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Sustainable Fishery Supply Chain in Indonesia

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ABSTRACT

Indonesia, as the largest archipelago in the world, has a vast potential for fisheries resources, with a coastline stretching over 81,000 kilometers and waters rich in marine biodiversity. The fisheries sector plays a vital role in national food security and is also a source of income for millions of people relying on fishing, aquaculture, and fish processing activities. However, the sustainability of the fisheries sector faces serious challenges, including overexploitation, marine habitat degradation, and inefficiencies in the supply chain, leading to economic and environmental losses. This literature review aims to synthesize recent academic literature on sustainable fishery supply chains in Indonesia, focusing on regulatory and public policy aspects, quota-based resource management strategies, supply chain optimization in the downstream sector, and multi-stakeholder coordination through the Pentahelix model. The review shows that the integration of quota-based policies, the application of Sustainable Supply Chain Management (SSCM), and coordination among Pentahelix stakeholders are three key pillars that must be implemented simultaneously to achieve the sustainability of Indonesia's fisheries sector. This study is expected to provide practical recommendations for policymakers, academics, and practitioners in designing a fishery supply chain system that is not only economically efficient but also socially equitable and environmentally sustainable.

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INTRODUCTION

Indonesia occupies a strategic position in the global fisheries sector as the second-largest fish-catching producer in the world. The fisheries sector contributes trillions of rupiah annually to the national Gross Domestic Product (GDP), with millions of workers directly or indirectly involved in the fisheries value chain. However, despite its immense potential, Indonesia's fisheries sector faces various structural problems that threaten its long-term sustainability. According to Kusdiantoro et al. (2019), Indonesia's fisheries face a

complex sustainability challenge, including declining fish stocks due to overfishing, the use of environmentally damaging fishing gear, and inadequate monitoring and enforcement in the field. This situation is exacerbated by climate change, which disrupts fish migration patterns and marine ecosystem productivity, thus threatening the livelihoods of traditional fishermen who are at the forefront of national fishery production. In addition, regional studies show that coastal areas such as Bone Regency in South Sulawesi possess high fisheries potential with moderate to high fish species diversity, indicating the importance of sustainable fisheries management at the local level (Gazali et al., 2025).

In this context, the concept of sustainability in the fishery supply chain not only refers to ecological aspects such as the preservation of fish stocks and marine habitats but also includes economic aspects like the equitable distribution of added value among supply chain actors, and social aspects related to the welfare of fishermen and coastal communities. Business diversification in fisheries has been proven to increase fishers' income and improve the welfare of coastal communities (Zaim et al., 2025) . Local wisdom practiced by fishing communities, such as seasonal fishing restrictions and environmentally friendly fishing gear, has also been recognized as an important approach to supporting sustainable fisheries resource management (Ningsih et al., 2025). A sustainable fishery supply chain requires the integration of resource management policies at the upstream level with responsible business practices at the downstream level, supported by adequate infrastructure and technology. This literature review aims to analyze and synthesize current academic literature on the various approaches and strategies that have been and are being implemented in Indonesia to achieve a sustainable fishery supply chain. Through thematic analysis of various scientific publications, this review will identify key challenges, available opportunities, and strategic recommendations that can serve as a reference for stakeholders in the development of Indonesia's fisheries sector moving forward.

RESEARCH METHOD

This study uses a literature review approach by analyzing relevant academic publications on sustainable fishery supply chains in Indonesia. The data were examined using thematic analysis to identify key patterns, challenges, and strategies related to fisheries policy, resource management, supply chain optimization, and stakeholder collaboration.

RESULT AND DISCUSSION

Regulatory Framework and Public Policy

The sustainability of the fisheries sector requires a strong, comprehensive legal foundation, and harmonization between different levels of regulation and related sectors. Without a solid regulatory framework, efforts for conservation and resource management will be difficult to implement consistently and effectively. Siregar et al. (2025), in their study on the harmonization of fisheries law, emphasize the importance of synergy between central and regional regulations to create legal certainty for fisheries entrepreneurs. This harmonization includes aligning various regulations related to licensing, monitoring, and sanctions for violations, thereby creating uniform understanding and implementation across Indonesia. Without this harmonization, the risk of regulatory conflicts and policy inconsistency will increase, which in turn will hinder investment and innovation in the fisheries sector. Siregar et al. (2025) further argue that the welfare of Indonesia's marine sector can only be achieved if there is a balance between economic, ecological, and social interests in every regulation produced, with continuous evaluation and improvement mechanisms.

Internationally, Indonesia has adopted various global legal instruments related to sustainable fisheries management, including the FAO SSF Guidelines or the Voluntary Guidelines for Small-Scale Fisheries. Vatria (2021) conducted an in-depth study on the implementation of these FAO guidelines in Indonesia and found that, although Indonesia has nominally recognized the importance of protecting small-scale fishermen, implementation in the field still faces several challenges. Small-scale fishermen, who constitute the majority of national fisheries actors, are often marginalized in policymaking and find it difficult to access various government assistance programs. Vatria (2021) suggests the need for a more inclusive mechanism to involve small-scale fishermen in the decision-making process, ensuring that the resulting policies are truly responsive to their needs and aspirations. The implementation of the FAO SSF Guidelines becomes even more critical given the strategic role of small-scale fishermen in maintaining local food security and preserving traditional knowledge about marine ecosystems.

Area-based management, another strategy currently being developed in Indonesia to strengthen the fisheries regulatory framework, is a key component of this effort. Pratiwi et al. (2022) analyzed the legal politics of designating fisheries management areas and regulated fishing as a crucial instrument for sustainable fisheries resource development. The concept of measured fishing requires clear limitations on the number, type, and area of fishing allowed, based on scientific and comprehensive fish stock assessments. Pratiwi et al. (2022) argue that this approach has the potential to address the tragedy of the commons in open-access fisheries management by creating a more structured and monitored system. However, implementing this policy requires significant investment in monitoring, control, and surveillance (MCS) systems, including the use of technologies like Vessel Monitoring Systems (VMS) and satellite-based observations.

From a marine conservation perspective, Tating & Marzaman (2023) discuss the policy of maintaining marine biodiversity in natural resource management in Indonesia. They emphasize that the sustainability of the fishery supply chain heavily depends on the health of marine ecosystems, which serve as the foundation for fishery resources. Habitat damage such as coral reefs, seagrass beds, and mangroves due to pollution, coastal development, and climate change will directly impact the productivity of fisheries. Tating & Marzaman (2023) advocate for an ecosystem approach to fisheries management, which considers the interaction between fish species and their environment, not just focusing on target species. This approach requires cross-sectoral coordination among relevant ministries, including the Ministry of Maritime Affairs and Fisheries, the Ministry of Environment and Forestry, and regional governments.

Resource Management Strategies: Towards a Quota-Based System

One of the most significant breakthroughs in modern fisheries management is the transition from an open-access system to a quota-based management system. This system is considered more effective in controlling the level of resource exploitation by setting a maximum limit for the total catch allowed each year (Total Allowable Catch or TAC), which is then allocated to fishermen or fishing companies. Trenggono (2023) in his study discusses the implementation of quota-based measured fishing as a solution to ensure the sustainability of fisheries resources in Indonesia. Trenggono (2023) identifies that the quota system has the potential to address the long-standing problem of overfishing, which has threatened fish stocks in Indonesia's waters, by providing economic incentives for fishermen to catch more efficiently without exceeding the established catch limits. Furthermore, this system also allows for more accurate catch data collection, which forms the basis for evidence-based management decisions.

However, the implementation of a quota-based system in Indonesia still faces various challenges that need to be addressed. Aritonang, Simatupang, & Handayati (2025)

conducted an in-depth review of the status quo and future needs for quota-based fisheries management in Indonesia, analyzing various factors that affect the success or failure of this policy. They found that the main challenges lie in the limitations of monitoring infrastructure, resistance from some fishermen accustomed to the open-access system, and the complexity of determining quota allocations that are considered fair by various parties. Aritonang et al. (2025) recommend a phased approach in implementing the quota system, starting from waters that already have adequate stock data and relatively strong monitoring before it is applied more broadly. They also emphasize the importance of involving fishermen in the quota-setting process to create a sense of ownership and compliance with the established regulations.

Strategic approaches to sustainable fisheries resource management must also consider the dynamics of climate change and advancements in modern technology. Narwadan, Kubela, & Tamalene (2024), in their study on resource management strategies in the modern era, argue that climate change has altered the distribution, abundance, and migration patterns of various fish species, requiring adaptations in management strategies. Sea warming, increased ocean acidification, and changes in rainfall patterns impact marine ecosystem productivity and, subsequently, the availability of fish resources. Narwadan et al. (2024) suggest adopting an adaptive approach to fisheries management, with mechanisms for periodic evaluation and adjustment of policies based on the latest scientific data. Furthermore, technological advancements such as satellite-based monitoring systems, artificial intelligence for fish stock prediction, and blockchain for traceability of fishery products offer new opportunities to enhance management effectiveness and supply chain transparency.

Supply Chain and Optimization in the Downstream Sector

The fishery supply chain does not stop at the sea or at the fish auction places but continues through various complex stages until it reaches the final consumer. Inefficiencies at any stage in the supply chain can impact product quality, the price received by fishermen, and consumer welfare. Arvitrida et al. (2019) in their study identify opportunities for improvement in the downstream sector of the fishery supply chain in Indonesia, focusing on post-harvest handling, storage, transportation, and distribution. They found that inadequate cold chain infrastructure is one of the main causes of product damage and economic value loss, especially for highly perishable fish products. Arvitrida et al. (2019) identified that most small-scale fishermen still use conventional ice for fish storage, with low cooling efficiency and high contamination risks. Investments in better cold chain infrastructure, including cold storage at fish landing sites and refrigerated vehicles for transportation, are priorities to reduce post-harvest losses.

To address various inefficiencies in the supply chain, the Sustainable Supply Chain Management (SSCM) approach offers a comprehensive framework that integrates sustainability principles into all aspects of the supply chain management. Aisyah, Masudin, & Zulfikarijah (2025) in their study explore the optimization of sustainable supply chains in the fish processing industry using the SSCM approach to achieve efficiency and sustainability simultaneously. The SSCM approach emphasizes the importance of coordination among various stakeholders in the supply chain to minimize environmental impact, optimize resource use, and ensure social welfare for all actors. Aisyah et al. (2025) found that applying SSCM principles in the fish processing industry can lead to various benefits, including waste and emission reduction, energy efficiency improvement, better working conditions, and an enhanced business reputation among consumers increasingly aware of sustainability issues. Their study also identifies various challenges in implementing SSCM, including limited capital, lack of knowledge and skills, and insufficient incentives from the government and buyers.

Beyond operational aspects, a sustainable fishery supply chain also requires transparency and traceability, enabling consumers and regulators to track the origin of fish products and the processes they undergo. Traceability systems based on technologies such as barcodes, QR codes, and blockchain allow tracking of products from the sea to the consumer's dining table, which is crucial to ensure compliance with sustainability standards and prevent illegal practices such as Illegal, Unreported, and Unregulated (IUU) fishing. Implementing an effective traceability system requires investments in digital infrastructure and the capacity to manage large volumes of data, which is a particular challenge for developing countries like Indonesia. However, the potential benefits of such a system are significant, both in terms of increasing consumer trust, gaining access to premium markets that value sustainable products, and enforcing regulations more effectively.

The Role of Stakeholders and the Pentahelix Model

The success of a sustainable fishery supply chain cannot be achieved by one party alone but requires close coordination and collaboration between various stakeholders with different roles and interests. Setiawan (2024) in his study analyzes the challenges, opportunities, and strategies of Pentahelix stakeholders in realizing a sustainable fishery supply chain in Indonesia. The Pentahelix model identifies five key actors involved in the system of innovation and sustainable development: academics (universities and researchers), business (entrepreneurs and business operators), communities (civil society and non-governmental organizations), government (government agencies at various levels), and the media. Setiawan (2024) argues that these five actors must work synergistically and strengthen each other, not work in isolation or even conflict. Academics play a role in generating knowledge and innovations necessary for better fisheries management, business contributes in terms of investment, technology, and economic value creation, communities ensure local participation and oversight, the government provides regulatory frameworks and infrastructure, while the media functions as a catalyst for communication and dissemination of information.

Kobayashi (2023) in his study of sustainable fisheries policies in Ambon, Maluku, provides concrete examples of how interaction among various stakeholders can lead to positive outcomes for the sustainability of the fisheries sector. Ambon, as one of the fishing centers in Eastern Indonesia, has developed various initiatives to promote sustainable fisheries, including the development of marine conservation areas, responsible fisheries certification programs, and market development for sustainable fishery products. Kobayashi (2023) found that the success of these initiatives highly depends on the support of local government policies, active participation from fishermen and local communities, and partnerships with the private sector and international organizations. This case study from Ambon shows that enabling policies are a critical prerequisite for fostering innovation and sustainable practices at the local level. Kobayashi (2023) also identified several challenges that still need to be addressed, including the limited institutional capacity at the regional level, lack of access to capital and technology, and the need to improve cross-sectoral coordination and intergovernmental levels.

The application of the Pentahelix model in the context of a sustainable fishery supply chain in Indonesia requires structured dialogue and coordination mechanisms among various actors. Multi-stakeholder forums involving representatives from the five sectors can serve as platforms to share information, identify common issues, and formulate solutions that can be agreed upon by all parties. Experiences from various countries indicate that the success of the Pentahelix model depends greatly on effective leadership in facilitating dialogue and building consensus, as well as long-term commitment from all actors to collaborate. In Indonesia, several multi-stakeholder initiatives have been developed in the fisheries sector, including co-management mechanisms involving fishermen and the

government in resource management, and various partnerships between government, academia, and the private sector in developing sustainable fisheries technologies and practices. The challenge moving forward is how to expand and strengthen these mechanisms to encompass the entire fishery supply chain, from upstream to downstream, and from Sabang to Merauke.

CONCLUSION

Based on a comprehensive review of recent academic literature on sustainable fishery supply chains in Indonesia, it can be concluded that achieving sustainability in the fisheries sector requires a holistic approach that integrates various dimensions and involves various stakeholders synergistically. From the perspective of regulation and public policy, the harmonization of fisheries laws is needed to create legal certainty as well as protection for small-scale fishermen and marine ecosystems, with consistent implementation across all regions of Indonesia. The quota-based management system offers a potential solution to address the problem of overfishing; however, its implementation must be adapted to the local context and supported by investments in technology-based monitoring systems. In the downstream sector, improving the efficiency of the supply chain through the application of Sustainable Supply Chain Management principles and strengthening cold chain infrastructure is a priority to reduce post-harvest losses and increase value-added benefits for all actors involved.

Equally important is strengthening multi-stakeholder coordination through the Pentahelix model, which integrates the roles of academia, business, communities, government, and media into a collaborative framework. Without effective coordination among stakeholders, efforts to achieve a sustainable fishery supply chain will struggle to achieve optimal results. The challenge ahead for Indonesia is how to integrate the lessons and recommendations from academic literature into concrete policies and practices, while considering the diverse geographic, socio-economic, and institutional conditions across Indonesia. Success in this area will determine not only the sustainability of Indonesia's fisheries resources but also the well-being of millions of people who depend on the marine and fisheries sector for their livelihoods. It is hoped that this literature review will contribute to a more comprehensive understanding of key issues in sustainable fishery supply chains in Indonesia and serve as a reference for future research and policy development.

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