Saintek: Jurnal Sains Teknologi dan Profesi Akademi Angkatan Laut
ISSN: 2828-7452 (online), 1979-3111 (print)
DOI: 10.59447

Menavigasi Masa Depan: Inovasi Multidisiplin untuk Pembangunan Maritim Berkelanjutan

Navigating the Future: Multidisciplinary Innovation for Sustainable Maritime Development

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Abstract

This paper examines Indonesia's initiatives to achieve sustainable maritime development, with a focus on port infrastructure modernization, environmental sustainability, and the reduction of illegal fishing. As the world's largest archipelagic nation, Indonesia's maritime sector holds significant potential for economic growth and biodiversity conservation. However, challenges such as outdated port facilities, environmental degradation, and illegal, unreported, and unregulated (IUU) fishing hinder progress. The study employs a SWOT analysis and a literature review to assess the current state of the maritime sector and identify opportunities for improvement. Key findings reveal that while Indonesia has made strides in developing Green and Smart Ports, there are limitations in scaling these initiatives across the archipelago. Additionally, despite advances in technology for monitoring IUU fishing, enforcement remains insufficient, especially in remote regions. The paper emphasizes the importance of decarbonization, the adoption of renewable energy sources, and the development of blue financing mechanisms to support sustainable projects. The study concludes that overcoming financial barriers, expanding green initiatives, and enhancing coordination between stakeholders are essential for Indonesia to realize its maritime sustainability goals by 2045.

Keywords: Sustainable Maritime Development, Green Ports, IUU Fishing, Blue Financing, Port Modernization.

Abstrak

Artikel ini membahas upaya Indonesia dalam mencapai pengembangan maritim yang berkelanjutan, dengan fokus pada modernisasi infrastruktur pelabuhan, keberlanjutan lingkungan, dan pengurangan penangkapan ikan ilegal. Sebagai negara kepulauan terbesar di dunia, sektor maritim Indonesia memiliki potensi besar untuk pertumbuhan ekonomi dan pelestarian keanekaragaman hayati. Namun, tantangan seperti fasilitas pelabuhan yang sudah usang, degradasi lingkungan, dan penangkapan ikan ilegal, tidak tercatat, dan tidak teratur (IUU) menghambat kemajuan. Penelitian ini menggunakan analisis SWOT dan tinjauan pustaka untuk menilai kondisi terkini sektor maritim dan mengidentifikasi peluang untuk perbaikan. Temuan utama menunjukkan bahwa meskipun Indonesia telah membuat kemajuan dalam pengembangan Pelabuhan Hijau dan Pintar, terdapat keterbatasan dalam memperluas inisiatif ini di seluruh nusantara. Selain itu, meskipun ada kemajuan dalam teknologi untuk memantau penangkapan ikan ilegal, penegakan hukum masih kurang, terutama di daerah terpencil. Artikel ini menekankan pentingnya dekarbonisasi, adopsi energi terbarukan, dan pengembangan mekanisme pembiayaan biru untuk mendanai proyek berkelanjutan. Penelitian ini menyimpulkan bahwa mengatasi hambatan finansial, memperluas inisiatif hijau, dan meningkatkan koordinasi antar pemangku kepentingan sangat penting bagi Indonesia untuk mewujudkan tujuan keberlanjutan maritimnya pada tahun 2045.

.**Kata kunci:** Pengembangan Maritim Berkelanjutan, Pelabuhan Hijau, Penangkapan Ikan Ilegal (IUU), Pembiayaan Biru, Modernisasi Pelabuhan.

1. Introduction

Indonesia, as the world's largest archipelagic nation, holds significant maritime potential with more than 17,000 islands and a coastline stretching over 95,000 kilometres. (2,5) In its Long-

Term Development Plan (RPJPN) for 2025–2045, the maritime sector is projected to contribute at least 15% to the national GDP and set a goal of conserving 30% of Indonesia's marine territory to protect biodiversity and ecosystem services. (Hadiningrat et al., 2024; Sidik et al., 2023). This ambition reflects Indonesia's strategic position as a key player in global maritime trade, marine biodiversity conservation, and blue economy development (Sidik et al., 2023). However, realizing this vision faces significant challenges. Much of Indonesia's port infrastructure remains outdated, resulting in inefficiencies in logistics, longer turnaround times, and higher trade and shipping costs.(Shodrokova et al., 2024)

Another challenge is institutional fragmentation across ministries and agencies, often resulting in overlapping responsibilities, policy gaps, and coordination failures in managing maritime resources. Illegal, unreported, and unregulated (IUU) fishing continues to threaten fish stocks and marine biodiversity, especially in remote regions where enforcement is limited. Additionally, the maritime transport sector, heavily reliant on fossil fuels, is a major source of greenhouse gas emissions, contributing to both local pollution and global climate change. Without urgent and coordinated action, these issues could undermine Indonesia's efforts to become a sustainable maritime nation. Addressing these structural challenges will require modernizing port facilities, strengthening governance and inter-agency collaboration, enforcing sustainable fisheries management, reducing maritime emissions, and expanding investment in green and blue infrastructure. Only through integrated and inclusive strategies can Indonesia fully realize its maritime potential and lead in sustainable ocean development.

Previous research has highlighted both the progress and challenges in developing sustainable port infrastructure in Indonesia. For example, studies on the implementation of the green port concept at Surabaya Port (Dirmansyah et al., 2024) and Sabang Port show that the transition to green ports focused on emission reduction and renewable energy use is both feasible and beneficial in the long run.(Hadiningrat et al., 2024). However, most of these green initiatives are still concentrated in a few ports and have not been widely implemented across Indonesia. Furthermore, while maritime monitoring technologies, such as satellite-based Vessel Monitoring Systems (VMS) and drones, have advanced, their adoption is still insufficient to effectively tackle IUU fishing (Elhussieny, 2025). Therefore, there is a need to expand and accelerate the implementation of these sustainable initiatives to address existing challenges.

The research gap currently lies in the lack of studies that integrate the various dimensions of green port development and digital technologies within a coherent framework, as well as the limited research on the role of blue financing in supporting sustainable maritime development in Indonesia. Although there have been various initiatives related to green ports and maritime monitoring, research into integrating smart ports based on digital technologies with environmental sustainability, and exploring the potential of blue financing instruments in Indonesia, remains sparse. Blue finance, which refers to financial activities that support the sustainable blue economy, can perform functions of resource allocation, directing capital towards sustainable ocean projects (Jiang et al., 2025). Instruments like blue bonds are emerging as crucial tools for financing sustainable ocean development, with countries like Indonesia already participating in this market (Rogge, 2025).

The novelty of this research lies in its multidisciplinary approach, combining green port development, digital technologies in port management, and the utilization of blue financing as a tool to support the sustainable blue economy. This study will construct a more comprehensive

framework for tackling port management and maritime resource challenges and will provide practical recommendations in the Indonesian context. Therefore, this research aims to fill the existing gap by offering innovative and practical solutions to advance Indonesia's maritime sector.

The central research question of this study is: *How can the integration of green ports, digital technologies, and blue financing strategies enhance the sustainability of Indonesia's maritime sector?* This question is crucial for exploring innovative approaches to address the structural issues within Indonesia's maritime sector and providing sustainable solutions for the future of the blue economy.

The objective of this study is to analyze and develop a strategic framework that integrates the development of green ports, the application of digital technologies in smart port operations, and the strengthening of blue financing mechanisms in Indonesia. Through this research, it is hoped that effective solutions will be found to enhance the sustainability of Indonesia's maritime sector, support carbon emission reductions, and promote inclusive and sustainable blue economic growth.

2. Method

This study uses two main methods, each of which plays an important role in this research. First, SWOT analysis with the IFAS/EFAS matrix helps identify strengths, weaknesses, opportunities, and threats in Indonesia's maritime sector, as well as guide the development of strategies for improvement. Second, the theoretical literature review examines successful examples of green and digital technologies at the global level, such as green ports and smart systems, to provide practical ideas for Indonesia's sustainable development. This review goes beyond simply summarising existing theories; it conducts a rigorous critical analysis, comparing different perspectives, identifying strengths and limitations, and evaluating their applicability in various contexts (Paul & Criado, 2020). Together, these methods provide a clear understanding of current challenges and potential solutions for a more sustainable future in the maritime industry.

a. SWOT Analysis and IFAS/EFAS Matrices

The SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) is a fundamental strategic planning tool used to evaluate the current state and future potential of an organization or, in this case, a national sector. This study adapts the SWOT framework to identify internal factors (Strengths and Weaknesses) and external factors (Opportunities and Threats) influencing Indonesia's sustainable maritime development. The process involves data collection from secondary sources, including government reports (e.g., RPJPN 2025-2045), academic publications, and industry analyses.

To add quantitative rigor to the qualitative SWOT factors, this study utilizes the Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) matrices. This technique involves assigning a weight to each factor based on its perceived relative importance and a rating based on the sector's current response or condition. The weighted score (weight × rating) for each factor is then summed to provide a total weighted score for both internal and external environments. This method helps prioritize the most critical factors and reduces subjectivity in strategy formulation. The use of weighted matrices like IFAS/EFAS is a established practice in strategic management research to translate qualitative assessments into actionable

strategic priorities (David et al., 2020; Gurl, 2017). The output of this analysis directly informs the development of strategies that leverage strengths and opportunities while mitigating weaknesses and threats.

b. Theoretical Review on Green and Digital Technologies

This method involves a comprehensive review of existing literature to examine the application of green and digital technologies in the maritime sector. A theoretical review focuses on the development of green ports, which integrate renewable energy sources (such as solar panels and electric cranes), as part of comprehensive environmental management systems (Xiao et al., 2024). as well as the adoption of smart port technologies that enhance operational efficiency through digital platforms. It also includes an examination of how digital monitoring systems are being used to combat illegal, unreported, and unregulated (IUU) fishing, as well as the role of blue financing mechanisms such as blue bonds in supporting sustainable maritime projects, which have emerged as critical instruments for funding the transition to sustainable ocean economies (Sumaila et al., 2023). The literature review provides a theoretical framework for understanding the potential and challenges of implementing sustainable technologies in the maritime sector and offers insights from global best practices, which inform the proposed strategies in the Indonesian context.

3. Result and Discussion

3.1 Result

Based on SWOT, IFAS, EFAS, and SWOT Quadrant analyses, these findings highlight the strengths, weaknesses, opportunities, and threats in Indonesia's maritime sector, particularly in relation to sustainable development, green ports, and blue financing. This analysis provides insights into the strategic actions needed to improve sustainability in Indonesia's maritime infrastructure, as illustrated in Table 1 below:

Table 1 : SWOT Analysis

Strength	Weaknesses
1. Strong Partnership 2. Innovative financing 3. Advanced monitoring technology	1. Limited scale and reach 2. Technology adoption gap 3. Financial risks
Opportunities	**Threats**
1. Technological innovation 2. International support 3. Economic benefits	1. Environmental risks 2. Illegal activities 3. Technological obsolescence

(Source: Accessed by the Writer, 2025)

The SWOT analysis Table 1 identifies key internal factors (strengths and weaknesses) and external factors (opportunities and threats) influencing the maritime sector in Indonesia:

Strengths

Strong Partnerships, Indonesia benefits from strategic collaborations with state-owned enterprises, international bodies, and private sector stakeholders, enabling successful initiatives such as the Green Port Program and blue financing mechanisms like green and blue bonds

(Hadiningrat et al., 2024). These collaborations help pool resources and share risks, creating synergies for sustainable maritime development. *Innovative Financing*, the introduction of green bonds and blue bonds has provided a new channel for financing sustainable maritime projects. However, the market remains underdeveloped, with only a small portion of global sustainable finance directed toward ocean-related sectors (Dirmansyah et al., 2024). *Advanced Monitoring Technology*, technologies like VMS (Vessel Monitoring Systems) and AIS (Automatic Identification Systems) have enhanced real-time surveillance, improving the monitoring and enforcement of IUU fishing (Dirmansyah et al., 2024).

Weaknesses

Limited Scale and Reach, despite successes in some regions, green port initiatives are not yet widespread across the country. Scaling these technologies nationwide remains a challenge, particularly in less developed regions. The Technology Adoption Gap, the slow pace of adopting advanced digital technologies and sustainable practices in the maritime sector, is a significant hindrance. This gap can limit the overall effectiveness of the green transition. *Financial Risks*, the underdeveloped green bond and blue bond markets, along with regulatory uncertainties, pose financial risks. Without robust investor confidence and more transparent frameworks, large-scale investments will be difficult to secure (Dirmansyah et al., 2024).

Opportunities

Technological Innovation, new technologies in AI, IoT, and big data analytics, present opportunities to improve port logistics, reduce emissions, and optimize resource use (Elhussieny, 2025). *International Support*, Indonesia has access to international climate finance and support from organizations such as the World Bank and UNDP, which can assist in financing green initiatives and capacity building (Agarwal et al., 2024). *Economic Benefits*, Sustainable ports can improve Indonesia's global competitiveness, create green jobs, and boost the maritime economy, contributing to long-term economic growth (Hadiningrat et al., 2024).

Threats

Environmental Risks: Climate change, including rising sea levels and extreme weather events, poses a direct threat to port infrastructure and marine ecosystems (Agarwal et al., 2024). *Illegal Activities,* Ongoing IUU fishing practices threaten marine biodiversity, undermine food security, and create governance challenges, especially in Indonesia's remote waters (Dirmansyah et al., 2024). *Technological Obsolescence*, the rapid pace of technological advancements in the global maritime sector, could leave Indonesia's infrastructure outdated if the adoption of newer technologies is not prioritized (Elhussieny, 2025).

Table 2 . Internal Factor Analysis Summary (IFAS)

IFAS FACTOR	WEIGHT	RATING	SCORE	REMARKS
STRENGTH				
1. Strong Partnership	+0,20	3	+0,60	
2. Innovative financing	+0,10	2	+0,20	
3. Advanced monitoring technology	+0,20	2	+0,20	
Total	**+0,50**		**+1,00**	
WEAKNESSES				
1. Technology adoption gap	+0,20	3	+0,30	
2. Limited scale and reach	+0,20	2	+0,20	

3. Financial risks	+0,10	2	+0,20
Total	**+0,50**		**+0,70**
Total Strength + Weaknesses	**+1,00**		**+1,70**

(Source: Accessed by the Writer, 2025)

2. Internal Factor Analysis Summary (IFAS)

Table 2 above illustrates how the IFAS Matrix evaluates the internal strengths and weaknesses of Indonesia's maritime sector:

Strengths

The Strong Partnerships and Innovative Financing factors were rated highly, with scores of 0.60 and 0.20, respectively, showing the importance of these collaborations in promoting sustainability. Advanced Monitoring Technology, despite being an asset, received a lower rating (0.20) due to its limited application in some regions and the need for broader adoption across the archipelago.

Weaknesses

The Technology Adoption Gap received the highest score (0.30), emphasizing the critical need for a more widespread integration of digital technologies in the maritime sector. Limited Scale and Reach and Financial Risks received moderate scores (0.20), highlighting the importance of addressing financial uncertainty and scaling green port initiatives for national impact.

The total internal score of 1.70 indicates that while Indonesia has significant internal strengths, the weaknesses, particularly the technology adoption gap, require urgent attention to fully leverage its strengths.

Table 3 : External Factor Analysis Summary (EFAS)

EFAS FACTOR	WEIGHT	RATING	SCORE	REMARKS
OPPORTUNITIES				
1. International support	+0,20	3	+0,60	
2. Technological innovation	+0,30	2	+0,60	
3. Economic benefits	+0,20	2	+0,40	
Total	**+0,70**		**+1,60**	
THREATS				
1. Environmental risks	+0,10	3	+0,20	
2. Illegal activities	+0,10	2	+0,20	
3. Technological obsolescence	+0,10	2	+0,30	
Total	**+0,30**		**+0,70**	
Total Strength + Weaknesses	**+1,00**		**+2,30**	

(Source: Accessed by the Writer, 2025)

3. External Factor Analysis Summary (EFAS)

Table 3 above illustrates how the EFAS Matrix evaluates external factors affecting Indonesia's maritime sector.

Opportunities

International Support received the highest score (0.60), signifying the importance of global partnerships and funding mechanisms to support sustainable maritime development.

Technological Innovation also scored highly (0.60), aligning with the internal strengths identified earlier and indicating that Indonesia is well-positioned to adopt emerging technologies to enhance port efficiency and sustainability. Economic Benefits scored 0.40, reflecting the potential for economic growth but also pointing out that economic gains from green technologies are not guaranteed without effective implementation.

Threats

Environmental Risks received a score of (0.20), indicating that while climate change poses significant challenges, Indonesia has the opportunity to mitigate these risks through green technologies. Illegal Activities and Technological Obsolescence both scored 0.20 and 0.30, indicating that while these threats exist, they are manageable with appropriate policies and technological advancements. The total external score of (2.30) underscores the substantial opportunities available to Indonesia through international support and technological innovation, which can help mitigate the threats posed by environmental risks and illegal activities.

Table 4. Calculation Quadrant

No	Internal	Score	External	Score
1	Strengths	**1,00**	Opportunities	**1,60**
2	Weaknesses	**0,70**	Threats	**0,70**
		0,30		**0,90**

(Source: Accessed by the Writer, 2025)

Table 4 above illustrates the results of calculating internal and external factors. After calculating the internal and external factors that influence, the selected quadrant results are obtained, which will determine the strategy to be used as a problem-solving approach, as shown in the SWOT quadrant matrix in Figure 1 below.

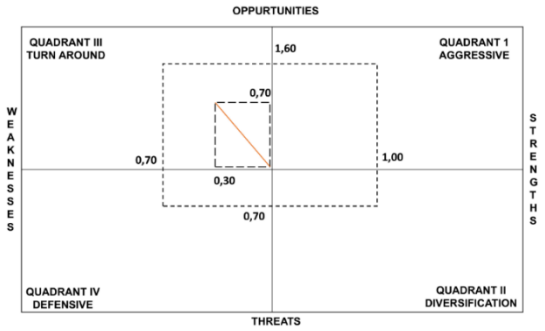

Figure 1. SWOT Quadrant

(Source: Accessed by the Writer, 2025)

Based on the results of the SWOT analysis, the selected quadrant is Quadrant I, which applies a Turnaround strategy by minimizing weaknesses to maximize existing opportunities.

Table 6. Priority of Policy Wisdom

No	Strategy Wo	Score W	Score O	Total	Priority
1	W1+O1	0,2	0,2	0,4	II
2	**W1+O2**	**0,2**	**0,3**	**0,5**	**I**
3	W1+O3	0,2	0,2	0,4	II

4	W2+O1	0,2	0,2	0,4	II
5	W2+O2	0,2	0,2	0,4	II
6	W2+O3	0,2	0,2	0,4	II
7	W3+O1	0,1	0,2	0,3	III
8	W3+O2	0,1	0,3	0,4	II
9	W3+O3	0,1	0,2	0,3	III

(Source: Accessed by the Writer, 2025)

Based on the analysis of Table 6 above, the highest priority strategy for determining the selected policy is strategy W1 and O2, with the following formulation: Utilizing all weaknesses (W) to take full advantage of existing opportunities (O).

W1: Technology adoption gap

O2: Technological innovation

The formulated policy is as follows: **"Minimise technology adoption gap to maximise technological innovation."** This policy will help Indonesia modernize its ports and reduce emissions, improving both environmental sustainability and operational efficiency.

The analysis strongly suggests that Indonesia's maritime sector must prioritize closing the technology adoption gap to fully exploit the opportunities provided by technological innovation. This requires targeted investments in digital technologies, enhanced regulatory frameworks, and improved financing mechanisms like green and blue bonds. Additionally, international partnerships are essential to providing both technical expertise and financial resources.(Lee, 2025)

The SWOT, IFAS, EFAS, and SWOT Quadrant analyses together underscore the importance of a balanced approach—leveraging internal strengths like strong partnerships while addressing critical weaknesses such as the slow adoption of green technologies. If Indonesia can effectively manage these internal and external factors, it can achieve its vision of becoming a leader in sustainable maritime development by 2045 (Lee, 2025).

3.2 Discussion

The discussion delves into the implications of these results and suggests strategic directions for addressing Indonesia's maritime challenges:

a. Green and Smart Ports.

The development of Green and Smart Ports is seen as a cornerstone of sustainable maritime development. This involves integrating eco-friendly principles with cutting-edge technology, such as using renewable energy, automating operations with Internet of Things (IoT) systems, and digitalizing processes to enhance efficiency and reduce the environmental footprint of port activities (Sucoffindo, 2024). By leveraging renewable energy, improving waste management, and enhancing digital connectivity, these ports are expected to contribute to reducing emissions and improving operational efficiency (Zhang et al., 2024). The government's commitment to converting 149 ports into Green and Smart Ports within two years is a significant step towards realising this vision, a move supported by national institutions like SUCOFINDO, which provides validation and verification services for greenhouse gas emissions to help ports meet international standards (Sucoffindo, 2024). The concept aligns with global trends where

ports are becoming testbeds for decarbonization and digital transformation, employing technologies like AI-based berth allocation and digital twins to optimize logistics and reduce emissions (*Green Logistics Initiatives at Ports in the East and South China Sea Regions*, 2025).

b. Environmental Issues and IUU Fishing

The ongoing threats from environmental degradation, such as coral reef destruction and mangrove loss, combined with illegal, unreported, and unregulated (IUU) fishing practices, continue to undermine Indonesia's efforts to maintain marine biodiversity. IUU fishing has been estimated to cost Indonesia immense economic losses, with one report citing over $800 million lost in five years and at least 7.5 million tons of fish caught each year illegally (Farhan, 2025). These practices do not cause direct economic damage but also threaten the health of marine ecosystems, which are already under pressure from issues like coral reef destruction and mangrove loss (Wuwung et al., 2024). The use of real-time surveillance technologies and stronger law enforcement, including partnerships with regional neighbors, is a vital component of tackling IUU fishing and preserving the country's marine resources, which are critical for the livelihoods of coastal communities and the national economy (Indonesia, 2024; Wuwung et al., 2024).

c. Decarbonization Efforts

Reducing carbon emissions from the maritime sector remains a top priority. Indonesia's decarbonization strategy can draw insights from global port innovations, such as deploying shore power (cold ironing) for docked vessels, electrifying port equipment like cranes and vehicles, and scaling up bunkering infrastructure for alternative fuels like liquefied natural gas (LNG), green methanol, and ammonia (Zhang et al., 2024). Improving energy efficiency in vessels and ports, and integrating renewable energy sources like solar and wind power into port operations, are key tactics. Furthermore, the use of digital technologies, such as AI and real-time data analytics, in optimizing vessel traffic and port logistics can further reduce fuel consumption and emissions, supporting Indonesia's climate goals (Zhang et al., 2024). Academic-industry partnerships, such as the collaboration between Institut Teknologi Sepuluh Nopember (ITS) and the international classification bureau DNV, are crucial for building local expertise and driving innovation in decarbonization and digitalization (Website, 2025).

d. Blue Financing

While Indonesia’s green and blue bond markets are still underdeveloped, they hold substantial potential for funding marine conservation and sustainability projects. Internationally, green bonds are increasingly used to finance port electrification and other low-carbon infrastructure projects within sustainable finance frameworks. By strengthening the regulatory and institutional frameworks and enhancing transparency and accountability in these financial instruments, Indonesia can unlock the capital needed to fund projects like mangrove restoration, clean shipping technologies, and renewable energy initiatives in ports. The development of a National Blue Economy Roadmap, supported by international organizations like the UN, provides a strategic foundation for attracting such investments by outlining a clear path towards a sustainable and diversified maritime economy (Xiao et al., 2024).

e. Strategic Policy Recommendations

To overcome the identified weaknesses, the discussion emphasizes the need for policies that support the scaling of green initiatives across the country. This includes incentivizing technology adoption, providing financial incentives for sustainable practices, and establishing clearer coordination between governmental agencies (Xiao et al., 2024). Additionally, increasing public and private investments, particularly in blue financing, and fostering international partnerships are essential to advancing Indonesia's maritime sustainability goals.

In brief, while Indonesia has made notable progress in developing green infrastructure and addressing illegal fishing, scaling these initiatives and securing sustainable financing remain pivotal challenges. By addressing these gaps, Indonesia can strengthen its position as a global leader in sustainable maritime development.

4. Conclusion

Indonesia's maritime sector holds immense potential as the world's largest archipelagic nation, with strategic significance in global trade, biodiversity conservation, and the blue economy. However, realizing this potential requires addressing several pressing challenges, including outdated infrastructure, environmental degradation, illegal fishing, and carbon emissions. The country's commitment to sustainable maritime development is reflected in its efforts to modernize ports, promote green technologies, enhance digitalization, and combat illegal activities in its vast territorial waters.

The analysis of Indonesia's current maritime conditions highlights the importance of developing Green and Smart Ports, which integrate renewable energy sources, waste management, and digital solutions to improve operational efficiency and environmental sustainability. Additionally, the adoption of advanced monitoring technologies is crucial for combating IUU fishing and ensuring sustainable fisheries management.

Decarbonization remains a priority, with initiatives focused on transitioning to cleaner fuels, enhancing energy efficiency, and integrating renewable energy into port operations. While these efforts are commendable, the challenges of scaling these solutions and ensuring their financial viability persist. Blue financing, particularly through green and blue bonds, offers significant promise, but further development of regulatory frameworks and increased investor confidence are needed to unlock its full potential.

Moreover, the integration of technological innovations and increased collaboration between the government, the private sector, and international partners will be key to overcoming the existing gaps in infrastructure and governance. Indonesia must continue to invest in capacity-building, research, and community involvement to ensure the long-term success of its maritime sustainability efforts.

In conclusion, while Indonesia has made significant strides in developing a sustainable maritime sector, much work remains to scale these efforts across the nation. By addressing gaps in technology adoption, financing, and inter-agency coordination, Indonesia can realize its vision of becoming a globally competitive, environmentally responsible, and economically resilient maritime nation by 2045. The future of Indonesia's maritime development lies in continued innovation, collaboration, and a strong commitment to sustainability.

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