Vol. 2, No. 1, 2025, pp. 78-90 | E-ISSN: 3063-3796

Jurnal Ekonomi Manajemen Bisnis dan Akuntansi

https://e-journal.penerbit-altafcorp.com/index.php/jemba **E-mail:** admin@penerbit-altafcorp.com

Challenges, Opportunities, and the Future of the Blue Economy in Indonesia

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Article History:
Received: 07-06-2025
Revised: 22-07-2025
Accepted: 25-07-2025

Keywords: *Archipelagic Country; Maritime; Blue Economy; Economic Development*

Abstract: *Indonesia, the world's largest archipelagic country with vast maritime territory, holds significant potential for developing a blue economy that promotes sustainable growth through effective marine resource management. Key sectors such as fisheries, maritime tourism, and marine renewable energy are essential to national economic development. However, the blue economy's progress faces challenges, including ecosystem degradation, maritime pollution, and sectoral fragmentation. This study identifies the main challenges and explores opportunities in sustainable fisheries, maritime ecotourism, and marine renewable energy. Using a descriptive-analytical approach with qualitative and quantitative analysis of secondary data, the findings reveal that Indonesia's blue economy remains highly promising, especially with policies supporting sustainability, human resource development, and eco-friendly technologies. The novelty of this research lies in its cross-sectoral synthesis, which emphasizes the need for convergence between environmental governance and maritime economic policy.*

Introduction

Indonesia, as the world's largest archipelagic country with a maritime territory spanning over 5.8 million square kilometers, is strongly identified as a maritime nation (Dao et al., 2024). With its vast territorial waters, comprising approximately 70% of its total land area, Indonesia holds significant potential in developing a blue economy (Bhuyan et al., 2021). The

blue economy concept integrates economic growth with environmental sustainability, specifically through the wise and eco-friendly management of marine resources (Ahammed et al., 2024). As global awareness of environmental issues and climate change increases, the blue economy has gained considerable international attention.

With a coastline stretching 108,000 kilometers and an abundant wealth of marine resources, Indonesia has the potential to become the world's most prosperous blue economy (Rani & Ismadianto, 2024). Marine resources such as fisheries, marine ecosystems, marine tourism, renewable ocean energy (e.g., wave and tidal energy), and marine biotechnology feedstock, position this sector as a crucial pillar of national economic development. According to the Ministry of Marine Affairs and Fisheries, the marine and fisheries sector significantly contributes to Indonesia's Gross Domestic Product (GDP). For instance, the fisheries sector contributes about 2.5% to national GDP and provides employment to over 4 million people. Furthermore, Indonesia's marine biodiversity, home to over 17,000 species of fish and various types of coral reefs, represents a valuable resource for tourism and fisheries (Ministry of Marine Affairs and Fisheries, 2024). Given these potentials, Indonesia's blue economy can be optimized not only to drive economic growth but also to safeguard marine ecosystems that are increasingly threatened by unsustainable human activities (Wasik et al., 2024).

Despite its enormous potential, the development of the blue economy in Indonesia faces several serious challenges that must be addressed to ensure its sustainability. A primary challenge is the degradation of marine ecosystems caused by human activities such as overfishing, marine pollution, and coastal land conversion (Haderer & Ciolacu, 2022). The decline in marine environmental quality threatens not only the sustainability of natural resources but also the economy of communities dependent on marine and fisheries sectors. Another obstacle is the lack of integration between the marine and fisheries sector and other

sectors contributing to the blue economy, such as tourism, renewable energy, and marine biotechnology industries (Bhuyan et al., 2021) Fragmented policies and weak coordination among government agencies often hinder the realization of a cohesive and holistic blue economy model (Okafor-Yarwood et al., 2020). Additionally, inadequate infrastructure in some coastal areas remains a significant barrier to improving the productivity of the marine and fisheries sectors.

Nevertheless, the development of the blue economy in Indonesia offers several promising opportunities. One of the primary opportunities is the development of sustainable fisheries through ecosystem-based approaches and circular economy principles (Elegbede et al., 2023). Indonesia can enhance its fisheries potential by adopting modern technologies, such as eco-friendly fishing systems and more efficient, sustainable aquaculture practices (Mulyono et al., 2023). Additionally, Indonesia's marine tourism sector holds enormous potential. Renowned for its stunning underwater beauty, destinations like Raja Ampat, Bunaken, and Komodo attract global attention. The development of marine-based ecotourism can provide sustainable income for coastal communities while supporting the conservation of marine ecosystems. Therefore, promoting environmentally responsible marine tourism, which prioritizes the sustainability of marine ecosystems, is vital in supporting Indonesia's blue economy (Supriyanto, 2022).

The future of the blue economy in Indonesia hinges on overcoming existing challenges and maximizing the opportunities available (Rianawati et al., 2024). To this end, Indonesia needs to formulate policies that support the sustainable development of the blue economy, including strengthening the governance of marine resources, enhancing human resource capacity in the marine and fisheries sectors, and improving coordination among relevant agencies. The application of environmentally friendly technologies and research-driven approaches is also critical to supporting efficient and sustainable blue economy development (Mondal et al., 2024).

Previous studies have examined the potential of the fisheries and marine tourism sectors in Indonesia; however, these investigations have generally adopted a sectoral approach and have yet to explore cross-sectoral linkages within an integrated blue economy framework. Moreover, research that connects the potential of the blue economy with policy design based on real-world challenges remains limited, this gap forms the foundation for the present study.

Accordingly, this research is of high urgency, given the critical role of the blue economy in supporting national economic growth while preserving marine ecosystem sustainability. The study aims to identify the key challenges in the development of Indonesia's blue economy particularly marine ecosystem degradation, lack of sectoral integration, and fragmented policy frameworks and to explore the available opportunities in the development of sustainable fisheries, marine ecotourism, and marine renewable energy. By employing a descriptive-analytical approach that integrates both quantitative and qualitative secondary data, this study seeks to offer a novel contribution in the form of an integrative framework that aligns environmental, economic, and governance dimensions in advancing the sustainable development of Indonesia's blue economy.

Research Methods

This study adopts a mixed-methods approach, combining qualitative content analysis with quantitative trend analysis, to provide an in-depth understanding of the challenges, opportunities, and future prospects of the blue economy in Indonesia. The qualitative component is employed to explore structural issues and policy-related constraints, while the quantitative component is used to analyze sectoral performance indicators over a defined period. Data for this study were collected from a range of secondary sources, including official publications by the Central Statistics Agency (Badan Pusat Statistik/BPS), National Geographic Indonesia, Sucofindo, relevant ministry reports, and academic articles. These sources

provide empirical data and policy narratives related to the fisheries sector, marine-based renewable energy, and marine tourism in Indonesia. The time frame of analysis spans from 2013 to 2022, allowing for an examination of long-term trends and policy impacts.

Specifically, trend analysis is conducted on fisheries production and seaweed export data to capture growth patterns and economic potential. Content analysis is applied to policy documents and reports to identify recurring themes and critical gaps in marine resource governance, infrastructure development, and human capital readiness. The use of a qualitative approach is justified to capture the contextual and multidimensional nature of the challenges in implementing the blue economy, including marine ecosystem degradation, marine pollution, and institutional limitations. Simultaneously, quantitative analysis is essential to objectively assess performance indicators and validate observed trends.

To ensure data validity, only verified and up-to-date statistical sources and institutional reports were selected. Limitations of the study include its reliance on secondary data, which may not fully capture recent or informal developments in local marine economies. Nevertheless, the combination of qualitative and quantitative methods strengthens the reliability and analytical depth of the study. The results are intended to inform policy recommendations that are both evidence-based and context-sensitive, aiming to support sustainable development within Indonesia's blue economy framework.

Result and Discussion

Indonesia holds a strategic position as one of the largest producers in the global fisheries industry, making a substantial contribution to the international market (Destiningsih et al., 2020). According to data from the Central Statistics Agency (2023), Indonesia's marine fisheries production in 2022 was recorded at 963,124.17 tons, while seaweed exports totaled

237,270.8 tons. Over the past decade, both marine fisheries production and seaweed exports have shown a consistent upward trend. Figure 1 below illustrates the trends in Marine Fisheries Production and Seaweed Exports from 2013 to 2022:

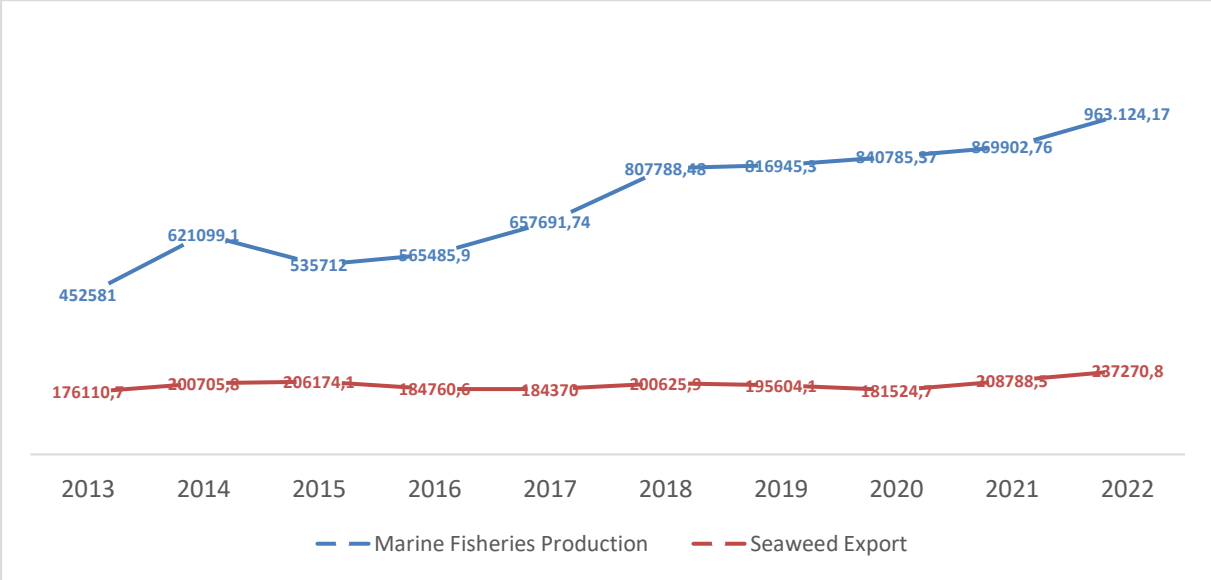

Figure 1. Marine Fisheries Production and Seaweed Exports 2013-2022

Between 2013 and 2022, marine fisheries production more than doubled from 452,581 tons to 963,124.17 tons while seaweed exports increased from 176,110.7 tons to 237,270.8 tons. These trends are consistent with the expansion phase described in blue economy development models, which emphasize the sustainable intensification of marine resource use. The empirical data supports the notion that Indonesia's fisheries sector has significant potential to drive inclusive and sustainable economic growth, in line with the UN's Sustainable Development Goal 14 (*Life Below Water*).

Beyond fisheries, Indonesia's marine economy includes emerging sectors such as ocean-based renewable energy (Oktaviani & Muhamad Iqbal, 2023). According to Sucofindo (2024), the country possesses an estimated 1.49 terawatts (TW) of wave energy potential, covering roughly 40% of its coastline. If only 10% of Java's southern coast were to be equipped with wave energy converters, it could generate 5.9 gigawatts (GW) of electricity equivalent to around 10% of the country's total electricity

production. This finding aligns with the "Blue Growth" model, which positions marine renewable energy as a key enabler of energy transition and economic diversification (Filimão Sitoe et al., 2023).

Indonesia's marine tourism sector also presents considerable opportunities. The country's archipelagic geography, comprising over 17,000 islands, supports a rich array of underwater biodiversity, coral reefs, and scenic coastlines. As noted by Wibawa et al. (2020), South Sulawesi alone offers more than 21 marine tourism destinations, such as Bira Beach in Bulukumba and Lemo Beach in East Luwu. This sector contributes approximately 10% to national GDP and aligns with experiential and ecological tourism trends globally. However, sustainability remains a concern, particularly in terms of coral reef damage and over-tourism in sensitive ecological zones.

However, despite its vast potential, the development of the blue economy in Indonesia faces numerous challenges that need to be addressed systematically (Rianawati et al., 2024). These challenges include limitations in infrastructure and facilities, marine ecosystem degradation, a shortage of skilled human resources, marine pollution, and unsustainable natural resource management practices. A detailed breakdown of the challenges faced by Indonesia is presented in Table 1 below:

Table 1. Blue Economy Challenges

Blue Economy Challenges	Data in Statistics
Infrastructure and Facility Limitations	Only 50% of ports and coastal facilities are optimal to support the marine industry (Central Statistics Agency, 2023b)
Marine Ecosystem Damage	Around 30% of Indonesia's coral reefs are in a state of severe damage (National Geographic Indonesia, 2023)
Lack of Skilled Human Resources	65% of workers in the maritime sector do not have adequate skills (Central Statistics Agency, 2023b)

Marine Pollution and Plastic Waste	More than 4 million tons of plastic waste enters Indonesia's seas every year (Winardi & Putri, 2024)
Unsustainable Natural Resource Management	50% of fisheries resources are managed unsustainably (Food and Agriculture Organization, 2022)

According to data from (Central Statistics Agency, 2023b), only approximately 50% of ports and coastal facilities are able to optimally support the marine industry. Furthermore, around 30% of Indonesia's coral reefs are severely damaged (National Geographic Indonesia, 2023), while 65% of the workforce in the marine sector lacks adequate skills (Central Statistics Agency, 2023b). Marine pollution, particularly plastic waste, also poses a significant challenge, with over 4 million tons of plastic waste entering Indonesian seas each year (Winardi & Putri, 2024). Additionally, the management of Indonesia's fisheries resources is far from sustainable, with 50% of these resources being exploited at unsustainable rates (Food and Agriculture Organization, 2022).

In addition to these technical and ecological issues, more complex systemic risks need to be acknowledged. For instance, governance fragmentation and overlapping authority among agencies often create inefficiencies and conflicts of interest across marine sectors. The absence of integrated spatial planning exacerbates disputes between fishing communities, tourism developers, and energy companies. Moreover, the long-term impacts of climate change—such as ocean acidification, sea level rise, and shifting fish migration patterns—pose existential risks to marine livelihoods and ecosystems, yet are underrepresented in current blue economy policy frameworks.

These challenges necessitate urgent attention and collaborative efforts to ensure sustainable management of the blue economy. Despite these issues, the future of Indonesia's blue economy holds promising prospects, given the country's abundant marine resources across fisheries, marine renewable energy, and marine tourism sectors (Sungkawati, 2024).

The fisheries and aquaculture sector makes a substantial contribution to the national GDP, positioning Indonesia as one of the world's largest fish producers (Puspitawati et al., 2022). Similarly, marine-based renewable energy sources such as wave and offshore wind energy present significant opportunities to reduce reliance on fossil fuels, aligning with global trends in renewable energy development.

From a theoretical perspective, these challenges reflect the gaps identified in Institutional Capacity and Sustainability Transition theories, which argue that structural reforms, knowledge transfer, and institutional coordination are essential to realizing the full potential of marine-based development. Nevertheless, the outlook remains promising. The fisheries and aquaculture sector continues to be a major contributor to national GDP and food security (Puspitawati et al., 2022). Similarly, the advancement of marine renewable energy and eco-tourism aligns with Indonesia's commitment to the Paris Agreement and its national energy mix targets.

To unlock the full potential of the blue economy, it is essential to adopt an integrated and multisectoral governance approach. This includes promoting technological innovation, strengthening institutional frameworks, and fostering cross-sector collaboration between government agencies, the private sector, academia, and coastal communities (Sungkawati, 2024). Sustainable marine economic development must also incorporate climate adaptation strategies, environmental safeguards, and inclusive benefit-sharing mechanisms.

Conclusion and Recommendation

The consistent growth in marine fisheries production and seaweed exports over the past decade reflects Indonesia's strengthening position in the global marine economy. In addition, the country's untapped ocean wave energy capacity and expansive marine tourism resources present further opportunities for economic diversification and climate-resilient

development. However, the research also reveals that the realization of this potential is constrained by systemic challenges most notably inadequate infrastructure, marine ecosystem degradation, limited skilled labor, pollution, and unsustainable resource exploitation. These issues not only hinder economic efficiency but also threaten the ecological foundations upon which the blue economy depends.

In addressing these challenges, this study proposes a set of prioritized and actionable strategies. First, investment in port modernization and coastal infrastructure must be accelerated to support efficient logistics and sectoral integration. Second, ecosystem rehabilitation particularly coral reef restoration should be institutionalized within marine spatial planning. Third, capacity building initiatives targeting the maritime workforce must be aligned with industrial demand and linked to technical and vocational education. Equally important, cross-sectoral governance mechanisms should be strengthened to ensure coordination among fisheries, energy, and tourism stakeholders.

Furthermore, combating marine pollution requires the integration of strict regulatory enforcement with community-based behavioral change programs, particularly concerning plastic waste management. Advanced technologies, such as real-time ocean monitoring systems and circular economy practices, should be adopted to support evidence-based and adaptive management. By integrating these strategic measures, Indonesia can transition from a resource-dependent marine economy to a more resilient, innovation-driven blue economy. This study contributes to the literature by applying a multidimensional framework linking economic output, ecological sustainability, and governance capacity to assess blue economy development. Practically, it offers policy-relevant insights that can guide the prioritization of interventions by governments, private actors, and civil society. If implemented effectively, the blue economy can become a key pillar of Indonesia's sustainable development trajectory, fostering inclusive growth while preserving marine biodiversity.

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