Proceeding of the 3rd International Conference of International Conference on Business and Economics
Faculty of Economy and Business, Universitas Pattimura,
December 11, 2025
PATTIMURA PROCEEDING: Conference of Science and Technology
e-ISSN: 2829-3770 | February 2026 | pp.80-88

Local Wisdom–Based Technology Strategies for a Sustainable Blue Economy in Indonesia

Ruth Natalia Achmad[1*], Elvando Lionel Hanas [2], Yerimias Manuhutu[3]
[1,2,3]*Economic Development, Faculty of Economic and Business, Pattimura University, Ambon, Indonesia*
[*]Corresponding author's e- mail: nataliaruth570@gmail.com

ABSTRACT

In the global world Indonesia's strategic position as the world's largest archipelagic state provides significant potential for developing a sustainable blue economy. However, geographical fragmentation, technological gaps, and socio-cultural diversity require development strategies that integrate technological innovation with local wisdom. This study aims to analyze strategies for utilizing local wisdom–based technology to strengthen the sustainable blue economy in the Indonesian archipelago. This research employs a qualitative literature review method, analyzing academic articles, government reports, and international publications published between 2015 and 2025. The findings indicate that integrating digital technologies with indigenous management systems—such as sasi laut, panglima laot, and awig-awig—enhances marine resource governance efficiency while preserving ecological sustainability and social legitimacy. This study concludes that synergy between technology and local wisdom is a key foundation for inclusive, adaptive, and sustainable blue economy development in archipelagic regions.

Keywords: *blue economy, local wisdom, digital technology, sustainability, Indonesian archipelagic*

Introduction

Indonesia is the world's largest archipelagic country, consisting of 17,380 islands and located along major international shipping routes such as the Malacca, Sunda, and Lombok Straits. This strategic position provides significant potential for marine-based economic activities, including fisheries, marine tourism, renewable marine energy, and maritime transportation. However, despite this advantage, marine resource utilization in Indonesia remains suboptimal due to technological disparities, governance limitations, and ongoing marine ecosystem degradation.

In response to these challenges, the blue economy has emerged as an important development paradigm that promotes economic growth through the sustainable use of marine resources, environmentally friendly technological innovation, and improved welfare of coastal communities (UNEP,2021) For Indonesia, the successful implementation of the blue economy requires development strategies that are not only technology-driven but also socially and culturally grounded.

Local wisdom plays a crucial role in coastal and marine resource management across Indonesia. Indigenous governance systems such as sasi laut in Maluku, panglima laot in Aceh, and awig-awig in Bali have long functioned as effective community-based mechanisms for regulating marine resource use and maintaining ecological balance. These traditional systems can be strengthened through the application of digital

DOI: https://doi.org/10.30598/pcst.2026.iconbe.p80-88

technologies, including the Internet of Things (IoT), geographic information systems (GIS), and digital monitoring systems, to support transparency, efficiency, and sustainability in marine governance.

Nevertheless, existing studies on the blue economy and digital transformation often treat technology and local wisdom as separate domains. Systematic integration of indigenous governance systems with modern technological frameworks in archipelagic contexts remains limited. This gap highlights the need for a concise and integrated approach that positions local wisdom as an active institutional foundation rather than merely cultural heritage.

Therefore, this study aims to analyze strategies for integrating local wisdom–based technology in building a sustainable blue economy in the Indonesian archipelago. By synthesizing insights from socio-cultural institutions, appropriate technology, and public policy, this research contributes to conference discussions on sustainable maritime development and offers practical perspectives for archipelagic regions.

Research Methods

Types of Research

This research uses a qualitative approach with a literature review method. This approach was chosen because the focus of the research is to examine various concepts, theories, and research findings related to the use of local wisdom-based technology to support blue economy development in the Indonesian archipelago. The literature review method allows researchers to explore, compare, and integrate findings from various scientific sources to produce a comprehensive and relevant conceptual framework for maritime sustainability issues.

This research data is entirely sourced from secondary literature, including national and international scientific journals, government agency reports, and policy documents from relevant agencies such as the Ministry of Maritime Affairs and Fisheries (MMAF) and the Ministry of Environment and Forestry. These documents serve as references to enrich the analysis of blue economy implementation in various countries. Source selection was carried out by considering the criteria of relevance and novelty, namely publications published between 2015 and 2025 and directly related to the themes of technology, local wisdom, and sustainable maritime economy.

Data collection was conducted through several stages. First, literature was identified using keywords such as blue economy, local wisdom, indigenous knowledge, and marine technology. Second, literature was selected based on the suitability of the content to the research topic and the completeness of both empirical and conceptual data. Third, all selected literature was recorded and organized in a literature matrix containing the author's name, year of publication, research focus, main findings, and its relevance to the research topic. The final stage was the synthesis process, which

examined the relationships between concepts that emerged in various sources to find patterns and strategies appropriate to the Indonesian archipelago context.

A total of 45 scientific publications were analyzed, consisting of peer-reviewed journal articles (32), government policy documents (8), and international reports (5). Literature selection followed a thematic screening process adapted from the PRISMA framework, including identification, screening, eligibility, and synthesis stages. Data analysis employed thematic content analysis to identify recurring patterns related to technology adoption, indigenous governance systems, and sustainability outcomes.

Data analysis was conducted using qualitative descriptive methods through content analysis and thematic synthesis. Relevant literature was analyzed to identify key themes, such as the use of technology in marine resource management, the role of local wisdom in maintaining coastal ecosystems, and the integration of technology with local cultural values in blue economy development. The results of the analysis were then interpreted to formulate a conceptual strategy that can be implemented sustainably in the archipelagic region.

Through this approach, the research is expected to produce a conceptual model for a strategy for utilizing local wisdom-based technology as a foundation for sustainable blue economy development in the Indonesian archipelago. The results of this study are expected to not only provide theoretical contributions to the development of maritime economics literature but also serve as a practical reference for formulating coastal development policies oriented toward sustainability and local independence.

Results and Discussion

Integration of Local Wisdom and Utilization of Technology

Local wisdom contains conservation elements and values relevant to blue economy principles. Through integration with technology, traditional practices can be strengthened. For example:

1. The Sasi Laut (Maluku) system can be combined with IoT sensor technology to monitor no-take areas in real-time.
2. The Acehnese “Panglima Laot”can use digital applications based on weather and ocean current data to determine safe and productive times for going to sea.
3. Awig-awig (Bali and Lombok) can be integrated into a blockchain-based data system to record transparent and fair seafood transactions.

Various studies have shown that the integration of technology and local wisdom can be effective if there is collaboration and respect for traditional practices. For example, in the case of Sasi Laut in Misool, Raja Ampat, Papua, a concession agreement between ecotourism operators and indigenous communities has enabled the preservation of the Sasi Laut tradition while protecting its biodiversity. (Asia Pacific Journal of Tourism Research, McLeod et al., 2019).

In today's globalized world, technology applications must take these local principles into account. The use of technology developed or implemented in coastal areas needs to be tailored to the social structure and aligned with the community's traditional knowledge. For example, the use of community-based digital monitoring systems can be combined with sasi practices to facilitate monitoring of marine conservation areas. Thus, technology serves as a complement, not as substitute, and has a positive impact on local wisdom within communities that has proven to be ecologically and socially effective.

Development of Appropriate Technology in the blue economy

Technology is a crucial aspect in realizing a productive and sustainable blue economy. Technology development in island regions needs to consider local characteristics. Furthermore, research in coastal communities reveals that the level of acceptance of fisheries technology is strongly influenced by how the technology is passed down, the extent to which local communities perceive the technology to be compatible with their values and culture, and the level of support from the government or relevant institutions, which must be aligned with local culture. (Jurnal Maksipreneur, Luhur, 2018). Appropriate technologies such as floating solar panels, eco-aquaculture, and environmentally friendly electric boats are alternatives to reducing carbon footprints and dependence on fossil fuels.

The use of the Internet of Things (IoT), marine monitoring drones, and geographic information systems (GIS) is also beginning to be applied in coastal mapping and marine resource monitoring. However, the success of these technologies depends heavily on the active participation of local communities. Without community involvement and adaptation to local wisdom, technologies often become unsustainable due to low levels of social acceptance. Starting with digital training for fishermen and coastal MSMEs is a crucial step in enabling local communities to operate the technology independently.

Policy and Collaboration between Technology, Local Wisdom and Public Policy

The results of the study show that the sustainability of the blue economy is not only achieved through technological innovation or community initiatives alone, but requires cooperation and support between three main pillars: local communities, the technology sector, and public policy. The development of digital business models in maritime training, as reviewed by Selasdini et al. (2025) is also an important component in establishing a maritime innovation ecosystem with local capacity as its basis.

In this regard, the government plays a crucial role in creating policies or establishing regional maritime centers that encourage collaboration between academics, business actors, and local coastal communities. The government needs to promote blue innovation hubs in archipelagic regions, where research institutions, local communities,

and the private sector collaborate on applied research. Programs such as the Smart Fisheries Village and the Digital Marine Economy can serve as integrative platforms between technology and local wisdom.

Implementation Challenges and Opportunities

Indonesia has substantial potential to integrate technology and local wisdom in blue economy development; however, several structural challenges remain. These include limited digital literacy among coastal communities, inadequate technological infrastructure in island regions, insufficient formal documentation of indigenous knowledge, and tensions between short-term economic interests and long-term environmental conservation values. Addressing these challenges requires governance approaches that place indigenous communities at the center of digital innovation design, as community involvement has been shown to strengthen socio-ecological sustainability and local ownership of technology-based initiatives (Ramadhan et al., 2024).

Comparative analysis across regions indicates that the effectiveness of integrating technology and local wisdom depends heavily on institutional strength and governance structures. In Aceh, the *panglima laot* system benefits from strong customary authority and formal recognition, enabling effective enforcement of marine regulations and smoother adoption of monitoring technologies. In contrast, *sasi laut* in Maluku relies primarily on communal compliance and cultural legitimacy, which, while socially robust, requires participatory and trust-based technological approaches rather than top-down interventions. These differences demonstrate that uniform technological solutions are unlikely to be effective across regions.

Consequently, policy interventions must be adaptive and context-specific. Governments should promote co-design mechanisms that integrate local knowledge into technology development, alongside practice-based capacity-building programs such as digital literacy training, fisheries management, and sustainable tourism. Strengthening cross-sector collaboration and aligning national blue economy policies with local governance systems are essential to ensuring that technological innovation supports, rather than undermines, indigenous institutions. Through such tailored policy support, the integration of technology and local wisdom can function not only as an innovative approach but also as a strategic foundation for Indonesia's sustainable maritime development.

Conceptual Synthesis

Based on the results of the literature review, a conceptual model for utilizing local wisdom–based technology in sustainable blue economy development can be formulated through several interrelated dimensions.

Socio-cultural aspects emphasize the involvement of local communities as the main actors at every stage of marine resource management. Indigenous practices such as *sasi laut* in Maluku demonstrate how communities collectively regulate harvesting periods, prohibit destructive fishing activities, and enforce customary sanctions to maintain ecosystem balance. Similarly, the traditional institution of *panglima laot* in Aceh establishes rules governing fishing schedules, customary prohibitions, and marine protection measures, contributing to the sustainability of fish stocks. These practices indicate that local communities are not merely policy recipients, but key institutional actors in sustaining marine resources.

Building upon this socio-cultural foundation, technological aspects focus on the use of appropriate and adaptive technologies that align with local environmental conditions and cultural values. Technology in this context is not imposed uniformly, but selectively adopted to complement existing governance systems. Digital monitoring tools, information systems, and data-based decision-support technologies can enhance the effectiveness of traditional practices when they are designed in accordance with local knowledge and social structures (Pramono, 2023).

From a sustainability perspective, ecological aspects highlight the role of technology in supporting conservation and monitoring efforts grounded in local wisdom. Empirical studies show that indigenous conservation practices such as sasi laut, sacred forest protection, and community-based medicinal resource management—play a significant role in preserving ecological balance. These local practices provide a strong foundation for integrating technological tools in monitoring marine and coastal ecosystems (Saputra, 2020).

To ensure long-term effectiveness, policy aspects serve as an enabling framework that connects socio-cultural institutions, technology, and ecological sustainability. Regulatory support, institutional recognition, and incentive mechanisms from the government are essential to strengthen collaboration between local communities, academics, and technological innovators. Supportive policies enhance the capacity of indigenous institutions and encourage innovation that aligns with sustainability objectives (Safaat & Yono, 2018).

Overall, this conceptual synthesis confirms that the success of technological innovation in the blue economy is not determined by the quantity or sophistication of technology deployed. Instead, it depends on the extent to which technology is socially accepted, culturally aligned, and institutionally embedded within local socio-ecological systems. Figure 1 illustrates the integrated conceptual model linking socio-cultural institutions, adaptive technology, ecological sustainability, public policy support, and participatory co-design as the foundation for sustainable blue economy development in archipelagic regions.

Conceptual Model of Local Wisdom-Based Technology Integration

Figure 1. Integrated Model for Sustainable Blue Economy

The proposed conceptual model consists of five interrelated dimensions: (1) socio-cultural institutions as governance foundations; (2) adaptive and appropriate technology; (3) ecological sustainability mechanisms; (4) supportive public policy and regulatory frameworks; and (5) participatory co-design processes. These dimensions interact dynamically to support sustainable blue economy development in archipelagic regions. As illustrated in Figure 1, these five dimensions interact dynamically to form an integrated governance framework for sustainable blue economy development in archipelagic regions.

Conclusion, Implications, Suggestions, and Limitations

The literature review shows that the development of blue economy in the Indonesian archipelago cannot be separated from the role of local wisdom and technology as the primary focus of sustainability. Local wisdom, embodied in social systems, customs, and marine management practices such as sasi laut (sea stipulations), awig-awig (a customary law), and panglima laot (the commanding officer) have proven effective in maintaining ecological balance and preserving the social identity of coastal communities. Meanwhile, the use of technology tailored to the local context, such as digital marine monitoring technology, geographic information systems (GIS), and fisherman empowerment applications, are crucial instruments for increasing maritime economic productivity.

The integration of local knowledge and technological innovation has created a participatory marine resource management model, where coastal communities can benefit not only by being beneficiaries but also by actively playing key roles as designers and managers of maritime development in island areas, particularly coastal communities. Through this approach, the blue economy concept can be realized in the

form of environmentally friendly, socially just, and economically sustainable economic practices.

This research confirms that utilizing technology based on local wisdom is an effective and efficient strategy for addressing development challenges in archipelagic regions, such as limited infrastructure, the digital divide, and ecological pressures. This approach strengthens the position of coastal communities as key players in the blue economy and supports Indonesia's vision of becoming a sovereign and sustainable global maritime axis.

Government policy support, digital education, and cross-sector collaboration are needed to ensure that the transformation to a blue economy is not only economically profitable but also equitable and inclusive for island communities. Further research is recommended to develop empirical models for the application of local wisdom-based technology in various island contexts, in order to obtain a more specific and targeted approach to the sustainability of the blue economy.

For Local Communities: It is important to strengthen human resource capacity through digital training for MSMEs, maritime business management, and increasing ecological awareness, so that communities can play an active role in managing marine resources independently and maintaining existing resources.

Thus, blue economy development in the Indonesian archipelago can only be sustainable if technology, policies, and local wisdom are integrated within a mutually reinforcing and harmonious framework, adapting to the conditions and culture of local island communities while respecting local values. The synergy of these three is key to creating a productive, inclusive, and sustainable maritime future for Indonesia.

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