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Green governance in maritime infrastructure development East Java as the new gateway of a sustainable Nusantara

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ABSTRACT

This study explores the implementation of green governance in East Java's maritime infrastructure development as the principal gateway to sustainable Nusantara. Positioned strategically as a national logistics and socio-economic hub connecting Java and Indonesia's new capital (IKN), East Java possesses strong institutional, geographic, and community capacities to lead the green maritime transition. This research highlights how environmentally responsible port management, the efficiency and transparency of the Sea Toll program, and collaborative governance among the government, regional enterprises, MSMEs, and coastal communities contribute to sustainable development. Despite regulatory fragmentation, limited funding, and low environmental literacy, grassroots innovation and civic participation have emerged as transformative social capital. This study emphasizes the need to strengthen public policy alignment, expand fiscal incentives for sustainable ports, and enhance community-based environmental education as key strategies to accelerate an inclusive and socially responsive maritime governance model that supports IKN connectivity and regional welfare.

Keywords: Green Governance, Maritime Infrastructure, Public Policy, Civic Participation, Sustainable Development, East Java

1. INTRODUCTION

The relocation of Indonesia's new capital city (IKN) to East Kalimantan marks a new phase in the country's national development. This transformation requires supporting regions, such as East Java, to evolve into a hub of connectivity and a new economic center that facilitates logistics distribution, population mobility, and industrial growth (Bappenas, 2022). In early 2023, the Ministry of Transportation launched the maiden voyage of the Sea Toll Program from Tanjung Perak Port using KM Kendhaga Nusantara 7, serving route T14 to Larantuka, Lewoleba, and Kalabahi with 57 TEUs of basic goods, such as rice, oil, and sugar. In total, 39 Sea Toll routes were opened that year, 20 operated by state-owned enterprises such as Pelni, ASDP, and Djakarta Lloyd, and 19 managed through public tenders for private operators (Bisnis.com, 2023). The major challenge lies in ensuring that this development is conducted sustainably and in an environmentally responsible manner.

The concept of green governance offers an essential framework for addressing this challenge. It refers to a mode of governance that integrates the principles of sustainability, transparency, public participation, and accountability (Meadowcroft, 2007). In the context of East Java, the application of green governance is crucial to ensure that maritime infrastructure development does not degrade coastal and marine ecosystems. According to Coordinating Minister Luhut B. Pandjaitan, Indonesia's ports must evolve toward green and smart port models that are efficient, transparent, and sustainable. where port digitalization plays a key role in minimizing corruption and improving logistical efficiency (IDNtimes, 2022).

The Teluk Lamong Terminal in Surabaya serves as a national pilot project for the implementation of green ports. Gautama showed that the automation and electrification of cargo-handling equipment reduced carbon emissions, improved energy efficiency, and enhanced air quality (Gautama, 2023). Meanwhile, the Sea Toll program has succeeded in reducing price disparities, particularly in Eastern Indonesia and remote or border regions (Viva.co.id, 2021).

From a green governance perspective, the sustainability of the Sea Toll must consider energy efficiency, emission reduction, and marine ecosystem preservation. These objectives can be achieved through low-emission fuel use, waste management systems, and periodic environmental monitoring (UNESCAP, 2020). The East Java Provincial Government has demonstrated its commitment to sustainable development through initiatives such as green industrial zones and coastal conservation programs in the region. However, its implementation still requires synergy among local governments, state-owned enterprises, MSMEs, and private investors (Pemprov Jatim, 2023).

The sustainable development paradigm emphasizes the balance between economic growth, environmental preservation, and social equity (WCED, 1987). In East Java, this theory provides a foundation for developing strategies that pursue economic growth while safeguarding natural resources. Community participation is a vital element of green governance, where local involvement in monitoring port operations and the Sea Toll enhances accountability and encourages innovation based on local needs (Fung, 2006). An ecosystem-based approach to port and sea transport planning should also be strengthened through comprehensive environmental impact assessments, coastal restoration, and integration between infrastructure development and conservation (MEA, 2005).

Facing global challenges such as climate change, rising sea levels, and ecosystem degradation, East Java's transformation into the gateway of a sustainable Nusantara requires a comprehensive green governance approach (IPPC, 2023). Ports and the Sea Toll program must function not only as logistical infrastructures but also as policy instruments for achieving inclusive, resilient, and socially responsive maritime development.

2. METHODOLOGY

This study employs a qualitative descriptive approach to explore the implementation of green governance principles in maritime infrastructure development in East Java. This approach was chosen for its ability to capture complex social and policy phenomena contextually and analyze the dynamics of

governance within sustainable development frameworks (Ishtiaq, 2019). This research adopts a descriptive qualitative design, aiming to describe and analyze green governance practices in the context of ports and the Sea Toll program without focusing on hypothesis testing (Chasanah, 2020). The study emphasizes interpretive understanding (verstehen) and policy relevance rather than statistical generalization.

Data were collected using three primary methods: (1) literature review, examination of scholarly articles, books, and policy reports related to green governance, green ports, and the Sea Toll program. Core references include materials from UNESCAP, OECD, and leading national journals; (2) Policy document analysis, review of official documents such as the East Java Regional Development Plan (RPJMD), Ministry of Transportation regulations, and port performance reports to assess the direction of sustainable governance policies; (3) Secondary data from Relevant Institutions, compilation of statistics and reports from the Ministry of Transportation, Bappenas, and the Provincial Government of East Java concerning logistics volume, carbon emissions, and Sea Toll performance indicators.

A qualitative thematic analysis with an inductive reasoning framework was applied, focusing on four analytical dimensions. Themes were derived from the literature synthesis, contextual interpretation, and narrative analysis of maritime governance practices in East Java. The analysis emphasizes the interconnection among: (1) Geographical connectivity and maritime infrastructure, this section examines East Java's strategic role as a national logistics hub through major ports (Tanjung Perak, Teluk Lamong, and Probolinggo), emphasizing capacity, multimodal integration, and contribution to national distribution systems, (2) Implementation of Green Governance, this analysis evaluates environmentally friendly port practices, electrification, digitalization, and coastal conservation. The Sea Toll program is assessed for energy efficiency, transparency, and ecological impact, with Teluk Lamong Port serving as a case study under the Smart Port Ecosystem and Green Connectivity frameworks, (3) Multi stakeholder synergy, this part identifies the roles of key actors, including local government, regional enterprises, coastal MSMEs, private investors, and community groups. Using a Collaborative Governance framework, it analyzes forms of cooperation, accountability mechanisms, and social innovation in maritime governance, (4) Challenges and transformation opportunities, the final theme discusses regulatory inconsistencies, funding limitations, and environmental awareness gaps, while highlighting East Java's potential as a national model for green maritime development. This approach supports the formulation of strategic recommendations rooted in local strengths and aligned with national sustainability priorities.

3. DISCUSSION

3.1. East Java as the Connectivity Hub of the Archipelago

East Java occupies a strategic geographical position as a connectivity hub linking major production centers in Java and Eastern Indonesia. Bordered by the Java Sea, Madura Strait, and the Indian Ocean, the province serves as the main maritime gateway for goods and services flowing toward the new capital city (IKN) in East Kalimantan, reflecting the concept of Geographical Centrality (Fujita, 2021). Economically, East Java contributes 14.5% of Indonesia's GDP (BPS, 2025) and ranks as the second largest maritime exporter in the nation, with Tanjung Perak Port handling over 79% of the province's seaborne exports (Richa, 2024).

The province's extensive infrastructure, such as the Trans Java Toll Road, railway networks, and Juanda International Airport, supports multimodal connectivity, consistent with the Multimodal Transport Integration Theory (Rodrigue, 2021). Programs such as the East Java Logistics Hub and Dry Port development illustrate the regional government's commitment to strengthening national distribution networks. Digital connectivity, coastal natural resources, and a skilled workforce supported by more than 40 universities position East Java as a competitive national logistics center. In the context of IKN development, sea routes connecting East Java's ports to East Kalimantan have become critical corridors for logistics and infrastructure.

Table 1. Geographic Position and Economic Potential of East Java (2025)

Aspect	Key Data (2025)	Remarks
Geographical Location	Eastern tip of Java Island	Key nexus connecting Java, Kalimantan, and Eastern Indonesia
National GDP Contribution	14.5%	Second largest economic contributor after West Java (BPS, 2025)
Maritime Exports	79% via Tanjung Perak Port	Main export hub to Kalimantan and Eastern Indonesia (Richa, 2024)
Transport Infrastructure	Trans-Java Toll Road, Railway, Juanda Airport	Supports multimodal land, sea, air integration (Rodrigue, 2021)
Strategic Industrial Areas	Gresik, Sidoarjo, Pasuruan	National production and distribution base
Skilled Human Resources	>40 universities in Surabaya	Provides competitive labor for logistics and industry
Natural Resources	Agriculture, fisheries, coastal mining	Supports primary commodities and downstream processing
Connectivity to IKN	Tanjung Perak–Kariangau sea route	Primary maritime corridor for IKN logistics (Fujita, 2021)

Sources: BPS East Java (2025), Fujita (2021), Richa (2024), Rodrigue (2021).

Table 1 underscores East Java's strategic role as a national logistics hub and the connectivity axis of the archipelago. Its location as a maritime gateway to East Kalimantan positions the province as a key player in the IKN development. Major seaports, multimodal infrastructure, industrial zones, skilled human resources, and coastal resources collectively enhance competitiveness. Drawing on the concepts of Strategic Location Advantage (Porter, 1990) and Integrated Transport Systems (Rodrigue, 2021), East Java demonstrates a sustainable and adaptive role within Indonesia's evolving national logistics framework.

3.1.1. The Role of Major Ports (Tanjung Perak, Teluk Lamong, and Probolinggo)

East Java's maritime system is anchored by three major ports, Tanjung Perak, Teluk Lamong, and Probolinggo, which together form an integrated and complementary logistics network. (1) Tanjung Perak Port, located in Surabaya, is the province's largest and busiest port, handling over 40 million tons of cargo annually (Kemenhub, 2024). Equipped with modern digital systems such as Inaportnet, Vessel Traffic Service (VTS), and Electronic Data Interchange (EDI), it functions as a central hub for import, export, and domestic distribution. In line with the Smart Port Ecosystem Theory, its technological innovations have enhanced efficiency and competitiveness (Heilig, 2017); (2) Teluk Lamong Port is Indonesia's first eco-friendly port, featuring automated container terminals and green port technologies. Its cargo handling efficiency is 30% faster than that of conventional ports (Gautama, 2023), making it a strategic facility for exports and distribution to Eastern Indonesia. (3) Probolinggo Port, although smaller, plays a critical role in the distribution of agricultural, fisheries, and small industry commodities in the Tapal Kuda region. The development of industrial port areas has strengthened local supply chains, aligning with Regional Port Development Theory, which emphasizes the significance of smaller ports as catalysts for local economic growth (Ducruet, 2019).

Together, these three ports constitute a synergistic maritime connectivity system: Tanjung Perak as the main logistics center, Teluk Lamong as a sustainable and technologically advanced port, and Probolinggo as a regional distribution node supporting local industries. See Table 2

Table 2. Characteristics of East Java's Major Ports

Port	Capacity & Main Function	Technology & Advantages	Role in IKN Connectivity
Tanjung Perak	>40 million tons/year; main import, export hub	Inaportnet, VTS, EDI, multimodal integration	Primary starting point for sea logistics to East Kalimantan supporting IKN construction

Teluk Lamong	Modern high-capacity port with automated container terminal	Green port system, shore power, smart port technology, 30% faster efficiency	Sustainable export and distribution port for Eastern Indonesia and IKN logistics
Probolinggo	Regional port for agriculture, fisheries, and small industries	Industrial port development, supports local economy	Supporting route for local commodity distribution to Kalimantan and Eastern regions

Sources: Ministry of Transportation (2024), Gautama (2023), Heilig (2017), and Ducruet (2019).

The data confirm that the three ports form an integrated maritime governance system that enhances national logistics efficiency and regional inclusivity. Applying the Smart Port Ecosystem (Heilig, 2017), Regional Port Development (Ducruet, 2019), and Collaborative Governance (Ansell & Gash, 2007), frameworks demonstrates how technology integration, policy coordination, and local participation drive the maritime transformation toward smart and inclusive connectivity in East Java.

3.2. Implementation of Green Governance in Maritime Infrastructure in East Java

East Java holds a strategic position within Indonesia's national logistics system, with its major ports serving as central distribution nodes to Eastern Indonesia. The increasing pressure of climate change demands that maritime development adopt a green governance approach that integrates operational efficiency, environmental preservation, and transparent governance. Within this context, the Ecological Modernization Theory emphasizes that industrial modernization can align with environmental protection through technological innovation (Arthur et al., 2013), while the Good Governance Theory highlights transparency and public participation as key elements of sustainable governance (UNDP, 1997). Despite strong government commitment, challenges related to infrastructure and community participation continue to hinder effective implementation.

3.2.1. Environmentally Friendly Practices in East Java Ports

Ports in East Java, such as Tanjung Perak, Gresik, and Banyuwangi, play vital roles in national logistics but also contribute to emissions and marine pollution problems. The shore power technology implemented by Pelindo has successfully reduced vessel emissions by 75–93% and decreased fuel costs by approximately IDR 2.26 billion per ship per year, consistent with the Ecological Modernization Theory (Pelindo, 2022). The adoption of ISO 14001 environmental management standards has significantly reduced liquid and solid waste (Lestari & Nugroho, 2022).

Banyuwangi Port maintains an active coastal conservation zone, although its waste management remains partial, making the Integrated Coastal Zone Management (ICZM) approach relevant. Meanwhile, port digitalization through e-logistics and IoT-based systems has improved efficiency and reduced fuel consumption (Ramli et al., 2024). However, waste management challenges persist, with 40% of ports discharging waste directly into the sea (Sari & Maulana, 2025). The adoption of renewable energy, such as solar panels and bioenergy, has reduced operational costs by up to 12% (Kompas, 2022).

Government environmental incentives also support green practices, reflecting Policy Feedback Theory (Douglass, 2011). Data-driven audits strengthen transparency (Good Governance Theory), while Environmental Justice Theory emphasizes fairness in social and ecological outcomes (Schlosberg, 2004). International collaborations have accelerated green port transitions (Tanaka, 2020).

Table 3. Environmentally Friendly Practices in East Java Ports (2020–2025)

Port	Shore Power	ISO 14001	Waste Management	Conservation Area	CO_2 Emissions (tons/year)	Additional Notes
Tanjung Perak	Yes	Yes	Integrated	Yes	10,800	Digital and open audit systems; model for national green port
Gresik	Yes	Yes	Integrated	Yes	11,300	Supports maritime industries with high energy efficiency
Banyuwangi	Partial	No	Partial	Yes	12,900	Active coastal conservation; needs better waste and certification systems
Probolinggo	No	No	Partial	No	14,200	Regional port; agro maritime potential underdeveloped
Paciran (Lamongan)	No	No	Minimal	No	16,500	Lacks significant green initiatives; requires policy and tech intervention

Sources: Pelindo (2022), Lestari and Nugroho (2022), Sari and Maulana (2025), and Ramli et al. (2024).

Table 3 illustrates the varying levels of green practice adoption among East Java's main ports. Tanjung Perak and Gresik demonstrate leadership through advanced technologies and waste management systems, while Banyuwangi shows potential constrained by infrastructure gaps. Probolinggo and Paciran lagged behind with higher emissions and limited sustainability measures. Sustainable transformation thus requires integrated approaches that combine Ecological Modernization, ICZM, and Policy Feedback Theory to ensure a balanced and inclusive maritime transition.

3.2.2. Efficiency and Transparency in Sea Toll Management

Green port practices provide the foundation for sustainable maritime logistics systems in East Java. Strategic ports, such as Tanjung Perak, Gresik, and Banyuwangi, facilitate national distribution and play a crucial role in reducing emissions and strengthening environmental accountability. The Green Port Concept, through technologies such as shore power and digital management systems, demonstrates how technological modernization can improve efficiency while aligning with sustainability goals (Pelindo, 2022).

The implementation of ISO 14001 reflects a commitment to systematic environmental management, whereas Banyuwangi's coastal conservation efforts align with the ICZM framework. Port digitalization, including e-logistics platforms and IoT-based cargo tracking, has improved monitoring accuracy and reduced fuel consumption (Ramli et al., 2024). However, challenges persist in smaller ports, such as Paciran and Probolinggo, where 40% of waste is still directly discharged into the ocean (Sari & Maulana, 2025).

The integration of renewable energy and environmental incentives promotes the wider adoption of green practices, consistent with the Policy Feedback Theory. Furthermore, open-data monitoring systems strengthen transparency in port operations (Good Governance Theory), while the relocation of coastal communities should ensure social fairness, as framed by Environmental Justice Theory. Thus, a holistic, multi-stakeholder approach can transform the Sea Toll Program into a strategic instrument for achieving equitable, efficient, and sustainable maritime logistics.

Table 4. Efficiency and Transparency in East Java's Sea Toll Ports (2020–2025)

Sea Toll Destination Port	Travel Time (days)	Capacity Utilization (%)	Tracking System	Cargo Data Transparency	Public Oversight Forum	Additional Notes
Tanjung Perak	4	90%	Digital & Real time	Open	Active	Main port with e-logistics and shore power system enhancing efficiency and transparency
Gresik	4	85%	Digital & Real time	Open	Active	Industrial hub with ISO 14001 certification and integrated tracking system
Banyuwangi	5	78%	Partially Digital	Open	Moderate	Coastal conservation potential; limited waste management
Probolinggo	5	70%	Semi manual	Limited	Moderate	Regional port with limited tracking and data transparency
Paciran (Lamongan)	6	65%	Not Available	Limited	Minimal	Not yet integrated with digital systems; low efficiency and accountability

Sources: Pelindo (2022), Sari and Maulana (2023), Ramli et al. (2024).

Table 4 highlights the crucial role of East Java's ports in enhancing the efficiency and transparency of the Sea Toll Program. Tanjung Perak and Gresik stand out for their digital integration and open-data systems, while Banyuwangi shows steady progress. Probolinggo and Paciran lag behind, constrained by low digital capacity and weak governance mechanisms. Continuous transformation demands the application of Ecological Modernization, Policy Feedback, and Collaborative Governance frameworks to achieve inclusive and transparent maritime governance.

3.3. Multi Stakeholder Synergy in Sustainable Maritime Development in East Java

Sustainable maritime infrastructure development requires multi-stakeholder synergy to ensure that policies are efficient, inclusive, and socially just. With its strategic ports and strong maritime economy, East Java holds significant potential to become a national model of cross sector collaboration. Partnerships among government agencies, regional enterprises (BUMDs), MSMEs, and private investors foster green innovation and financing. The government functions as a regulator and facilitator, BUMDs and private investors drive technological advancement, while MSMEs strengthen local value chains and community based enterprises.

The Network Governance Theory emphasizes the importance of non governmental actors in public policy formulation (Rhodes, 2007), while the Participatory Development Theory argues that communities must act as subjects rather than objects of development (Chambers, 1994). Research from the Faculty of Economics and Business, Universitas Brawijaya, highlights significant opportunities for MSMEs within the industrial smelter supply chain (Tempo, 2025). Multi stakeholder synergy requires coordination, incentives, and sustained dialogue. Initiatives such as the Green Maritime Forum and public private partnerships (PPPs) in East Java demonstrate a positive direction toward collaborative and sustainable maritime development.

3.3.1. Collaboration among Government, Regional Enterprises, MSMEs, and Private Investors in Green Projects

The transformation of maritime infrastructure in East Java depends on synergistic collaboration among public and private stakeholders. The government, BUMDs, MSMEs, and investors play complementary roles in promoting technically efficient and socially responsible green projects. Within

the framework of green governance, these collaborations form an inclusive and adaptive ecosystem capable of addressing global environmental challenges.

The Provincial Government of East Java acts as regulator and facilitator through fiscal incentives, simplified licensing, and partnership forums. BUMDs such as PT Pelindo Regional III support digitalization and wharf electrification, reducing CO_2 emissions by 12% (Lestari & Nugroho, 2022). Private investors have begun investing in shore power and solar energy through Public Private Partnership (PPP) schemes, such as the Saguling Floating Solar Power Project (PERS, 2025). Meanwhile, MSMEs such as Pasta 30 in Palembang transform food waste into animal feed and biosolar materials, strengthening coastal economies through inclusive and circular practices (Detik.com, 2025).

The Green Maritime Forum serves as a coordination platform, though bureaucratic gaps and uneven stakeholder capacities remain challenges. Stronger environmental regulation is required, consistent with Institutional Theory, while Environmental Justice Theory emphasizes fairness in coastal community relocation. Digitalization acts as a key catalyst for collaboration, with AI, IoT, and blockchain based logistics platforms enhancing transparency, efficiency, and accountability (Malline, 2025). Through a structured and participatory approach, East Java has the potential to become a national model of resilient and competitive green maritime development.

Table 5. Forms of Multi Stakeholder Collaboration in Green Maritime Projects in East Java (2020–2025)

Project Location	Government	Regional Enterprise (BUMD)	Local MSMEs	Private Investors	Type of Green Projec	Level of Synergy
Tanjung Perak	Active	Pelindo III	Involved	Yes	Shore power, port digitalization, e-logistic	High (integrated)
Gresik	Active	Pelindo III	Involved	Yes	Solar panels, bioenergy dock electrification	High (sustainable)
Banyuwangi	Active	Partial	Active	No	Coastal conservation, organic waste management	Moderate (community drive
Probolinggo	Partial	Partial	Limited	Yes	Green port planning, feasibility study	Low (initial stage)
Paciran (Lamongan)	Partial	No	No	Yes	Clean energy feasibility study, solar potential	Low (non integrated)

Sources: Lestari & Nugroho (2022); Coordinating Ministry for Economic Affairs (2025); Detik.com (2025); Malline (2025).

The Table 5 shows varying degrees of multi stakeholder collaboration in green maritime projects across East Java. Tanjung Perak and Gresik serve as models of synergy through PPP and network governance, while Banyuwangi excels in community involvement but lacks private investment. Probolinggo and Paciran remain in the early stages of collaboration. Sustainable transformation requires stronger institutions, environmental incentives, and digital integration. Guided by Green Governance, Institutional Theory, and Environmental Justice Theory, East Java's maritime development can become more efficient, fair, and sustainable.

3.3.2. Community Participation and Local Innovation in Maritime Oversight

Within the green governance framework, community participation is a core pillar of sustainable maritime development. Coastal communities in East Java possess crucial local knowledge and social capital for environmental monitoring and innovation. The Participatory Development Theory underscores that communities must actively shape development outcomes (Chambers, 1994). In Gresik, community involvement in mangrove rehabilitation has improved project success rates by 40% (Tempo, 2025).

Local innovations also emerge across regions: solar-powered cooling systems developed by fishermen in Probolinggo, and zero waste product processing by women's cooperatives in Paciran

(Pemprov Jatim, 2023). Yet, limited environmental literacy and restricted access to information remain barriers to meaningful participation. The East Java government addresses these challenges through initiatives such as the Green Maritime School Program and community based environmental training. Digitalization via environmental reporting apps expands participation channels (Malline, 2025). Collaboration between communities and academic institutions strengthens policy legitimacy and effectiveness. The Deliberative Democracy Theory, reinforces that inclusive dialogue enhances decision quality and trust among actors (Dryzek, 2000).

Table 6. Forms of Community Participation in Green Maritime Projects in East Java (2020–2025)

Project Location	Type of Participation	Local Actors Involved	Innovation/Monitoring Form	Measured Impact (%)	Additional Notes
Gresik	Mangrove Rehabilitation	Fishermen Groups	Environmental audit, mangrove replanting	+40% success rate	Collaboration with NGOs and government improved coastal vegetation cover
Banyuwangi	Waste Monitoring	Coastal Community Forum	Independent reporting, policy advocacy	+35% transparency	Strengthened port accountability; supported by academics and local media
Probolinggo	Technological Innovation	Fishermen Groups	Solar powered cooling systems	+28% operational efficiency	Local solution for seafood preservation; energy-saving and eco friendly
Paciran (Lamongan)	Product Innovation	Women's Coastal Groups	Zero waste product diversification	+32% community income	Women empowerment; reduced waste and increased local value added
Tanjung Perak	Environmental Education	Student Communities	Green Maritime School, digital campaigns	+45% ecological literacy	Promotes youth awareness; integrates education and digital monitoring

Sources: East Java Provincial Government (2023); Malline (2025); Fox (2015); Dryzek (2000); Tempo.co (2025).

The Table 6 reinforces that community participation in East Java's green maritime projects yields tangible results. Initiatives in Gresik, Banyuwangi, Probolinggo, Paciran, and Tanjung Perak demonstrate how local actors contribute to rehabilitation, innovation, and ecological education. The integration of Participatory Development (Chambers, 1994), Social Accountability (Fox, 2015) and Deliberative Democracy (Dryzek, 2000), theories strengthens an inclusive green governance ecosystem that empowers communities while enhancing environmental performance.

3.4. Challenges and Opportunities in Sustainable Maritime Development in East Java

Sustainable maritime development in East Java has advanced through the implementation of green governance, multi stakeholder synergy, and local innovation. However, structural, institutional, and cultural challenges continue to hinder systemic transformation. Unsynchronized regulations between coastal zoning and logistics policies create legal uncertainty and delay green projects (Hukumonline, 2025). The implementation of Green Port initiatives also requires significant investment, which often exceeds regional fiscal capacity. These challenges can be mitigated through stronger cooperation among

the government, private sector, and international partners to mobilize financial and technological support (Safuan, 2024).

The Lestari Summit 2024 emphasized that public education and environmental campaigns are strategic tools for behavioral change and accelerating the transition toward green development (Budiman, 2024). Despite persistent challenges, East Java possesses considerable potential to serve as a national model of green development, supported by advanced port infrastructure, a strong MSME base, and consistent government commitment. Through collaborative and innovative approaches, the province can evolve into a policy laboratory for sustainable and inclusive green governance that is replicable nationwide.

3.4.1. Regulatory, Financial, and Environmental Awareness Barriers

Sustainable maritime development in East Java faces intertwined structural and cultural constraints. Despite political commitment and local initiatives, overlapping regulations, limited financing, and low environmental awareness continue to impede effective green governance implementation. Regulatory inconsistencies, such as mismatches between coastal zoning and logistics policies, reduce system adaptability (Ostrom, 2005).

Electrification of wharves has begun at Tanjung Perak and Teluk Lamong Ports, converting loading equipment to electric systems as part of Indonesia's national green port transformation program (Pelindo, 2025). Coastal mangrove rehabilitation programs involving local communities contribute to the national coastal restoration agenda (BRGM, 2024).

Financing remains a major challenge, especially for small ports and coastal MSMEs. Dependence on external funding makes sustainability vulnerable, consistent with Resource Dependence Theory, which states that organizations rely on external environments for critical resources (Hillman et al., 2009). Financial diversification through green bonds and community funds should be developed, in line with Social Investment Theory (Mulgan, 2010). Limited understanding of green logistics principles among industry actors also hinders adoption, as many companies lack integrated sustainability strategies, resulting in resistance to innovation (Naomy, 2024).

According to Environmental Behavior Theory and Cultural Cognition Theory, cultural values and information access shape environmental attitudes. Thus, public education, community training, and local media engagement are essential. Collaboration among government, academia, and community organizations, facilitated through multi stakeholder forums and digital platforms, can strengthen institutional capacity. These challenges also present opportunities to build a more adaptive and inclusive maritime governance system.

Table 7. Key Barriers to Green Maritime Development in East Java (2020–2025)

Barrier Aspect	Main Constraints	Impact on Green Projects	Dominant Locations	Additional Notes
Regulation	Overlapping between coastal zoning and logistics policies	Project delays, legal and technical uncertainty	Tanjung Perak, Gresik	Weakens adaptive capacity; requires cross sectoral harmonization (Ostrom, 2005)
Financing	Limited access of MSMEs to green funding	Low community participation, stagnant local innovation	Paciran, Probolinggo	High external dependency; requires financing diversification (Hillman et al., 2009)

Environmental Awareness	Low ecological literacy and resistance to innovation	Rejection of green technology, slow coastal conservation	Banyuwangi, Lamongan	Influenced by cultural values and access to information; needs public education (Naomy, 2024)

Sources: Pelindo (2025); BRGM (2024); Hillman et al. (2009); Naomy (2024); Mulgan (2010).

The Table 7 highlights three primary barriers to green maritime development in East Java: regulatory inconsistency, limited financing, and low environmental awareness. Strategic solutions include the introduction of green bonds and community-based funding mechanisms (Mulgan, 2010), coupled with behavioral and cultural approaches derived from Environmental Behavior Theory and Cultural Cognition Theory, supported through digital collaboration and community training programs.

3.4.2. East Java's Potential as a Model for Green Development in Indonesia

East Java has strong potential to become a national model for green maritime development. With advanced port infrastructure, a robust maritime economy, and institutional ecosystems that foster innovation, the province can function as a living laboratory for green governance. The transformation of Tanjung Perak and Gresik Ports through wharf electrification, ISO 14001 certification, and logistics digitalization reflects the principles of Ecological Modernization (Arthur et al., 2013). The Green Maritime Forum serves as a coordination platform consistent with Collaborative Governance Theory (Ansell & Gash, 2008). Coastal MSMEs in Banyuwangi and Paciran exhibit adaptive capacity through zero waste products and bioenergy innovation (Hendi, 2025).

Digitalized logistics have enhanced efficiency and transparency, increasing cargo traceability by 22% and reducing emissions (Malline, 2025). Fiscal incentives and micro financing schemes strengthen the local sustainability ecosystem. East Java's geographical advantage as a bridge between Java and Eastern Indonesia reinforces its role in national green logistics distribution (Strategic Location Advantage Theory).

Programs like Desa Pesisir Bersih in Banyuwangi exemplify community empowerment in marine waste management. The central government emphasizes the need for local participation and environmental partnerships to build an integrated governance system (KKP, 2022)

Table 8. Strategic Potential of East Java as a Model for Green Maritime Development (2020–2025)

Potential Dimension	Key Strengths	Key Locations/Institutions	National Impact Potential	Additional Notes
Green Infrastructure	Shore power, ISO 14001, logistics digitalization	Tanjung Perak, Gresik	Replication of green port systems	Energy efficiency, emission reduction, integrated logistics
Local Innovation	Zero-waste products, bioenergy, coastal conservation	Banyuwangi, Paciran	Strengthened circular economy	Community-based solutions supporting energy transition and waste reduction

Institutional Framework	Green Maritime Forum, fiscal incentives, PPPs	East Java Provincial Gov., Pelindo III	Model of multi-stakeholder collaboration	Enhances coordination among government, SOEs, MSMEs, and investors
Human Resources & Academia	Conservation research, environmental audit, technology transfer	ITS, Universitas Hang Tuah	Replicable policy and technology innovation	Strong academic base supporting green knowledge production
Public Participation	Community forums, environmental schools, digital reporting	Gresik, Lamongan, Banyuwangi	Social legitimacy and policy sustainability	Improves accountability and implementation effectiveness

Sources: Arthur et al. (2013); Hendi (2025); Malline (2025); KKP (2022).

The Table 8 underscores five strategic dimensions of East Java's potential in green maritime development: electrified ports, community innovation, collaborative institutions, academic capacity, and public participation. Through Ecological Modernization, Collaborative Governance, Institutional Analysis, and Environmental Behavior frameworks, East Java can emerge as a national model and policy laboratory for replicable green governance practices.

4. CONCLUSION

The sustainable maritime development in East Java has shown significant progress through the implementation of green governance principles, electrified ports, coastal conservation, and digital logistics integration. The transformation of Tanjung Perak and Gresik Ports, supported by ISO 14001 and digital systems, illustrates the application of Ecological Modernization, while community participation in environmental monitoring represents effective Collaborative Governance in practice.

East Java's strategic geographic position as a connector between Java and Eastern Indonesia strengthens its role in national green logistics. However, several structural barriers, such as regulatory overlap, bureaucratic complexity, and dependency on external funding, still hinder full implementation. Enhancing policy harmonization and institutional capacity is therefore essential.

To sustain the transformation, cross sector consistency and local institutional strengthening must be prioritized. The central government should provide fiscal and regulatory support for port electrification, coastal restoration, and digital logistics. At the same time, diversified financing mechanisms, such as green bonds and community based funds, are required to ensure resilience. Strengthening environmental literacy among industries and coastal communities will also be crucial to accelerate inclusive adoption of green innovation and reinforce East Java's position as a national model for sustainable maritime development.

Ethical Approval
Not Applicative.

Informed Consent Statement
Not Applicative.

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Notes on Contributors

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