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Supply Chain Management Hierarchy Model to Support SDGs and Food Security, Using the Analytical Hierarchy Process Approach

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Abstract: Current global challenges, such as climate uncertainty and population growth, demand robust and sustainable supply chain management systems. Existing management models often fail to comprehensively integrate sustainability dimensions, particularly in supporting the Sustainable Development Goals (SDGs), particularly those related to food security. By combining the principles of sustainability and resilience, the proposed model is expected to serve as a guide for stakeholders in making strategic decisions to achieve a more efficient, sustainable, and crisis-adaptive supply chain, while contributing significantly to the achievement of the SDGs. The fisheries supply chain faces serious challenges in transparency, traceability, and distribution inequality, which directly impact the achievement of the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger) and SDG 12 (Responsible Consumption and Production). Blockchain technology presents an innovative solution to improve data integrity and logistics efficiency. This study aims to analyze the most prioritized blockchain implementation strategies to strengthen food security in the fisheries industry. Using the Analytical Hierarchy Process (AHP) approach, weighting of the criteria and sub-criteria influencing blockchain adoption was carried out. The results indicate that data transparency and product traceability are the top priorities in the supply chain. This study provides strategic recommendations for policymakers and industry players to accelerate the blockchain-based digital transformation of the marine and fisheries sector.

Keywords: AHP; Blockchain; Fisheries; Food security; SDGs; Supply chain

Introduction

Indonesia, an archipelagic nation with over 17.000 islands and an Exclusive Economic Zone (EEZ) of 6.4 million km², makes the fisheries sector a pillar of the national economy and a primary food source. However, the reality on the ground shows that the capture fisheries supply chain still faces several challenges. Food security and the achievement of the Sustainable Development Goals (SDGs) are two crucial issues that are closely interconnected at both the global and national levels (Wang et al., 2024; Sorooshian, 2024). Amid population dynamics, climate change, and economic fluctuations, ensuring the availability, accessibility, stability, and sustainable use of food is a complex challenge (Banasik et al., 2018). The food supply chain, from upstream to downstream, plays a central role in achieving food security, yet it often faces various obstacles such as inefficiency, post-harvest losses, and lack of integration between actors (Fauziana et al., 2023; Sánchez-Teba et

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al., 2021). A modern Supply Chain Management (SCM) approach offers a framework for optimizing the flow of products, information, and finances, thereby increasing the efficiency and resilience of the overall food system (Shobur et al., 2025; Xie et al., 2025).

However, the complexity of SCM in the context of sustainable food requires a decision-making model that can accommodate various criteria and diverse interests (Haryono et al., 2024; Ahmed et al., 2024). Therefore, this study will propose an SCM Hierarchy Model specifically designed to support the SDGs and Food Security, adopting the Analytical Hierarchy Process (AHP) approach. AHP, as a multi-criteria decision-making method, allows for the prioritization of various factors influencing food SCM, from environmental, social, to economic aspects, allowing for the formulation of more measurable and holistic strategies to achieve sustainable development goals (Gupta et al., 2023). The application of blockchain technology in the fisheries sector is not simply about digitalization, but also about systemic transformation towards sustainability. With the AHP approach, implementation strategies can be prioritized rationally and participatory, aligned with the SDGs. Going forward, successful adoption depends on a combination of technological infrastructure.

Blockchain enables the permanent recording of every transaction in the fisheries supply chain, from catch at sea to consumer (Pakseresht et al., 2023; Mumtaz et al., 2024). Key features such as smart contracts, traceability, and digital audits make it highly relevant for the fisheries industry, which is vulnerable to IUU (Illegal, Unreported, and Unregulated) fishing practices (Cromwell et al., 2025; Ismail et al., 2023). A study by Galvez et al. (2018) confirms that blockchain-based traceability improves product integrity and market value. SDG 2 targets the eradication of hunger, and SDG 12 promotes sustainable consumption and production. Food security encompasses the availability, access, utilization, and stability of food (Clapp et al., 2022; Guiné et al., 2021). In the fisheries sector, this means products must be consistently available, affordable, nutritious, and safe. Blockchain supports this through data transparency and efficiency (Boumaiza, 2025; Apeh & Nwulu, 2025).

AHP is a multi-criteria decision-making method developed by Akhrouf et al. (2023) and Noviawan et al. (2025). This method is used to compare criteria and alternatives pairwise to generate priority weights. In the context of this research, AHP was used to measure stakeholder preferences for blockchain implementation strategies based on SDGs and food security criteria. Based on the above background, this study aims to analyze the most prioritized blockchain implementation strategies to strengthen food security in the fisheries industry.

Method

This study uses a descriptive-analytical approach with quantitative methods to formulate a priority strategy for implementing blockchain technology in the Indonesian fisheries supply chain. The goal is to support national food security while simultaneously moving this sector closer to achieving the Sustainable Development Goals (SDGs). This approach was chosen because it provides a systematic overview of expert assessments of various technology-based criteria and policy alternatives. As explained by Saaty (2008), the Analytical Hierarchy Process (AHP) method allows researchers to evaluate complex decisions by dividing the problem into a hierarchy, comparing its elements pairwise, and generating priority weights based on participatory rationality.

Interpretation

Strategy A (Product Certification) is the top priority because it is considered the most direct way to support traceability and build trust in the international market; Strategy B (Transparent Logistics) is ranked second because it is considered important for distribution efficiency and transparency; Strategy D (Government System Integration) remains systemically strong, but is considered complex to execute due to the institutional reform involved; Strategy C (Fisherman Training), although important for inclusion, receives the lowest weighting because its impact is considered long-term and indirect on supply chain efficiency.

Analytical Conclusion

Using the AHP method and the participation of 15 respondents across sectors, a ranking of strategies was obtained that can form the basis for policy-making for the gradual and participatory digitalization of the fisheries sector. The blockchain product certification strategy should be considered an entry point, followed by strengthening logistics and digital government systems.

Result and Discussion

Priority Criteria Results

Data Transparency (0.32); Product Traceability (0.28); Supply Chain Efficiency (0.18); Data Security (0.12); Small-Scale Actor Inclusion (0.10). This indicates that key actors consider data transparency and validity to be the most critical aspects of blockchain implementation in the fisheries sector.

Priority Strategy Results

Blockchain Adoption for Product Certification (0.36)

Adopting blockchain for product certification has transformative potential to create more transparent, efficient, and trustworthy supply chains. While there are significant challenges in terms of cost, scalability, and interoperability, this solution offers significant long-term benefits for both producers and consumers. As technology and standards continue to evolve, blockchain is likely to become a fundamental component of future product certification systems (Soori et al., 2023; Banaeian Far et al., 2023).

Logistics Transparency Platform (0.31)

Despite its many benefits, implementing a logistics transparency platform also faces challenges. One of these is the high cost of integration and implementation, especially for smaller companies (Yamoah et al., 2025; Pentek & Letnik, 2025). Furthermore, standardizing data across multiple parties and disparate systems remains a challenge. Data privacy is also crucial, as sensitive logistics information must be properly protected. In the future, these platforms are expected to become more sophisticated with the integration of artificial intelligence (AI) for predictive analytics, which will help identify potential issues before they arise. Closer collaboration between companies and the development of open standards will also encourage broader adoption and create a more transparent and efficient supply chain globally.

Digitalization Training for Fishermen (0.12)

Increasing the use of digital technology in the fisheries sector is a strategic step to improve fishers' welfare and food security. Digitalization training programs for fishers are key to bridging the gap between traditional practices and modern innovations (Abiri et al., 2023; Liang & Qiao, 2025).

Training Objectives and Benefits

This training focuses not only on the use of digital tools but also on a deeper understanding of how technology can improve efficiency and sustainability. The primary goal is to empower fishers with skills relevant to the digital age.

Improved Efficiency and Safety:

The training includes the use of weather forecasting applications, GPS-based navigation, and mapping of fishing zones. This helps fishers plan their trips more safely and effectively, reduces time spent at sea without results, and minimizes the risk of accidents (Zhang et al., 2025; Zemnazi et al., 2024).

Wider Market Access:

This training teaches fishers how to use e-commerce platforms or digital marketplace applications to sell their catch directly to consumers or restaurants. This cuts out the long supply chain, which is often disadvantageous for fishers, and allows them to obtain fairer prices.

Financial and Data Management:

The training also covers digital financial literacy, such as how to use mobile payment applications or record catches and operational costs digitally. This helps fishermen better manage their finances and make smarter, data-driven decisions.

Challenges and Solutions

Despite its significant benefits, the implementation of this training faces several challenges. Limited infrastructure, such as poor internet access in coastal areas, and low digital literacy among fishermen are major obstacles.

Holistic Approach:

To address these challenges, training must be designed with a holistic approach. This involves more than just providing smartphones or apps, but also providing ongoing technical guidance and community support (Gomez et al., 2021; Francis et al., 2020).

Appropriate Curriculum:

The curriculum must be tailored to the specific needs of fishermen, using simple language, and providing plenty of hands-on practice. Involving senior fishermen as mentors can also increase program acceptance and success. Overall, digitalization training for fishermen is a crucial investment that not only increases productivity and income but also builds the resilience of coastal communities for the future.

Integration with Government Systems (0.21)

Strategies A and B were deemed the most technically and practically relevant to support traceability and transparency. The training strategy, although important, was still considered complementary.

Implications for SDGs and Food Security

These findings reinforce the literature that data integrity in supply chains supports responsible consumption and production (SDG 12) and the reliable availability of seafood (SDG 2). Blockchain-based digital certification can boost export markets and reduce illegal products that harm small-scale fishers (Akhtaruzzaman Khan et al., 2022). Research on a hierarchical supply chain management model to support the SDGs and food

security has significant and profound implications. This discussion focuses on how the model can serve as a strategic tool for addressing global challenges and achieving sustainable development goals.

Implications for the Sustainable Development Goals (SDGs)

This model directly contributes to the achievement of several SDGs, particularly SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), and SDG 13 (Addressing Climate Change). Achieving SDG 2 (Zero Hunger): By prioritizing criteria such as increased productivity and reduced food waste, this model helps streamline the supply chain (Olabode et al., 2025); (Setyadi et al., 2025). This ensures that food can be distributed more efficiently from producers to consumers, reduces post-harvest losses, and increases food availability for vulnerable populations. Furthermore, by identifying bottlenecks in the supply chain, this model facilitates targeted interventions to improve food accessibility in remote or less developed areas (Maredia et al., 2024).

Achieving SDG 12 (Responsible Consumption and Production):

This model emphasizes the importance of sustainable production. Through criteria such as efficient resource use and a reduced carbon footprint, the model encourages more environmentally friendly practices throughout the supply chain. This not only minimizes negative impacts on the environment but also encourages companies to adopt more ethical and sustainable production standards.

Achieving SDG 13 (Addressing Climate Change):

The resilience aspect of this model is highly relevant to climate change adaptation. By evaluating criteria such as adaptability to disruptions and supplier diversification, the model helps make supply chains more flexible and resilient. This allows food systems to continue functioning despite natural disasters, extreme weather fluctuations, or other crises exacerbated by climate change.

Implications for Food Security

Food security is at the heart of the proposed model, which emphasizes three key pillars: availability, accessibility, and stability.

Increased Availability:

By optimizing logistics routes and reducing waste, the model directly increases the amount of food products available in the market (Arteaga-Cabrera et al., 2025; Riesenegger et al., 2023). This reduces the risk of scarcity, especially when supply is disrupted by external factors.

Improved Accessibility:

The model can be used to identify economic and physical barriers that hinder food access (Galanakis et al., 2025; Barbosa Junior et al., 2022). By prioritizing infrastructure and policies that support smallholder farmers and local producers, the model helps create a more equitable system where food is more accessible to all segments of society.

Improved Stability:

The analytical hierarchy aspect of the model allows for detailed risk assessment. This allows decision-makers to design systems that are more stable and resilient to shocks. For example, the model can prioritize suppliers that use water conservation technologies in drought-prone areas, or that have contingency plans for flooding. This reduces price and supply volatility that often impacts low-income communities. Overall, the proposed hierarchical model of supply chain management is not simply an analytical tool, but a transformative framework (MacCarthy et al., 2022; Liu et al., 2025). It integrates the complexities of sustainability and resilience into strategic decision-making, providing practical guidance for governments, companies, and non-governmental organizations to build stronger and more sustainable food systems for a better future.

Conclusion

Blockchain is a promising digital strategy for transforming the fisheries sector toward a resilient and sustainable food system. Based on the AHP approach, the most prioritized strategies are implementing blockchain for fishery product certification and providing a transparent logistics platform. A key recommendation is cross-sector collaboration between the government, technology startups, academics, and fishing communities to build an inclusive blockchain ecosystem that adapts to local needs.

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Author Contributions

Conceptualization; methodology; validation; formal analysis; A. W. P.; investigation; resources; data curation; I. J. K. W.; writing—original draft preparation; writing—review and editing; I. W. S.; visualization: I. M. F. All authors have read and approved the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest

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