Egyptian Journal of Aquatic Biology and Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 29(4): 2437 – 2449 (2025)
www.ejabf.journals.ekb.eg

Optimizing the Trash Fish Supply Chain: A Sustainable Model for Marine Fisheries in East Java, Indonesia

Sukoso[1]*, Hartatik Kartikaningsih[1], Tian Nur Ma'rifat[1], Muhammad Zubir[2], Sorbakti Sinaga[1], Eni Sri Rahayuningsih[3], Luai Hana Adilah[4], Yogita Ayu Dwi Susanti[5], Ilham Misbakudin Al Zamzami[6]

[1]Fisheries Product Technology Study Program, Faculty of Fisheries and Marine Science Brawijaya University, Malang 65145, Indonesia
[2]Agriculture Industrial Technology Study Program, Faculty of Fisheries and Marine Science Brawijaya University, Malang 65145, Indonesia
[3]Economic Development Program Trunojoyo University, Madura 69162, Indonesia.
[4]Faculty of Public Health, Brawijaya University, Malang 65145, Indonesia
[5]Aquatic Resources Management Study Program, Faculty of Fisheries and Marine Science, Universitas Brawijaya, Malang 65145, Indonesia
[6] Coastal and Marine Research Center, Universitas Brawijaya, Malang 65145, Indonesia

*Corresponding Author: alislah@ub.ac.id

ARTICLE INFO

Article History:
Received: May 30, 2025
Accepted: Aug. 1, 2025
Online: Aug. 20, 2025

Keywords:
Catch,
Environment,
Sustainable,
Management trash fish

ABSTRACT

The supply chain is a series of processes that connect various stages of production, distribution, and delivery of goods or services from producers to final consumers. Understanding the supply chain enables companies to monitor the quality of raw materials and components used in production, allowing them to take quick action if problems with product quality arise. Several regions, including Tuban, Sidoarjo, and Banyuwangi, have significant potential for producing marine fishery products, with the fisheries sector serving as one of the main pillars of their regional economies. These areas have diverse aquatic environments, ranging from coastal waters to deep-sea areas. This environmental diversity supports various species of fish and marine organisms, resulting in abundant fisheries resources, including trash fish. Trash fish refers to small fish that are caught but are not the primary target of fishermen. This research aimed to develop a supply chain management model for trash fish that ensures high quality and efficiency in line with its intended use. The study utilizes both primary and secondary data. The results indicate sustainability index scores of 63.319 for the environmental dimension, 44.173 for the social dimension, 61.747 for the technological dimension, 45.578 for the economic dimension, and 24.454 for the resource dimension. Overall, the trash fish supply chain in Tuban, Sidoarjo, and Banyuwangi is not yet fully sustainable. Implementing zero-waste management in trash fish processing is essential to optimize utilization, increase added value, and enhance the economic potential of trash fish.

INTRODUCTION

The supply chain is a concept that describes the process of flowing goods, information, and services from the initial producer or supplier to the final consumer **(Kumar *et al.*, 2023)**. Supply chains involve many entities and processes working together to produce, deliver, and support products or services ultimately enjoyed by customers **(Dutta *et al.*, 2020; Bistarelli *et al.*, 2023; Szablewska & Kubacki, 2023)**. Many companies depend on efficient supply chains to run their operations **(Jueseah *et al.*, 2020; Aragão *et al.*, 2022; Bassett *et al.*, 2022; Diaz *et al.*, 2022; Hirokawa & Thompson, 2023; Rowan, 2023)**. Disruptions or problems at any stage of the supply chain can significantly impact companies, and even the economy as a whole **(Grillo-Núñez *et al.*, 2021; Hashim *et al.*, 2021; Soares *et al.*, 2022; Amaralal *et al.*, 2023)**.

In the era of globalization, supply chains often involve entities in various countries, presenting additional challenges in management, communication, and regulation **(Little *et al.*, 2018)**. Understanding the supply chain helps business units identify areas where efficiency can be improved, thereby saving costs and production time **(Parreño-Marchante *et al.*, 2014; Kaminski *et al.*, 2018)**. Business units that understand the supply chain well are better able to adapt to changes in market demand or disruptions **(Oliveira *et al.*, 2021)**. Another critical point is that business units with efficient supply chains can become more competitive by offering products or services at more competitive prices.

Tuban, Sidoarjo, and Banyuwangi are several areas with significant marine fisheries potential, and the fisheries sector is one of the main pillars of their local economies **(Umroh *et al.*, 2020; Putri *et al.*, 2022; Rachman *et al.*, 2022)**. Apart from providing a source of income for fishermen, marine fishery products from these regions are also essential contributors to the supply of fish and fishery products for consumers both inside and outside the area **(Lestari *et al.*, 2019; Khan *et al.*, 2020)**. This region has various aquatic environments, from coastal waters to the deep sea, supporting a diversity of fish species and marine organisms that result in abundant fisheries. These three regions are located on the north coast of East Java, directly bordering the Java Sea and the Madura Strait **(Malisan *et al.*, 2023)**, which provides easy access to waters rich in marine resources **(Anam *et al.*, 2021)**. This potential has resulted in a high production of trash fish.

Trash fish is a term usually used to describe small fish that live in various types of water, including rivers, lakes, swamps, ponds, estuaries, or coastal waters **(Da Costa *et al.*, 2023)**. Classification is often based on where they are found. Trash fish typically have a small body size, less than 15– 20cm, although variations depend on the species **(Hien *et al.*, 2015)**. They are dominated by species with short life cycles, meaning they mature more quickly and reproduce faster **(Bunlipatanon *et al.*, 2014)**. These fish play an ecological role in specific aquatic ecosystems, serving as small predators, detritus feeders, or plankton eaters **(Belton & Thilsted, 2014)**.

Understanding the supply chain in Tuban, Sidoarjo, and Banyuwangi is important because trash fish is the primary source of protein for many communities in the region **(Priatni *et al.*, 2018)**. The availability of trash fish in the supply chain affects local communities' welfare and food security. Knowledge of the trash fish supply chain aids in managing fisheries resources, including fishing practices, marine ecosystem preservation, and conservation efforts to ensure sustainability **(Chiat Lee & Viswanathan, 2019; Sampantamit *et al.*, 2020)**. It can also be used to assess the environmental impact of fisheries.

Moreover, information about the trash fish supply chain is essential for government authorities to develop appropriate regulations and policies **(Sinh *et al.*, 2014; Andrean, 2020; Kurniawan *et al.*, 2025)**. This includes determining catch limits, fishing seasons, quotas, and other measures to maintain sustainable fisheries. Understanding fish supply chains also helps manage risks related to fish stock fluctuations, price changes, natural disasters, or climate change, which can affect the sustainability of fisheries businesses **(Piredda *et al.*, 2023; Tola *et al.*, 2023)**.

This research aimed to produce a supply chain management model for trash fish that ensures good quality and efficiency according to its intended purpose. Similar research has never been conducted in this area, making this study a valuable contribution. The specific objective was to identify the trash fish supply chain in Tuban, Sidoarjo, and Banyuwangi.

MATERIALS AND METHODS

This research was conducted in three locations—Tuban, Sidoarjo, and Banyuwangi—from March to August 2023. Two types of data were used: primary and secondary. Primary data included expert opinions and views regarding the attributes of sustainability indicators, the structure of actors in the fish waste fishery industry supply chain, and information on company operational activities. These data were obtained through questionnaires, expert surveys, interviews, expert panel discussions, and direct field observations **(Sinh *et al.*, 2014; Cao *et al.*, 2015)**. Using these various methods allowed the researchers to gain diverse perspectives on the fish waste supply chain.

Secondary data included information on relevant laws and regulations, statistical reports, program and budget planning documents, studies related to damage in fisheries areas, monitoring and evaluation results, and other supporting materials **(Belton *et al.*, 2018)**.

Stages of the trash fish supply chain

A descriptive approach and situational assessment were used to outline the profile, sustainability, and performance of the trash fish industrial sector. Sustainability indicators were determined through in-depth research, including literature reviews and field observations **(Sinh *et al.*, 2014; Kurniawan *et al.*, 2024b)**.

During the research process, interviews were conducted with stakeholders, and the information obtained formed the basis for brainstorming sessions and discussions with expert sources. This process was repeated multiple times, including the comparison of indicators using the compare-and-contrast method, to reach a final agreement on the type and value of sustainability indicators for the trash fish industry in Tuban, Sidoarjo, and Banyuwangi. These indicators were designed to comprehensively reflect the performance of various aspects of trash fish sustainability.

The sustainability indicator values obtained through interviews and questionnaires were then analyzed using the Rapfish technique (Rapid Appraisal for Fisheries) **(Haridhi *et al.*, 2018; Yasir Haya & Fujii, 2020; Vismann *et al.*, 2022)**. Rapfish relies on ordination techniques using Multi-Dimensional Scaling (MDS). The results of the Rapfish analysis were classified based on index scores and sustainability status, as presented in Table (1).

The data were further processed and evaluated using the Fuzzy AHP method and the SCOR (Supply Chain Operations Reference) approach. The supply chain performance assessment was conducted based on the information shown in Table (2).

Table 1. Index categories and sustainability status

Index Value	Category
0,00-25,00	Not sustainable
25,01-50,00	Not sustainable
50,01-75,00	Quite sustainable
75,01-100,00	Sustainable

Table 2. Trash fish supply chain performance criteria

Performance Value	Criteria
95 -100	Excellent
90 - 94	Above Average
80 - 89	Average
70 - 79	Below average
60 - 69	Poor
< 60	Unacceptable

Stages of designing a trash fish supply chain management model

The trash fish supply chain management model was developed through two steps of the Soft Systems Methodology (SSM):

1. **Evaluation** of the problem situation within the trash fish supply chain.
2. **Identification** of the problem and creation of a comprehensive visual representation.

RESULTS AND DISCUSSION

Situational conditions of the trash fish processing industry

Statistical data and field observations show that most waste in the fish processing industry comes from small- to medium-scale operations, indicating the dominance of micro, small, and medium enterprises (MSMEs). The presence of MSMEs has the potential to provide income to local communities and contribute to regional economic growth. However, this industry faces several challenges, including limited facilities and infrastructure, which can hinder development.

Adequate transportation facilities are critical to support the distribution of trash fish products **(Hien *et al.*, 2015; Piredda *et al.*, 2023)**. The quality of human resources (HR), access to capital, and the capacity of business actors are also key factors for success **(Wang *et al.*, 2016; Howson, 2020; Kurniawan *et al.*, 2024a)**. Training and education are necessary to improve the skills and capacity of workers and business owners in this industry. A stronger focus on commodity development and the waste fish processing sector can increase efficiency and competitiveness. Furthermore, strong institutions and an understanding of social and cultural aspects are essential for managing resources sustainably and maintaining positive relationships with local communities **(Fréon *et al.*, 2014; Al Zamzami *et al.*, 2023)**.

Technological improvements and better processing practices are needed to enhance the quality of trash fish products. With proper training and education, MSMEs in this sector could also develop derivative products from trash fish, thereby increasing their market value.

The research findings reveal the sustainability level of the trash fish fishing industry in Tuban, Sidoarjo, and Banyuwangi. The study involved interviews and brainstorming sessions with various stakeholders, including fishermen, the fishing industry, local governments, and experts. The sustainability index consists of five primary dimensions:

1. **Environmental Dimension** – Evaluates waste management practices, water use efficiency, and the potential volume of liquid waste generated by the fishing industry.
2. **Social Dimension** – Assesses fishermen’s skills and income, the cooperative relationship between fishermen and the fishing industry, and the industry's capacity to employ local workers.
3. **Technological Dimension** – Examines the suitability of technology, the variety of products produced, and the quality of outputs from the fishing industry.
4. **Economic Dimension** – Measures net profit, profit margin, economic contribution, product quality, and the number of businesses involved.
5. **Resource Dimension** – Evaluates the availability, continuity, and quality of raw materials, as well as the sources of raw material supply.

Table 3. Category and sustainability index for each dimension

Dimension	Continuity	Category Index Value
Environment	63,319	Quite sustainable
Social	44,173	Not sustainable
Technology	61,747	Quite sustainable
Economy	45,578	Not sustainable
Resource	24,454	Not sustainable

The sustainability of trash fish in Tuban, Sidoarjo, and Banyuwangi requires assessment across multiple dimensions, including environmental, economic, social, and technical aspects of fisheries. Sustainability experts must collect and evaluate relevant data from each of these dimensions. The outcome is a multidimensional sustainability index, which indicates that trash fish sustainability in the region is currently classified as "less sustainable" (Table 3). This classification suggests the presence of several challenges that require immediate attention, such as implementing stricter regulatory frameworks, introducing sustainable fishing and processing practices, increasing public awareness, and strengthening collaboration with relevant stakeholders. The trash fish supply chain model for Tuban, Sidoarjo, and Banyuwangi is illustrated in Fig. (1).

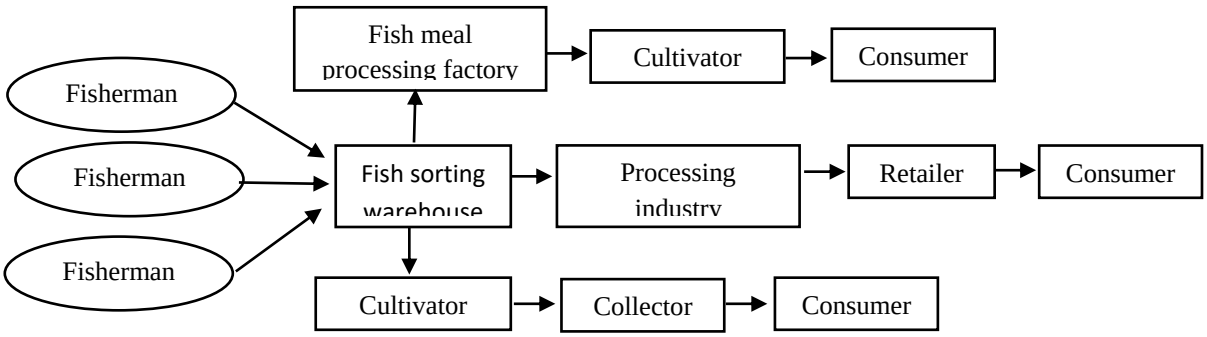

Fig. 1. Trash fish supply chain model in Tuban, Sidoarjo, and Banyuwangi

The results of the expert evaluation using the Fuzzy AHP method for performance measurement show the highest weights at each level as follows:

- **Business process level** – Procurement: 0.474
- **Performance parameter level** – Quality: 0.773
- **Performance attribute level** – Reliability: 0.651
- **Performance matrix level** – On-time arrival: 0.412

These results indicate that arrival punctuality is a key performance factor that must be prioritized in managing the fresh fish supply chain. Furthermore, the high weight for the reliability performance attribute highlights the importance of building and maintaining trust as a central focus of the company's supply chain management strategy.

Ideal model of the trash fish supply chain

Evaluate the problem situation in the trash fish supply chain

A complex situation exists in the fish supply chain of Tuban, Sidoarjo, and Banyuwangi, with several critical problems, including overfishing and the use of environmentally damaging fishing gear. These practices harm fishermen and marine ecosystems, threatening the sustainability of fish resources **(Olopade *et al.*, 2017; Sumaila & Tai, 2020; Al Zamzami *et al.*, 2025)**. Fishermen in these regions often face limited market access and low added value in the fish supply chain, which negatively affects their income.

In addition, inadequate infrastructure and technology hinder improvements in the efficiency of fish production and distribution. Climate change further compounds these challenges with rising sea temperatures, extreme weather events, and increasing ocean acidity affecting fish stocks and causing fluctuating fish prices—making business planning difficult **(Rodrigues *et al.*, 2015; Stewart-Sinclair *et al.*, 2020; Anggayasti *et al.*, 2025)**. These issues directly impact fishing companies and processing SMEs, limiting their ability to secure sufficient quantities of high-quality raw materials and resulting in low-quality fishery products. Consequently, consumer demand for fishery products remains unmet.

The difficulty of addressing these challenges makes it hard to implement fisheries industrialization strategies and promote sustainable fisheries development. The fishing industry in Tuban, Sidoarjo, and Banyuwangi remains unsustainable, with raw material supplies still relying heavily on an order-based system due to difficulties in ensuring a consistent and sustainable supply.

Recognition of the problem and creation of a comprehensive visual representation

Based on the problem situation identified in Stage 1, a cause-and-effect analysis was conducted using diagrams to determine the root causes of issues in the trash fish supply chain in Tuban, Sidoarjo, and Banyuwangi. This analysis revealed several crucial challenges:

1. Limited diversification of processed products made from trash fish.
2. Underdeveloped domestic market for processed trash fish products.
3. Lack of assistance for MSMEs in maintaining and monitoring product quality.
4. The need for halal certification of trash fish products.
5. Limited market development efforts.
6. Insufficient recycling of all types of fish to increase economic value.
7. Limited distribution permits for trash fish products.

The problem situation in the trash fish supply chain is visually represented as a rich picture, as shown in Fig. (2)

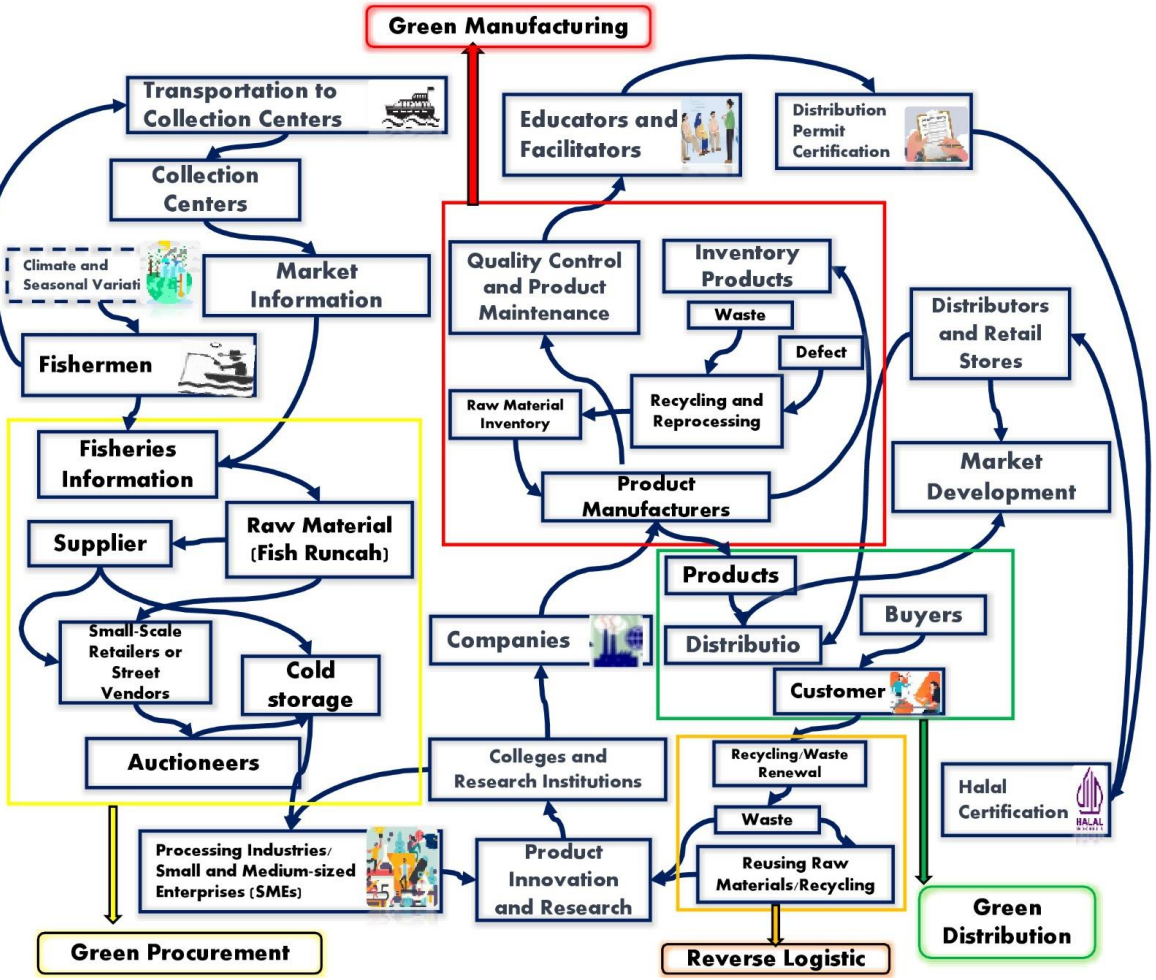

Fig. 2. A rich picture of the trash fish supply chain

The diagram presents an integrated framework for sustainable fisheries supply chain management, highlighting the interconnected roles of green procurement, green manufacturing, reverse logistics, and green distribution.

At the upstream stage, green procurement begins with the collection of fisheries data from fishermen, suppliers, small-scale retailers, vendors, and auctioneers. Raw materials—specifically fish (locally termed *runcah*)—are stored in cold storage facilities before being delivered to processing industries or small and medium-sized enterprises (SMEs). This stage also incorporates market intelligence derived from transportation networks, collection center operations, seasonal climate patterns, and other environmental factors, enabling more accurate demand forecasting and resource allocation.

The green manufacturing stage focuses on environmentally responsible production. Educators and facilitators train stakeholders to ensure compliance with distribution permits and certifications. Quality control and product maintenance are prioritized, supported by close monitoring of raw material inventories. Defective or waste products

are recycled or reprocessed to minimize environmental impact. This closed-loop system integrates product innovation and research from academic and research institutions, ensuring continuous improvement and sustainable production practices.

Reverse logistics ensures that waste generated along the supply chain is effectively managed through recycling, resource renewal, and raw material reuse. Waste return systems link customers back to manufacturers, reducing the supply chain's ecological footprint.

The green distribution stage ensures products reach buyers and retail distributors via environmentally responsible channels. This process is reinforced by halal certification for market compliance and targeted market development strategies. Companies, distributors, and customers are connected in a feedback loop where recovered resources and insights feed back into the production cycle.

Overall, this framework adopts a circular economy approach in the fisheries sector, integrating information flow, material recycling, and sustainable certification to achieve environmental responsibility, product quality, and market competitiveness. It underscores the synergy between stakeholders—from fishermen to end consumers—ensuring that sustainability is embedded throughout the entire supply chain.

CONCLUSION

Based on the research findings, the trash fish supply chain in Tuban, Sidoarjo, and Banyuwangi is classified as less sustainable. Implementing zero-waste management is essential to optimize utilization, increase added value, and maintain the long-term sustainability of trash fish resources.

The study also highlights the importance of providing community assistance, particularly in developing processed food products from trash fish, which have high nutritional content. To enhance marketability, these processed products should obtain both halal certification and quality standard certification to ensure product safety and compliance with regulatory requirements.

Acknowledgement

This research was financially supported by the Faculty of Fisheries and Marine Science Brawijaya University through the Community Fund of the Budget Implementation Document **(**DPA**)** of the Legal Entity State University **(**PTNBH**)** Universitas Brawijaya in the year 2022, under the Professor Grant Scheme with contract number 2429/UN10.F06/PP/2022. The authors would like to express their sincere gratitude for this support.

Conflicts of interest

The authors have no conflicts of interest to declare.

REFERENCES

Al Zamzami, I.M.; Kilawati, Y.; Pramudia, Z.; Susanti, Y.A.D. and Kurniawan, A. (2023). Analysis of microbial abundances in biofilms and water in hypersaline environments with different NaCl levels. *The Journal of Experimental Life Science*, **13**(2):113-121.

Al Zamzami, I.M.; Yona, D. and Kurniawan, A. (2025). Decoding halophilic biofilm development across salinity gradients in hypersaline environments. *Biodiversitas Journal of Biological Diversity*, **26**(6).

Amaralal, K.H.M.L.; Edirimanna, E.M.A.P.; Lakmini, W.A.S.W.; Chamodi, K.K.D.; Kuragodage, A.U.; Sanuja, R.G. and Deepananda, K.A. (2023). Impacts of COVID-19 pandemic on the fisheries sector of Sri Lanka. *Marine Policy*, **147**:105339.

Anam, C.; Harini, N.; Damat, D.; Wahyudi, A.; Witono, Y.; Kuswardhani, N. and Rachmawati, D. (2021). Potential analysis of low economic value fish in Lamongan regency, East Java, Indonesia. *E3S Web of Conferences: 1st International Conference on Bioenergy and Environmentally Sustainable Agriculture Technology (ICoN BEAT 2019): Malang, East Java, Indonesia. EDP Sciences*, **226**:1-12.

Andrean, D. (2020). Supply Chain As a Role Model for Fish Protein. *Jurnal Rekayasa Mesin*, **11**:401–407.

Anggayasti, W.L.; Pramudia, Z.; Susanti, Y.A.; Al Zamzami, I.M.; Moehammad, K.S.; Wardana, I.N.G. and Kurniawan, A. (2025). Epilithic biofilm as a potential biomonitor for microplastics contamination in Brantas River of Malang City, Indonesia. *Case Studies in Chemical and Environmental Engineering*, **11**:101083.

Aragão, G.M.; Saralegui-Díez, P.; Villasante, S.; López-López, L.; Aguilera, E. and Moranta, J. (2022). The carbon footprint of the hake supply chain in Spain: Accounting for fisheries, international transportation and domestic distribution. *Journal of Cleaner Production*, **360**:131979.

Bassett, H.R.; Lau, J.; Giordano, C.; Suri, S.K.; Advani, S. and Sharan, S. (2021). Preliminary lessons from COVID-19 disruptions of small-scale fishery supply chains. *World Development*. **143**:105473.

Bassett, H.R.; Sharan, S.; Suri, S.K.; Advani, S. and Giordano, C. (2022). A comparative study of small-scale fishery supply chains' vulnerability and resilience to COVID-19. *Maritime Studies*, **21**(2):173-192.

Belton, B. and Thilsted, S.H. (2014). Fisheries in transition: Food and nutrition security implications for the global South. *Global Food Security*, **3**(1):59–66.

Belton, B.; Hossain, M.A.R. and Thilsted, S.H. (2018). Labour, Identity and Wellbeing in Bangladesh's Dried Fish Value Chains, **217–241**.

Bistarelli, S.; Faloci, F. and Mori, P. (2023). *-chain: A framework for automating the modeling of blockchain based supply chain tracing systems. *Future Generation Computer Systems*, **149**:679-700.

Bunlipatanon, P.; Songseechan, N.; Kongkeo, H.; Abery, N.W. and De Silva, S.S. (2014). Comparative efficacy of trash fish versus compounded commercial feeds in cage aquaculture of Asian seabass (Lates calcarifer)(Bloch) and tiger grouper (Epinephelus fuscoguttatus)(Forsskål). *Aquaculture Research*, **45**(3):373-388.

Cao, L.; Naylor, R.; Henriksson, P.; Leadbitter, D.; Metian, M.; Troell, M. and Zhang, W. (2015). China's aquaculture and the world's wild fisheries. *Science*, **347**(6218):133–135.

Chiat Lee, W. and Viswanathan, K.K. (2019). Subsidies in the Fisheries Sector of Malaysia: Impact on Resource Sustainability. *Review of Politics and Public Policy in Emerging Economies*, **1**(2):79–85.

da Costa, I.D.; Costa, L.L. and Zalmon, I.R. (2023). Are fishes selecting the trash they eat? Influence of feeding mode and habitat on microplastic uptake in an artificial reef complex (ARC). *Science of The Total Environment*, **904**:166788.

Diaz, F.; Koiro, L. and Romagnoli, F. (2022). Environmental and economic life cycle evaluation of potential energy efficiency measures on Latvian fish supply chain. *Future Foods*, **6**:100203.

Dutta, P.; Choi, T.M.; Somani, S. and Butala, R. (2020). Blockchain technology in supply chain operations: Applications, challenges and research opportunities. *Transportation Research Part E: Logistics and Transportation Review*, **142**:102067.

Fréon, P.; Sueiro, J.C.; Iriarte, F.; Miro Evar, O.F.; Landa, Y.; Mittaine, J.F. and Bouchon, M. (2014). Harvesting for food versus feed: A review of Peruvian fisheries in a global context. *Reviews in Fish Biology and Fisheries*, **24**(1):381–398.

Grillo-Núñez, J.; Mendo, T.; Gozzer-Wuest, R. and Mendo, J. (2021). Impacts of COVID-19 on the value chain of the hake small scale fishery in northern Peru. *Marine Policy*, **134**:104808.

Haridhi, H.A.; Nanda, M.; Haditiar, Y. and Rizal, S. (2018). Application of Rapid Appraisals of Fisheries Management System (RAFMS) to identify the seasonal variation of fishing ground locations and its corresponding fish species availability at Aceh waters, Indonesia. *Ocean and Coastal Management*, **154**:46–54.

Hashim, Z.H.; Azra, M.N.; Noor, M.I.M.; Kasan, N.A. and Tan, S.H. (2021). Impact of COVID-19 on marine fisheries supply chains: Case study of Malaysia. *Advances in Food Security and Sustainability*, **6**:169-210.

Hien, T.T.T.; Dinh, T.D.; Phu, T.M. and Bengtson, D.A. (2015). Assessment of the trash-fish diet for snakehead aquaculture in Vietnam: species composition and chemical characterization. *Asian Fisheries Science*, **28**:165-173.

Hirokawa, T. and Thompson, B.S. (2023). The influence of new sustainable fisheries policies on seafood company practices and consumer awareness in Japan. *Marine Policy*, **157**:105819.

Howson, P. (2020). Building trust and equity in marine conservation and fisheries supply chain management with blockchain. *Marine Policy*, **115**:103873.

Jueseah, A.S.; Knutsson, O.; Kristofersson, D.M. and Tómasson, T. (2020). Seasonal flows of economic benefits in small-scale fisheries in Liberia: A value chain analysis. *Marine Policy*, **119**:104042.

Kaminski, A.M.; Genschick, S.; Kefi, A.S. and Kruijssen, F. (2018). Commercialization and upgrading in the aquaculture value chain in Zambia. *Aquaculture*, **493**:355-364.

Khan, S.; Rehman, A.; Shah, H.; Aadil, R.M.; Ali, A.; Shehzad, Q. ... and Xia, W. (2022). Fish protein and its derivatives: The novel applications, bioactivities, and their functional significance in food products. *Food Reviews International*, **38**(8):1607-1634.

Kumar, A.K.; Aeri, M.; Grover, A.; Agarwal, J.; Kumar, P. and Raghu, T. (2023). Secured supply chain management system for fisheries through IoT. *Measurement: Sensors*, **25**:100632.

Kurniawan, A.; Aziz Amin, A.; Yanuar, A.T.; Pramudia, Z.; Susanti, Y.A.D. and Zamzami, I.M.A. (2024a). Exploring viability and innovation requirements for novel salt production: a case study of Kangen Beach, Malang Regency's South Coast, Indonesia. *Cogent Social Sciences*, **10**(1):2434667.

Kurniawan, A.; Dhea, L.A.; Ulfa, S.M.; Yanuar, A.T.; Al Zamzami, I.M. and Nurjannah. (2025). Assessment of water quality in the upper Brantas River through microplastic-associated biofilms and heavy metal accumulation. *International Journal of Environmental Studies*, **1-23**.

Kurniawan, A.; Pramudia, Z.; Susanti, Y.A.D.; Al Zamzami, I.M. and Yamamoto, T. (2024b). Comparative biosorption proficiency in intact and autoclaved biofilm matrices. *Journal of Ecological Engineering*, **25**(4).

Lestari, E.K.; Komariyah, S. and Nurafiah, S. (2019). The analysis of economic structure based on shift share approach in east java province (Study in minapolitan area). *International Journal of Scientific and Technology Research*, **8**(12):1447-1452.

Little, D.C.; Young, J.A.; Zhang, W.; Newton, R.W.; Al Mamun, A. and Murray, F.J. (2018). Sustainable intensification of aquaculture.