  
Indirect Effect of Government Policy on Sustainable Competitiveness

Indirect Effect	Coefficient ( $\beta$ )	Significance
Policy $\rightarrow$ Investment $\rightarrow$ Sustainable Competitiveness	0.38	Significant ( $p < 0.001$ )

Figure 2 and Table 5 confirms that investment significantly mediates the relationship between policy and competitiveness. Table 6 reports the results of the mediation analysis. The indirect effect of Government Policy  $\rightarrow$  Investment  $\rightarrow$  Sustainable Competitiveness is positive and significant ( $\beta = 0.38$ ,  $p < 0.001$ ). This indicates that investment functions as a mediating mechanism through which government policy enhances sustainable competitiveness. In other words, beyond its direct contribution, government policy improves competitiveness by stimulating greater investment in infrastructure, technology, and human capital, which in turn strengthens economic, environmental, and social outcomes in the maritime sector.

The significance of this indirect effect provides strong support for  $H_4$ , confirming that investment plays a pivotal role in translating policy actions into tangible competitiveness outcomes. This finding highlights the necessity for policymakers not only to implement effective regulations and incentives but also to ensure that such measures are capable of mobilizing investments aligned with sustainability objectives.

Beyond statistical significance, the results provide clear implications for real-world maritime policy. First, the strong effect of government policy on investment indicates that regulatory clarity, stable incentives, and coordinated infrastructure planning are not merely administrative functions but key drivers of capital mobilization. In practical terms, this means that inconsistent regulations or short-term policy shifts may directly weaken investment flows in the maritime sector.

Second, the significant impact of investment on sustainable competitiveness implies that competitiveness is not achieved through regulation alone but through tangible improvements in infrastructure, technology adoption, and workforce development. Policymakers should therefore prioritize policies that translate into measurable investments, particularly in green port facilities, digital logistics systems, and human capital upgrading.

Finally, the mediation results suggest that policies are most effective when they successfully trigger investment rather than remaining declarative. In real-world terms, maritime policies should be designed with clear financial mechanisms, implementation roadmaps, and monitoring systems to ensure that regulatory intentions lead to actual resource allocation. Overall, the findings indicate that effective maritime competitiveness strategies require policy stability, investment facilitation, and sustainability integration working simultaneously.

#### 4.2 Discussion

The results confirm the hypothesized relationships. Government policy shapes investment, which drives sustainable competitiveness in the maritime sector. However, policy also exerts a direct effect, suggesting some levers (e.g., regulation, reputation, or subsidies) act independently of investment flows. Beyond their statistical significance, the findings carry important practical implications for maritime governance and industry strategy. The strong effect of government policy on investment suggests that policy consistency, regulatory clarity, and long-term planning are critical in attracting both public and private capital. In practical terms, unstable or fragmented policies may significantly reduce investor confidence and delay infrastructure development.

Furthermore, the substantial impact of investment on sustainable competitiveness indicates that competitiveness cannot be achieved through regulation alone. Instead, tangible investments in port modernization, digital logistics systems, green technologies, and workforce development are essential. This implies that policymakers should prioritize investment-oriented policy instruments, ensuring that regulatory frameworks are directly linked to financial mechanisms and implementation strategies.

The moderate direct effect of government policy on competitiveness also highlights that certain regulatory instrument—such as environmental standards and governance transparency—can independently shape competitiveness. However, their impact is more limited compared to investment-driven pathways. Therefore, the most effective maritime strategies are those that integrate policy design with investment facilitation, ensuring that regulatory intentions are translated into measurable outcomes.

The findings of this study provide robust empirical support for the hypothesized relationships between government policy, investment, and sustainable competitiveness in the maritime sector. Using a PLS-SEM framework, the results confirm that government policy significantly influences investment ( $H_1$ ), investment positively affects sustainable competitiveness ( $H_2$ ), government policy has a direct effect on competitiveness ( $H_3$ ), and investment mediates the relationship between government policy and competitiveness ( $H_4$ ). These findings contribute both theoretically and practically to the growing literature on maritime governance, sustainability, and competitiveness.

#### *4.2.1 Government Policy and Investment ( $H_1$ )*

The results show that government policy exerts a strong and significant positive effect on investment in the maritime sector. This finding aligns with prior studies emphasizing that regulatory frameworks, subsidies, and infrastructure provisions create a more conducive environment for mobilizing both public and private capital ([Ayhan, 2023](#); [Dağistan et al., 2025](#)). In particular, well-designed policies reduce uncertainty, lower transaction costs, and enhance investor confidence, which are critical factors in maritime industries where infrastructure and technology investments are capital-intensive.

Government policy not only provides the structural conditions for investment but also acts as a signaling mechanism to global and domestic markets. Stable and transparent policy frameworks send clear signals to investors regarding long-term commitment to maritime development, particularly in areas such as green port infrastructure, digitalization of logistics, and low-carbon shipping technologies. This signalling effect reduces perceptions of risk and uncertainty, which are often cited as barriers to large-scale maritime investment. Moreover, international experiences demonstrate that countries with consistent maritime spatial planning and environmental safeguards attract higher levels of sustainable investment, as these policies are aligned with global sustainability standards and investor expectations.

Additionally, government policy can foster partnerships and collaborative financing models, such as public–private partnerships (PPPs), which are increasingly essential in addressing the scale of investment required in the maritime sector. By offering fiscal incentives, risk-sharing mechanisms, or access to concessional financing, governments can lower the entry barriers for private investors while ensuring that investments align with national development and sustainability priorities. Evidence from recent studies indicates that such collaborative policy-driven investment frameworks contribute not only to economic efficiency but also to social and environmental goals, thereby reinforcing the broader notion of sustainable competitiveness.

#### *4.4.2 Investment and Sustainable Competitiveness ( $H_2$ )*

The analysis also confirms that investment in infrastructure, technology, and human capital directly improves sustainable competitiveness. This supports earlier research indicating that investments in port modernization, green shipping technologies, and workforce skills significantly enhance efficiency and environmental performance, while also generating social benefits such as job creation ([Lam & Notteboom, 2014](#)). These results underscore the idea that investment acts as a strategic lever for balancing economic, environmental, and social dimensions of maritime competitiveness.

Beyond the direct improvements in efficiency and environmental outcomes, investment also stimulates innovation capacity within the maritime sector. Firms that allocate resources to Research and Development (R&D), digital platforms, and smart logistics systems are better positioned to adapt to global trade shifts and environmental regulations. This innovation-driven competitiveness not only reduces operational costs but also differentiates firms in increasingly sustainability-conscious markets. Importantly, innovation fueled by strategic investment generates spillover benefits across the maritime cluster, such as enhanced supply chain resilience and greater regional integration.

Furthermore, investments in human capital are equally vital, as the maritime industry is labor- and knowledge-intensive. Continuous training programs and capacity-building initiatives ensure that the workforce is equipped with technical expertise in areas such as digital navigation, environmental monitoring, and port automation. Skilled labor enhances operational safety, regulatory compliance, and overall productivity, thereby reinforcing the triple bottom line of competitiveness—economic viability, social inclusivity, and ecological responsibility. This finding resonates with recent studies that highlight the synergy between human resource development, technological adoption, and sustainable performance in maritime and logistics sectors.

#### *4.4.3 Direct Effect of Government Policy on Competitiveness (H<sub>3</sub>)*

Interestingly, the findings demonstrate that government policy does not only affect competitiveness indirectly through investment, but also exerts a significant direct effect. This suggests that certain policy instruments—such as environmental regulations, subsidy mechanisms, and maritime reputation strategies—shape competitiveness independently of investment flows. For instance, strong regulatory enforcement may compel firms to innovate and adopt sustainable practices even in the absence of major capital inflows (Cullinane & Bergqvist, 2014; Notteboom et al., 2022). Thus, government intervention plays a dual role: as both an enabler of investment and as a direct driver of sustainable outcomes.

In addition to driving compliance and innovation, direct government intervention also enhances the institutional quality of the maritime sector. Transparent governance, consistent policy implementation, and the enforcement of international standards such as IMO regulations strengthen trust among global partners and stakeholders. This institutional stability can improve the country's maritime reputation, attract international shipping lines, and enhance trade competitiveness without relying solely on new investment. Prior research emphasizes that governance quality and policy credibility are crucial determinants of competitiveness in global logistics and maritime performance.

Moreover, government policies often generate non-financial competitive advantages by fostering social and environmental legitimacy. For example, proactive maritime spatial planning, environmental safeguards, and safety regulations can elevate a country's status as a sustainable and responsible maritime hub. This reputational capital attracts eco-conscious clients, improves international cooperation, and ensures long-term access to global markets. Such direct pathways underscore that competitiveness in the maritime industry is not exclusively resource-dependent but also shaped by the broader regulatory and institutional ecosystem.

#### *4.4.4 Mediating Role of Investment (H<sub>4</sub>)*

The mediation analysis further reveals that investment significantly transmits part of the effect of government policy onto sustainable competitiveness. This finding is consistent with institutional theory, which emphasizes that policies influence organizational behaviour through the allocation of resources and incentives. The results show that while policy can act directly, its greatest impact emerges when it successfully mobilizes investments aligned with long-term sustainability objectives. For policymakers, this highlights the importance of designing frameworks that not only regulate but also incentivize and channel financial resources into sustainable maritime projects. In particular, investment serves as the operational mechanism through which abstract policy intentions are translated into tangible outcomes. For example, when governments introduce environmental regulations or green subsidies, these policies only achieve long-term competitiveness if they trigger actual capital allocation into cleaner technologies, port modernization, and workforce development. Without this investment transmission, the policy effect may remain symbolic rather than transformational.

Prior studies in maritime economics highlight that investment functions as a bridge between institutional frameworks and firm-level performance, ensuring that sustainability goals are embedded into the sector's daily operations. Furthermore, the mediating role of investment reflects the dynamic alignment between public policy objectives and private sector strategies. When policies successfully mobilize financial resources, they not only enhance competitiveness but also foster shared responsibility between the state and industry actors. This co-investment approach is especially critical in developing economies, where public funding alone cannot cover the scale of infrastructure and technological upgrades required. Evidence suggests that policy-induced investments accelerate innovation diffusion and reinforce the balance between economic efficiency, social equity, and ecological resilience.

#### *4.4.5 Implications for Research and Practice*

Taken together, these findings enrich theoretical discussions on maritime resilience and competitiveness by integrating policy, investment, and sustainability into a single empirical framework. Practically, they suggest that policymakers in developing economies must adopt integrated approaches that combine regulatory authority with investment facilitation mechanisms. In the Indonesian context, this can be operationalized through several concrete investment strategies. For example, port modernization programs in major hubs such as Port of Tanjung Priok and Port of Tanjung Perak can prioritize automation systems, smart logistics platforms, and capacity expansion to reduce dwelling time and logistics costs. Additionally, investment in green port initiatives, such as shore power facilities, electrified cargo handling equipment, and waste management systems, can support Indonesia's commitment to sustainable maritime development while enhancing environmental competitiveness.

Furthermore, the development of integrated maritime logistics corridors—for instance, strengthening connectivity between eastern regions such as Sulawesi and Nusa Tenggara with western economic centers can improve national supply chain efficiency and reduce regional disparities. Investment strategies can also include public-private partnership (PPP) schemes to mobilize private capital in port infrastructure and digitalization, supported by government incentives and risk-sharing mechanisms. In parallel, human capital development programs, including maritime training, digital skills, and sustainability certification, are essential to ensure that technological investments are effectively utilized. For industry stakeholders, these examples underscore the importance of aligning investment strategies with both policy frameworks and sustainability goals to achieve long-term competitiveness in a highly globalized and environmentally constrained maritime environment.

## **5. Conclusions**

### **5.1 Conclusion**

This study provides empirical evidence that government policy significantly influences investment, and both factors contribute to sustainable competitiveness. The findings highlight the dual role of policy as both a driver of investment and as a direct determinant of competitiveness. This study set out to investigate the dynamic relationships between government policy, investment, and sustainable competitiveness in the maritime sector using a PLS-SEM framework. The first objective was to model the effect of government policy on investment. The findings confirm that government policy exerts a strong positive effect on investment, indicating that regulatory support, fiscal incentives, and infrastructure planning serve as critical enablers for mobilizing capital and encouraging private participation in maritime development. This highlights the role of governments in shaping favourable conditions for sustained investment flows into infrastructure, technology, and human capital.

The second objective was to examine the effect of investment on sustainable competitiveness across economic, environmental, and social dimensions. The results show that investment significantly enhances competitiveness by improving efficiency and productivity, enabling adoption of green technologies, and fostering employment and social inclusion. These findings provide empirical evidence that targeted investments not only create economic value but also reinforce the environmental and social sustainability of the maritime sector, which is increasingly vital in the context of global decarbonization and social equity goals. The third objective was to test whether government policy has a direct effect on sustainable competitiveness and whether investment mediates this relationship. The results demonstrate that government policy does indeed exert a direct influence on competitiveness,

independent of investment flows. This suggests that instruments such as regulations, reputation-building, and subsidies can shape competitiveness outcomes directly. At the same time, mediation analysis confirms that investment serves as a key transmission mechanism, amplifying the impact of policy measures on long-term competitiveness.

From a policy perspective, the findings suggest several concrete recommendations for more effective maritime governance in developing countries. First, policymakers should ensure regulatory consistency and long-term policy stability to reduce uncertainty and attract sustained private investment. Second, fiscal instruments such as targeted subsidies, tax incentives, and green financing schemes should be strategically aligned with sustainability objectives, particularly in port modernization, digitalization, and low-carbon technologies. Third, governments should strengthen Public–Private Partnership (PPP) frameworks to mobilize capital while maintaining accountability and environmental standards. Additionally, integrating maritime spatial planning with environmental safeguards and workforce development programs can ensure that investment translates into balanced economic, social, and ecological gains. By adopting a coordinated and investment-oriented policy approach, maritime authorities can more effectively transform regulatory frameworks into measurable improvements in sustainable competitiveness.

Taken together, the findings underline the dual role of government policy: as a catalyst for investment and as a direct determinant of sustainable competitiveness. This duality highlights the necessity of integrated governance approaches in which policy frameworks are not only designed to regulate but also to incentivize and channel investments toward sustainable maritime development. By addressing these three objectives, this study fills an important research gap and provides both theoretical insights and practical guidance for policymakers, industry stakeholders, and scholars concerned with the future of sustainable maritime competitiveness in Indonesia. Despite its contributions, this study has several limitations. The cross-sectional design limits causal interpretation, and the use of purposive sampling may reduce generalizability beyond the Indonesian maritime context. In addition, the reliance on self-reported data may introduce potential bias. Future research is recommended to use longitudinal approaches to better capture dynamic relationships over time. Incorporating additional variables, such as institutional quality or access to green finance, may also provide deeper insights. Comparative studies across different countries, as well as qualitative case studies in specific Indonesian ports, would further strengthen the understanding of how policy and investment influence sustainable competitiveness in practice.

### ***5.2 Research Limitations***

This study has several limitations. First, the cross-sectional design limits the ability to draw strong causal conclusions, as the relationships were examined at a single point in time. Second, the use of purposive sampling, while ensuring expert and relevant respondents, may limit the generalizability of the findings beyond Indonesia's maritime sector. Third, the data are based on self-reported perceptions, which may introduce subjective bias. Finally, the model focuses on three main constructs and does not include other contextual factors, such as institutional quality or financial capacity, which may also influence sustainable competitiveness.

### ***5.3 Suggestions and Directions for Future Research***

Future research should consider longitudinal designs to better capture dynamic relationships between policy, investment, and competitiveness over time. Expanding the model to include moderating or contextual variables such as governance quality, environmental regulation intensity, or access to green finance would provide deeper insights. Comparative studies across different developing countries are also recommended to test the robustness of the findings. Additionally, combining quantitative analysis with qualitative case studies could enrich understanding of how maritime policies are implemented in practice.

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## Authors' Contributions

AA conceptualized the research framework, developed the theoretical model, designed the questionnaire, conducted data collection and statistical analysis using PLS-SEM, and drafted the manuscript. DH contributed to the research design refinement, supervised the methodological approach, validated the analytical results, provided critical revisions to the manuscript, and approved the final version for publication.

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