# Household Income Diversification Strategy for Tuna Fishermen in Tehoru District, Central Maluku Regency, Indonesia

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## ABSTRACT

High dependence on fishery resources has an impact on the economic vulnerability of fishermen's households due to seasonal fluctuations, market prices, and environmental changes. This study aimed to identify the socio-economic, technological, and institutional characteristics of fishermen, assess the contribution of tuna fishing to household income, and formulate income diversification strategies for fishermen in Tehoru District, Central Maluku Regency. The study was conducted in January–March 2024 in Haya and Tehoru Villages, involving 40 respondents selected through purposive sampling. Data collection methods included surveys, in-depth interviews, observations, and secondary data review. The results showed that fishermen were dominated by the productive age group (21–40 years), with secondary education and 6–10 years of work experience. Fishing technology is still traditional with handlines, and fishing activities are highly dependent on the season. The contribution of tuna fishing to total household income reached 88.2%, while diversification through fish processing (5.28%) and non-fishery businesses such as plantations and services (6.52%) functioned as a buffer during the lean season. Recommended strategies include environmentally friendly technology training, diversification of processed products, strategic partnerships, and integration of marine tourism. Sustainability efforts require multi-party collaboration to strengthen economic adaptation and fishermen's resilience to environmental changes.

## INTRODUCTION

The fisheries sector in the Maluku region plays an important role in the local and national economy. The abundant wealth of marine resources makes it one of the fish-producing areas in Indonesia. Among the various types of fish produced, tuna is one of the leading commodities that not only has high economic value but also contributes to the provision of food, creates jobs and supports the fish processing industry. Central Maluku

Regency, especially Tehoru District, is one of the tuna-producing areas because it borders directly on the Banda Sea Waters which have long been known as a location for catching and producing tuna. 90.87% of fisheries households in Central Maluku Regency are engaged in the capture fisheries sector with a total production of 157,819 tons per year or contributing 30.43% of the total regional production **(BPS Provonsi Maluku, 2022)**. This production and income contribution comes from small-scale fishermen in the Banda Sea utilization area of 95% **(Haruna *et al.*, 2018; Haruna, 2021)**. As many as 63.74% of the population in Tehoru District are engaged in the fishing sector with tuna as the main commodity that supports the community's economy as well as a source of income for fishermen's households **(BPS, Maluku Tengah, 2024)**.

The great potential in Tehoru District, Central Maluku Regency has not been fully utilized optimally, tuna fishermen face various multidimensional challenges that affect the dynamics of their income. Most small-scale fishing households still rely on traditional fishing, have limited skills, and face a lack of capital support and inadequate business management. As a result, the income of fishermen's households is still in the lowest category **(Satria, 2020)**. In addition, various studies show that coastal communities are very vulnerable to poverty. These vulnerability factors include low access to financial capital, unfair fisheries profit sharing systems, limited infrastructure, technology, institutions, knowledge, innovation, problems of business efficiency and productivity, the impact of seasons and climate change **(Jacques, 2015; Cintra *et al.*, 2017; Nainggolan *et al.*, 2019; Haruna, 2021; Tauda *et al.*, 2021)**. On the ecological side, less environmentally friendly fishing technology without good management has also triggered a decline in catches of up to 30% in the last five years. This condition is exacerbated by climate change, such as rising sea temperatures and shifts in fishing seasons **(Bakti *et al.*, 2022; Haruna *et al.*, 2023; N'Souvi *et al*, 2024)**.

In the economic sector, fishermen's dependence on middlemen who control 80% of the supply chain has caused the selling price of tuna at the producer level to be depressed by half **(Royandi, 2019)**. Fluctuations in tuna prices in the global market fluctuate significantly, minimal access to markets, cold storage technology, and business capital are a threat to fishermen's households in poverty **(Sukiyono *et al.*, 2020; Sahara *et al.*, 2022)**. Limited skills and business management, as well as low participation of women and the younger generation in post-harvest processing, also further weaken the economic resilience of fisheries households **(Satria & Matsuda, 2004)**.

Economic vulnerability in the fisheries sector in Tehoru sub-district will significantly affect the stability of household income of fishermen, so it is important to find solutions that can increase income and sustainability of tuna fishermen's businesses in this area. Income diversification is an important solution for tuna fishermen to reduce dependence on one source of income. Given the risks associated with fluctuations in catches and tuna prices, diversification can provide economic stability for fishermen. Several studies have shown that diversification in the fisheries sector in small countries

significantly improves the local economy and affects the socio-economic resilience of coastal communities (**Henichart *et al.*, 2010; Mitu *et al.*, 2021; Roscher *et al.*, 2022**). Efforts have ben made to empower local communities through active involvement, implementation of a community participation-based resource management system, and increasing independent capacity in optimizing existing resources (**Hahury *et al.,* 2025**). This research was conducted because there is still a lack of information that specifically discusses diversification strategies for tuna fishermen in Tehoru District.

This study aimed to identify the socio-economic, technological, and institutional characteristics of fishermen, assess the contribution of fishing to fishermen's household income, and formulate strategies for diversification and sustainability of tuna fishermen's income in Tehoru District. This study is expected to be a reference for policy makers in formulating programs that support the development of the fisheries sector in Central Maluku.

Although the concept of income diversification for fishermen has been widely studied, most studies still focus on macroeconomic aspects or technical approaches alone, without considering the local context and specific types of fisheries such as tuna handline. Diversification studies that focus on tuna fishermen's households in remote areas such as Tehoru District are still very limited, even though this area has a strategic role as a center for tuna production in the Banda Sea. In addition, there have not been many studies that integrate socio-economic, institutional, and ecological aspects in formulating adaptive strategies based on local potential. Therefore, this study provides a novel contribution with a holistic approach to developing income diversification strategies that not only rely on the economic sustainability of fishermen's households but also strengthen social resilience and adaptation to climate change in the eastern coastal areas of Indonesia.

However, to date, there has been no comprehensive study that specifically examines income diversification strategies for small-scale tuna fishing households in Tehoru District by integratively considering socio-economic, institutional, and ecological aspects. Therefore, this research is essential to identify the key factors influencing fishermen's economic resilience and to formulate locally based diversification strategies aimed at reducing economic vulnerability caused by environmental changes and market fluctuations.

## MATERIALS AND METHODS

### Time and location of the research

This research was conducted from January to March 2024. The research location is in Tehoru District, Central Maluku Regency, which focuses on villages that have a dominant number of Tuna handline fishermen, namely Haya Village and Tehoru Village.

**Data collection method**

This study used a descriptive method, while for data collection a survey technique was used. The sample locations were Haya Village and Tehoru Village selected by purposive sampling on the consideration that these villages are the villages with the most fishermen households for tuna fishing fishermen. The determination of the number of respondents of fishermen households in each village was selected using the Slovin equation with a margin of error of 20% **(Usman & Setiady, 2008)**. The total number of respondents was 40 fishermen, with 19 from Tehoru Village and 21 from Haya Village. Determination of respondents in each sample village was carried out using proportional sampling techniques. In addition, key informants such as fishermen figures and cooperative administrators were selected purposively through snowball sampling techniques to obtain in-depth information.

Data collection through surveys using structured questionnaires were filled out by respondents with researcher assistance to minimize errors. The questionnaire included variables of fishermen's characteristics including fishermen's profiles, fishing fleet assets, business activities, production, handling of catches and marketing. Fishermen's household income contributions include household income based on the type of main job as a fisherman or a side job and business challenges. On the qualitative side, data were also collected through in-depth interviews with open-ended question guide to explore adaptation strategies, supply chain dynamics, participation of vulnerable groups, and field observations to document fishing activities and environmental conditions. Secondary data were obtained from fisheries service documents, local institutional reports, and literature related to sustainable fisheries policies.

Before being used in field research, the questionnaire instrument and interview guide were validated through expert judgment by two academicians with expertise in fisheries socioeconomics. In addition, a limited pilot test was conducted with five fishermen outside the study area to ensure the clarity of the questions and consistency of the responses. Instrument revisions were made based on the results of the pilot test to enhance the validity and reliability of the data.

**Data analysis**

The types of data used include quantitative data and qualitative data with primary and secondary data sources. The collected data were analyzed descriptively. The analysis of the income contribution of tuna handline fishermen used the formula proposed by **Latief** *et al.***(2021)** as follows:

$$A = B/C \times 100\%$$

Where: A = Fisherman's Contribution; B = Fisherman's Income; C = Total Fisherman's Household Income. The criteria for fishermen's income contribution were as follows:

- If the contribution of capture fishermen's income is <25% of the fishermen's household income, it is categorized as very low.

- If the contribution of capture fishermen's income is 25-49% of the fishermen's household income, it is categorized as low.
- If the contribution of capture fishermen's income is 50-75% of the fishermen's household income, it is categorized as high.
- If the contribution of capture fishermen's income is >75% of the fishermen's household income, it is very high.

The sustainability strategy of tuna fishing household income was analyzed using the SWOT (Strengths, Weaknesses, Opportunities, Threats) approach. This analysis aims to systematically identify internal factors (strengths and weaknesses) and external factors (opportunities and threats) that affect the sustainability of Fisherman Household income. Furthermore, the relationship between internal and external factors was evaluated through the SWOT matrix **(Rangkuti, 2005)** to formulate realistic, adaptive, and sustainable strategic recommendations for fisher households in the study area.

## RESULTS AND DISCUSSION

### 1. Socio-economic, technological and institutional characteristics of tuna handline fishermen

Table (1) shows that the social conditions of most tuna fishermen in Tehoru District are in the productive age group of 21-40 years (62.5%) which is a key factor in increasing the productivity and income of fishermen's households **(Nainggolan *et al.*, 2021)**. The majority of fishermen have a secondary or higher education background (45%) and 6–10 years of work experience (55%), reflecting adequate work capacity, local skills, and depth of knowledge of aquatic ecosystems. However, the absence of fishermen under 20 years old and the low participation of the 51–60 age group (5%) indicate challenges in workforce regeneration and the risk of early retirement due to the burden of physical work.

The relatively high level of education opens up opportunities for the development of sustainable fishing technology training and business management, but incentives such as access to capital or entrepreneurship programs are needed to attract the interest of the younger generation. On the other hand, strengthening institutions through fishermen groups and health support for elderly fishermen are critical steps to ensure the sustainability of household income and sustainable fishing practices. The combination of productive age and work experience has the potential to increase technical skills, collaborative attitudes, and productivity that have an impact on fishermen's welfare **(Metekohy, 2020)**.

Tuna fishermen in Tehoru District operate boats made of fiber reinforced plastic with two types of engines, 50% using a 15 HP short-shaft outboard engine (size 8.3m x 1.26m x 60.3cm) and 50% using a 9.5 HP long-shaft outboard engine (size 7.2m x 0.9m x 60cm). The boat is equipped with a deck for fishing operations, a cool box for storing fish, and a room to protect the engine and fishing gear. The main fishing gear is a

handline consisting of a main line (Dolphin nylon no. 60-80), branch line (Superwata nylon no. 150), spool, hook (tuna hook no. 03/04 or no. 07 made by fishermen), and weights.

**Table 1.** Social conditions of tuna fishermen in Tehoru District

| Age (years) | | |
|---|---|---|
| Description | Amount (People) | Percentage (%) |
| <20 | 0 | 0.0 |
| 21-40 | 25 | 62.5 |
| 41-50 | 13 | 32.5 |
| 51-60 | 2 | 5.0 |
| **Educational Strata** | | |
| Description | Amount (People) | Percentage (%) |
| Elementary School | 7 | 17.5 |
| Junior High School | 15 | 37.5 |
| Senior High School | 18 | 45.0 |
| **Experience (years)** | | |
| Description | Amount (People) | Percentage (%) |
| >5 | 5 | 12.5 |
| 6-10 | 22 | 55.0 |
| 11-15 | 7 | 17.5 |
| 16-20 | 4 | 10.0 |
| >21 | 2 | 5.0 |

Fishermen fish around fish aggregating devices (FADs) or follow schools of dolphins, using both natural and artificial bait. Fishing operations begin at midnight with squid bait collection before heading to the FAD location, which determines travel distance. When targeting dolphins, fishermen block the school's movement while deploying baited fishing rods with squid or live fish—unlike the stationary method used at FADs. The entire process, including preparation, catching, handling the catch, and selling, is completed within a single day.

Tuna catches were processed with a cold chain to maintain freshness. Large yellowfin tuna (>20kg) were filleted into 4 parts, separated from the head and bones, then put into airtight plastic to prevent contact with water. Small yellowfin tuna (<20kg) and skipjack tuna were sold in the form of WGG (Whole Gillet and Gutted). All catches were stored in tightly closed containers. Tuna fillets were marketed in pieces, while small fish were sold as a whole.

Fishing activities are influenced by seasonal patterns. During the dry season (April–September), rough seas and large waves reduce fishing intensity, impacting income stability. In contrast, the rainy season (October–March) brings calmer waters, making it the peak fishing period and a time of higher earnings for fishermen. Fishermen maximize fishing efforts during the fishing season ranging from 17-20 trips/month, while in other months, categorized as not the fishing season, it drops to 9-10 trips/month. Despite

extreme weather challenges, fishermen continue to adapt to maintain productivity and safety at sea **(Sangadji & Muspida, 2019)**. The peak of fishing is due to the fulfillment of optimal conditions for both sea surface temperature and chlorophyll-a concentration, thus creating an ideal environment for tuna to feed and there is stability in the weather and ocean currents **(Haruna *et al.*, 2019)**.

Fishermen's catches consist primarily of yellowfin tuna (70%), followed by bigeye tuna (10%), skipjack tuna (10%), and bycatch species including *Coryphaena hippurus*, marlin, and mackerel tuna (10%). Upon landing, the catch is transported directly to company-owned weighing and sales facilities. Pricing follows a graded system: tuna fillets command IDR 55,000/kg for grade A/B, IDR 37,000/kg for grade B, and IDR 25,000/kg for grade C. Whole small tuna and skipjack tuna fetch lower prices, ranging from IDR 12,000/kg to IDR 15,000/kg. Fig. (1) illustrates this sales process.



**Fig. 1.** The process of selling tuna catches in Tehoru District

Fishermen's institutions in Tehoru District, Central Maluku, are generally united in fishermen's groups or fisheries cooperatives that play a role in regulating fishing activities, distribution of catches, and access to markets. This group also functions as a coordination forum to face challenges such as fish price fluctuations and seasonal changes **(Haruna *et al.*, 2023)**. In addition, fishermen groups also work together with the local Marine and Fisheries Service in empowerment programs, such as training in environmentally friendly fishing technology and fish processing. However, the main challenges include minimal access to capital, limited cold chain infrastructure, and lack of participation of the younger generation in traditional institutions **(Siahainenia *et al.*, 2021)**. A study by **Roscher *et al.* (2022)** emphasized the importance of strengthening community-based institutions to support the ecological and economic sustainability of fishermen such as in the coastal areas of Maluku.

## 2.  Household income of fishermen

Based on data from 40 fishermen, the fishermen's household respondents showed that 100% of respondents depended on their main income or revenue from the type of business as tuna handline fishermen and the type of activity related to fish, namely the salted fish processing business "tuna cakalang banda" (67.5%) which is generally managed by the fishermen's wives (Table 2). The gender-based livelihood strategy of female fishermen plays an important role in strengthening the household economy through side businesses **(Trivianti & Zulkarnain, 2022)**. However, they also develop diversification of other economic activities through gardening efforts on clove plants and durian plants (62.5%). These side economic activities not only utilize local resources but also support economic stability during the lean season or when catches decrease, demonstrating the creative adaptation of fishermen in maintaining the sustainability of family livelihoods.

**Table 2.** Sources of household income for tuna fishermen

| No | Type of Business | Tehoru Village | Haya Village | Total | % |
|----|------------------|:--------------:|:------------:|:-----:|:---:|
| 1 | Tuna handline fishermen | 19 | 21 | 40 | 100 |
| 2 | Activities related to fish "Processed salted fish" | 12 | 15 | 27 | 67.5 |
| 3 | Other economic activities (Gardening clove plants and durian plants) | 11 | 14 | 25 | 62.5 |

The study found that the estimated average income earned by fishing households that only do fishing is IDR 522,750 per trip, thus providing an estimate per year (Fig. 2). In Fig. (2), the income distribution shows that the income of fishing households is dominated by tuna fishing using hand lines, which is in the very high category, contributing IDR 142,000,000 (88.2%) of the total income of IDR 161,000,000. As shown in Fig. (2), the contribution of tuna handline fishing amounts to IDR 142,000,000 per year, or 88.2% of the total household income of fishermen, while the fish processing sector and other economic activities contribute only to 5.28 and 6.52%, respectively. This activity is the backbone of the fishermen's economy, especially during the fishing season, when the catch is abundant and the selling price of tuna loin and fish logs is relatively stable. Outside the main sector, the processing of salted fish "cakalang banda" provides an additional contribution of IDR 8,500,000 (5.28%) which is generally managed by fishermen's wives to utilize excess catches or small fish. Non-fishery economic activities such as clove and durian gardening, or services contribute to IDR 10,500,000 (6.52%), although the scale is still very limited. Fishing is the main source, but it will be at risk to economic stability if there is a decrease in fish stocks or price fluctuations **(Efani** *et al***, 2024)**. The finding that 88.2% of household income relies on tuna handline fishing underscores the urgent need to accelerate business diversification efforts to mitigate fishermen's economic risks related to resource fluctuations and market instability.
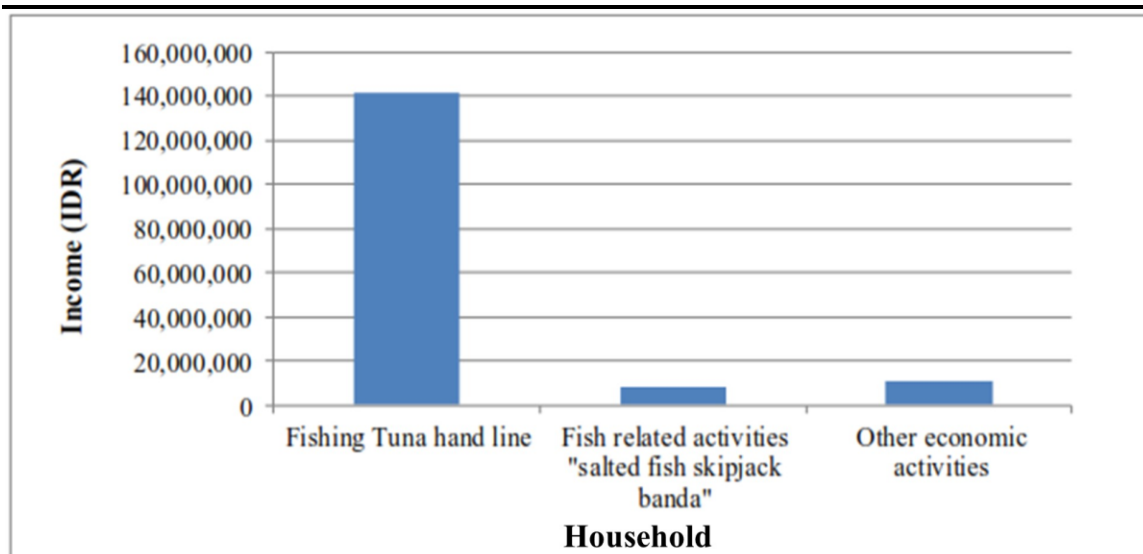
**Fig. 2.** Average contribution of household income of fishermen in the study area

The fluctuation of fishermen's income is closely tied to the fishing season, posing a significant challenge to the sustainability of household economies in coastal communities. While fishermen may earn a relatively high income during peak seasons, their earnings often decline sharply during off-seasons when fish production decreases. This income instability not only disrupts household cash flow but also hampers the ability to finance subsequent fishing activities. Consequently, fishermen's families become vulnerable to economic hardship and may struggle to meet basic needs during periods of low income. This phenomenon emphasizes the importance of income diversification strategies and strengthening the local financial system to reduce dependence on the fluctuating fisheries sector. Therefore, side activities such as fish processing and non-fishing businesses play an important role as economic buffers, especially outside the fishing season; this is in line with the concept of livelihood diversification, namely diversification of local resources is the key to household economic resilience **(Sikhunyana *et al*, 2020; Pical & Rahman, 2025)**. The importance of strengthening diversification to reduce vulnerability and ensure the sustainability of fishermen's livelihoods is remarkable.

## 3. Sustainability strategy for fishermen's household income in Tehoru District

Tehoru District has the potential of natural resources including large tuna fishery resources, but faces internal and external challenges in maintaining the sustainability of fishermen's household income. The following internal and external factor variables have been identified:

1) Internal factors include strengths such as: abundant natural resources in the Banda Sea, traditional skills of fishermen passed down from generation to generation, business diversification (gardening, salted fish processing), and community

solidarity that facilitates collaboration. On the other hand, the main weaknesses include dependence on fishing seasons, limited infrastructure (ports, storage), and minimal access to education and capital. The contribution of fishing to household income reaches 82.7%, while other sectors such as gardening (7.9%) are still not optimal, thus emphasizing the need for risk mitigation strategies.

2) External factors provide opportunities, such as government support through training programs and capital assistance, utilization of digital technology for marketing, development of marine tourism, and ecolabel certification, to increase the competitiveness of fishery products. However, threats such as climate change that disrupts fish migration, over-exploitation, changes in fish price policies and competition with large fishing industries also act as obstacles.

3) Analysis of the EFAS Score matrix (3.85) which is higher than IFAS (3.56) shows that external opportunities can be maximized to overcome internal weaknesses, thus placing the main strategy in the SO (Strengths-Opportunities) quadrant which combines internal strengths with external opportunities as seen in the IE matrix (Fig. 3).

4) Priority strategies include: (1) increasing the capacity of fishermen through environmentally friendly technology training and diversification of processed products (tuna meatballs, shredded fish, canned); (2) market expansion through strategic partnerships with industry and government, supported by ecolabel certification; (3) utilization of government incentives for infrastructure improvements and adoption of digital technology; and (4) integration of marine tourism as an alternative source of income. These efforts aim to reduce dependence on fishing seasons, increase added value of products, and open wider market access.

5) Recommendation: Effective strategy implementation requires multi-stakeholder collaboration among government agencies, educational institutions, and NGOs, focusing on three critical areas: (1) providing access to capital through microcredit programs, (2) delivering business management training, and (3) establishing data-driven fish stock monitoring systems. Economic diversification should be pursued through complementary livelihood development and climate change adaptation initiatives, ensuring alignment with sustainable fishing practices. For Tehoru's fishermen, this integrated approach can simultaneously maintain productivity and build climate-resilient economies while preserving marine resources. However, revitalizing coastal island economies faces complex challenges, demanding coordinated policy implementation between central/regional governments, private sector engagement, and community-based resource management. Such collaboration is vital to mitigate persistent poverty **(Sangadji, 2020; Sangadji & Duwila, 2020)** while balancing ecological and economic sustainability.
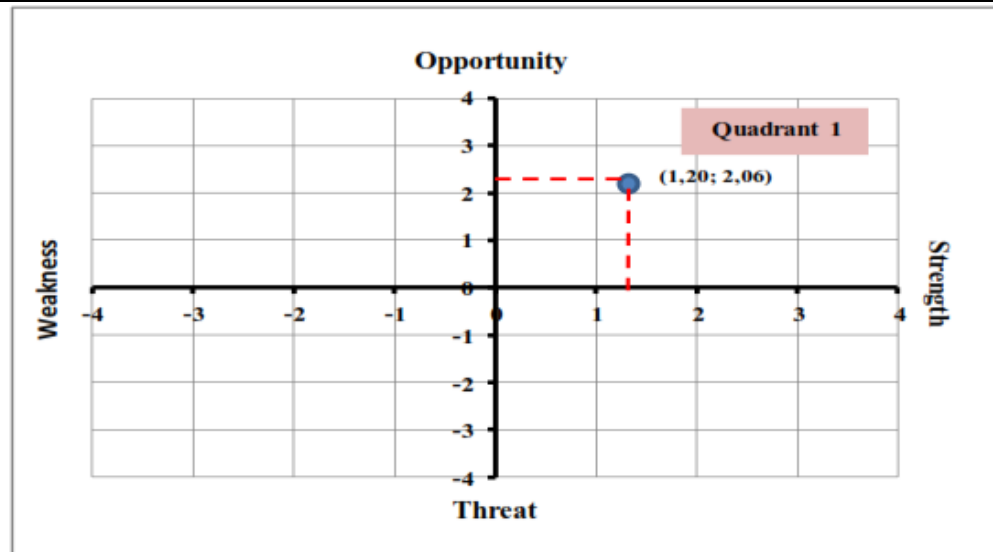
**Fig. 3.** Internal-external matrix (IE)

## CONCLUSION

This study shows that tuna fishing households in Tehoru District are still highly dependent on capture fisheries as their main source of income, with a contribution of 88.2%. The characteristics of fishermen are dominated by the productive age group (21–40 years), secondary education level and above, and 6–10 years of work experience. However, they face structural challenges such as low workforce regeneration, limited supporting infrastructure, and dependence on seasons and weather.

The fishing technology used is still traditional, while economic diversification activities such as processing of catches and plantation businesses have not been maximized. The proposed sustainability strategy includes training in environmentally friendly technology, diversification of processed tuna products, strengthening institutions and partnerships with industry and government, and integration of the marine tourism sector as an alternative source of income.

This research provides an important contribution in formulating an integrated approach based on local context to strengthen the economy of fishermen in coastal areas. The success of this strategy depends on multi-stakeholder collaboration in providing access to capital, business management training, and strengthening institutions and adaptation to climate change. Thus, a diversification approach designed in a participatory manner can be the key to building socio-economic resilience of tuna fishermen sustainably in the archipelago.

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