Navigating archipelagic constraints: price volatility and marketing efficiency of small pelagic fish in Biaro Island

Jardie A. Andaki, Djuwita R. R. Aling, Jeannette F. Pangemanan

Fisheries Agribusiness Study Program, Faculty of Fisheries and Marine Sciences, Sam Ratulangi University, Manado, Indonesia. Corresponding author: J. A. Andaki, jardieandaki@unsrat.ac.id

https://doi.org/10.67784/1020

Abstract. Small pelagic fisheries are vital to the economic resilience of coastal communities in archipelagic regions, yet they face distinctive challenges associated with isolation and logistical constraints. This study analyzes price volatility, supply chain structure, and marketing efficiency of small pelagic fish (*Decapterus macarellus*, *Selaroides leptolepis*, and *Euthynnus affinis)* on Biaro Island, Siau Tagulandang Biaro (SITARO) Regency, Indonesia. Using a mixed-methods approach, data were collected through "grand tour" observations and interviews with 30 purposively selected fishermen and 8 traders identified through snowball sampling. Descriptive qualitative analysis was used to map the supply chains, while quantitative analysis was used to calculate farmer's share, marketing margins, and revenue-cost (R/C) ratios. The results reveal a complex, multi-tiered supply chain involving fishermen, collectors, intermediaries, and industrial consumers, which increases distribution costs and weakens fishermen's bargaining position. The findings indicate substantial price volatility driven by seasonality, weather conditions, and industrial demand. Although the average Farmer's Share of 74.5% indicates that fishermen receive a relatively high proportion of the final consumer price and an R/C ratio >1 indicates profitable marketing activities, disparities in profit distribution persist, with intermediaries capturing higher margins than primary producers. These findings show that high marketing efficiency does not necessarily translate into economic equity for island-based fishermen and indicate the need for policy interventions to shorten supply chains and improve market access in remote island settings.
Keywords: bargaining power, distribution channels, farmer's share, inter-island logistics, market access, profit distribution.

Introduction. Indonesia, as the world's largest archipelagic state, relies heavily on small-scale fisheries (SSF) as a critical pillar of food security and the economic resilience of coastal communities. Because of their abundance and affordability, small pelagic fish serve as a major source of protein and an important economic commodity for millions of households. However, the potential of these marine resources is often constrained by the distinctive geographical characteristics of the archipelago. Unlike continental fisheries, island-based fisheries face severe connectivity challenges, often referred to as the "island penalty", whereby remoteness and isolation result in high transportation costs and logistical complexity (Baldacchino, 2005).

In remote islands, the distribution of perishable commodities such as fish is strongly influenced by supply chain efficiency. The separation between production centers on remote islands and consumption centers in urban areas often results in substantial market inefficiencies (Crona et al., 2010). These inefficiencies are exacerbated by price volatility, a common feature of fishery markets driven by seasonality, weather conditions, and fluctuations in catch volume (Purcell et al., 2017). On many of Indonesia's outer islands, fishermen have limited bargaining power because of information asymmetry and restricted access to wider markets, making them vulnerable to price shocks (Ferse et al., 2012). Therefore, understanding the interactions among price fluctuations, supply chain mechanisms, and marketing efficiency is not merely an economic exercise but an important step toward ensuring sustainable livelihoods for island communities.

Biaro Island, situated within the Siau Tagulandang Biaro (SITARO) Archipelago, provides a representative case of these dynamics. Although the island is characterized by high productivity in small pelagic fisheries, particularly *D. macarellus* and *Selaroides leptolepis*, local fishermen continue to face difficulties in maintaining stable incomes because of unpredictable market prices and multi-tiered distribution channels. Previous studies have focused largely on biological stock assessments of pelagic fish in North Sulawesi (Manik, 2009), yet research on the socio-economic dimensions of marketing efficiency in this specific remote-island context remains limited.

To address this gap, this study aims to analyze price volatility, map the distribution channels, and evaluate the marketing efficiency of small pelagic fish on Biaro Island. Specifically, it examines market structure at the village, sub-district, and district levels to identify bottlenecks in the distribution process. By integrating qualitative data on supply chain actors with quantitative measures of marketing margins and farmer's share, this study provides a comprehensive overview of the island's fishery economy. The findings are intended to provide strategic insights for policymakers and stakeholders in formulating interventions to enhance market access and improve the welfare of fishermen in archipelagic regions.

Material and Method. This study was conducted on Biaro Island, approximately 80 nautical miles from Manado, the capital of North Sulawesi, Indonesia, from March 2025 to November 2025. Five villages served as sampling sites: Tope, Lamanggo, Karungo, Dalinsaheng, and Buang (Figure 1).

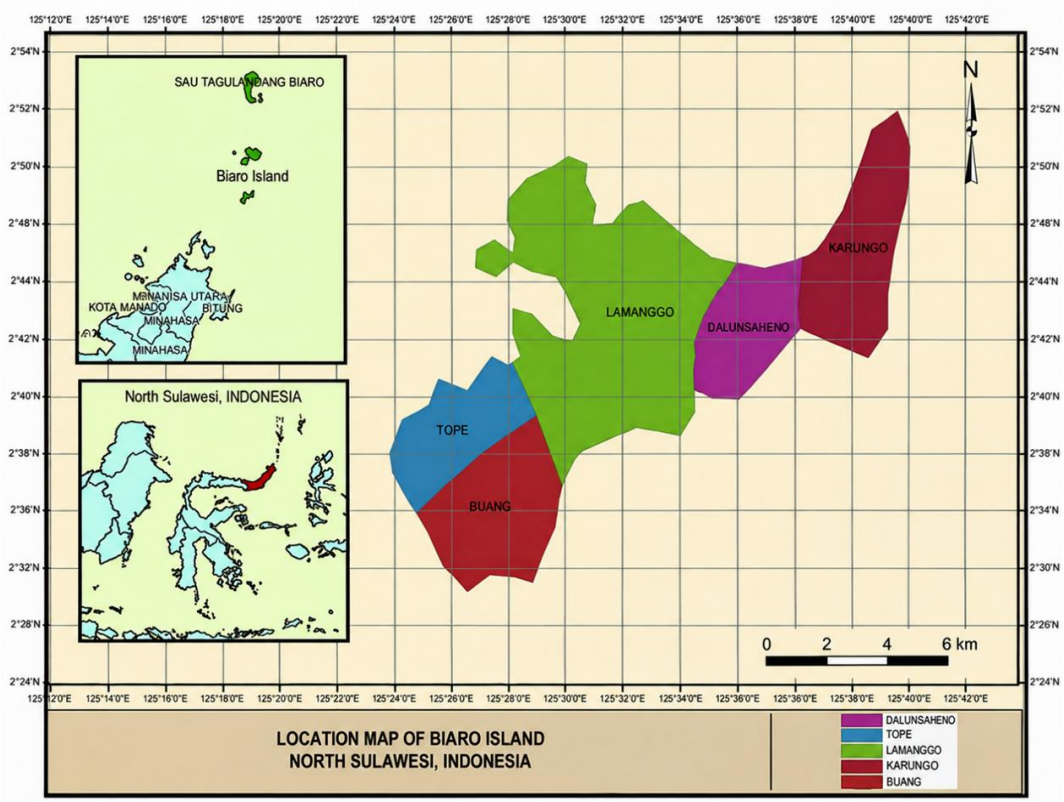


Figure 1. The five villages used as research locations.

This study combined qualitative and quantitative approaches to examine social phenomena with specific meanings (Sugiyono, 2019). In qualitative research, the population is conceptualized as a social situation consisting of actors, places, and activities. This study focused on fishermen and small pelagic fish marketing institutions, with a population of 212 fishermen (SITARO Regency Fisheries Service). A total of 30 fishermen were selected using purposive sampling. Marketing institutions were sampled using the snowball sampling method, resulting in 8 collecting traders: 4 at the Village level, 2 at the Sub-district level, and 2 at the Regency/City level.

The study used both primary and secondary data. Primary data were obtained through direct observation and interviews. Secondary data were obtained from the SITARO Regency statistics agency to support the analysis.

Data analysis. Data analysis was conducted concurrently with data collection through documentation, observation, and interviews, beginning with a direct field "grand tour". Data from observations and interviews were reduced, organized, and interpreted in accordance with the research objectives. The study employed two forms of data analysis, as follows:

- qualitative descriptive analysis was used to describe the relationships and distribution processes among actors in the small pelagic fish supply chain. This analysis involved reviewing the information obtained during data collection, summarizing the findings, and presenting the results based on the factual evidence collected without altering the original information;
- quantitative analysis was conducted to measure the performance of the small pelagic fish supply chain using farmer's share, marketing margin, and revenue–cost (R/C) ratio analyses. Microsoft Excel was used to process the data for the supply chain performance analysis.

Analysis of farmer's share. Farmer's share analysis was used to determine the proportion of the market price received by fishermen by comparing the price at the fishermen's level with the price at the trader or market level. Farmer's share is an analytical tool used to assess marketing efficiency from the perspective of fishermen's income. Farmer's share analysis can be applied to fishermen, although the concept was originally used more commonly in the agricultural sector. The principle remains relevant because it determines the percentage of the final consumer price received by fishermen. The farmer's share formula for fishermen is (Asmarantaka, 2012):

$$FS = \frac{P_n}{P_k} \times 100$$

where: FS = farmer's share (%);
P_n = price received by fishermen (e.g., the price of fish at the fishermen's level);
P_k = price paid by the final consumer (e.g., the price of fish at the market or supermarket)

The higher the farmer's share value, the greater the proportion of the final price received by fishermen, indicating a more efficient supply chain. Conversely, a low value indicates a large marketing margin, which may result from distribution costs, trader profits, or supply chain inefficiencies. A farmer's share value greater than 50% indicates that the marketing system can be considered efficient.

Marketing margin analysis. Marketing margins indicate market conditions at different institutional levels, particularly at the fisherman and final-consumer levels (Asmarantaka, 2012). Marketing margins reflect the income of the marketing institutions involved and are expressed as the difference between the purchase price and the selling price at each institutional level. Mathematically, the marketing margin can be formulated as follows:

$$\text{Marketing Margin (Mi)} = Psi - Pbi$$

where: MI = marketing margin at the i-th level;
Psi = selling price at level i;
Pbi = purchase price at level i.

Revenue-cost ratio analysis. The R/C ratio was used to assess the profitability of marketing activities by comparing total revenue with total cost. An R/C ratio > 1 indicates that total revenue exceeds total cost and that the marketing activity is profitable. This ratio does not, by itself, establish an equitable distribution of profits among supply chain actors. The ratio was calculated as follows (Asmarantaka, 2012):

$$R/C = \frac{TR}{TC}$$

where: R/C = revenue-cost ratio;
TR = total revenue (IDR kg^{-1});
TC = total cost (IDR kg^{-1}).

Results and Discussion

General condition of the research location. The study was conducted in Biaro Subdistrict, which is part of the administrative region of the Siau Tagulandang Biaro Archipelago Regency, North Sulawesi Province, Indonesia. Biaro Subdistrict comprises five villages with a total land area of 19.19 km² (Table 1).

Table 1

Villages of Biaro Subdistrict by village area and percentage of subdistrict area

No.	*Village/Sub-district*	*Total area (km^2)*	*Percentage of district area*
1	Buang	3.41	17.77
2	Lamanggo	5.58	29.08
3	Dalinsaheng	2.46	12.82
4	Karungo	4.94	25.74
5	Tope	2.80	14.59
	Biaro District	19.19	100.00

Source: Communication and Information Service of Siau Tagulandang Biaro Islands Regency (2024).

Geographically, Biaro Subdistrict is situated in a strategic coastal zone. To the north, it faces Tagulandang Island, while to the south and west it is bordered by the Sulawesi Sea. To the east, the subdistrict opens directly onto the Maluku Sea. This location places Biaro at the intersection of two major marine ecosystems, giving it ecological and socio-economic significance for fisheries and coastal resource management.

In 2023, Biaro Subdistrict had a recorded population of 3,388 people. This figure included both permanent and non-permanent residents. Buang Village had the largest population, with 1,012 residents.

Supply chain structure of small pelagic fish. The small pelagic fish supply chain on Biaro Island reflects complex relationships among actors that influence prices, margins, and market access. The supply chain consists of fishermen as primary producers, intermediary traders, collectors, industrial consumers, and traditional market consumers. Each actor has a distinct but interconnected role, while profit distribution remains uneven. Fishermen, as primary producers, occupy the weakest bargaining position because of limited market access and dependence on collectors. This situation is consistent with Oppier et al. (2024), who emphasized that small-scale fishermen in archipelagic regions often have limited livelihood assets and access to distribution channels, making supply chain efficiency difficult to achieve.

Intermediary traders serve as the initial link between villages and regional distribution centers, while wholesalers control wholesale distribution to major markets and processing industries. End consumers are divided into two segments: the processing industry (fish factories in Bitung) and regional traditional markets. This diversification of marketing destinations may help stabilize demand, but it also increases price disparities among distribution points. FAO (2024b) highlights the importance of upgrading aquatic food value chains, reducing post-harvest losses, and improving market access for small-scale producers. In the present study, the involvement of multiple intermediaries was associated with increased distribution costs and unequal profit distribution. This finding is supported by Kahar et al. (2023), who reported similar problems in the fish supply chain at Paotere Port in Makassar, including high distribution costs and the dominance of wholesalers in price determination.

The structure of the small pelagic fish supply chain in Biaro District is presented in Table 2, which identifies five categories of supply chain actors, their main roles, and their

distribution locations. Fishermen serve as primary producers, while intermediary traders connect fishing communities in Buang Village with distribution centers in Likupang. Collector traders facilitate further distribution to markets in Bitung, while industrial consumers and traditional market consumers represent the main marketing destinations. This structure illustrates the involvement of multiple intermediaries in fish distribution, which may contribute to increased marketing costs and reduced bargaining power among fishermen.

Table 2

Supply chain structure of small pelagic fisheries in Biaro District

No.	*Supply chain actors*	*Main role*	*Distribution location*
1	Fisherman	Major producers	Buang Village, Biaro
2	Intermediary trader	Initial connector	Buang Village → Likupang
3	Collector trader	Large distribution	Healthy Market, Bitung
4	Industrial consumers	Processing	Bitung Fish Factory
5	Market cnsumers	Direct consumption	Regional traditional market

Source: primary data processing (2025).

From an economic perspective, supply chain length creates a multiplier effect on distribution costs. Each additional intermediary increases the price margin, but this does not necessarily translate into improved welfare for fishermen. Conversely, collectors and industrial consumers obtain greater profits because they have broader market access and a greater ability to manage price risk. This situation illustrates an asymmetric distribution of profits, in which profits are not distributed equitably. According to Ode et al. (2023), collectors play a dominant role in determining pelagic fish prices in local markets, often leaving fishermen as price takers.

This supply chain structure indicates the need for strategies to shorten the distribution chain. One possible solution is the establishment of fishermen's cooperatives as collective institutions that can strengthen fishermen's bargaining position. Through cooperatives, fishermen can market their catch directly to processing plants or industrial consumers without passing through numerous intermediaries. This strategy can both increase fishermen's profit margins and reduce distribution costs. Kotler & Keller (2016) emphasized that supply chain efficiency can be achieved through vertical integration and price transparency, enabling each actor to receive a fairer share of the profits.

The use of digital technology in marketing is another important factor. Low digital literacy among fishermen in Biaro is a barrier to accessing modern markets. However, integrating digital marketing can expand direct market access and reduce dependence on middlemen. A study by Oppier et al. (2024) showed that strengthening fishermen's capacity through management and information technology training can improve supply chain efficiency and profit distribution. Therefore, policies that strengthen fishermen's capacity, provide distribution infrastructure (cold storage and refrigerated transportation), and shorten the supply chain will be important for improving the marketing efficiency of small pelagic fish on Biaro Island.

Overall, the small pelagic fish supply chain in Biaro reflects the typical challenges of Indonesia's capture fisheries system: long distribution chains, weak bargaining power among fishermen, and the dominance of middlemen. However, appropriate policy interventions, such as fishermen's cooperatives, digital marketing integration, and the provision of distribution infrastructure, can improve supply chain efficiency. These interventions can ultimately improve fishermen’s welfare and support the sustainability of fisheries businesses in the archipelago.

Price fluctuations and volatility analysis*.* Monthly price data for small pelagic fish from 2023-2024 show substantial variation, particularly for mackerel scad (*D. macarellus*). To strengthen the analysis, standard deviation (SD) was calculated as an absolute measure of volatility, while the coefficient of variation (CV) was calculated as a relative measure of price variation around the average.

Based on Table 3, mackerel scad had the highest average price (IDR 17,500/kg), with a standard deviation of IDR 5,590/kg. The coefficient of variation of 31.94% indicates relatively high price volatility, although mackerel scad was relatively more stable than yellowstripe scad (*S. leptolepis*) and eastern little tuna (*Euthynnus affinis*). The relatively high average price of mackerel scad in Biaro reflects the market conditions observed in this study. More broadly, FAO (2024a) reports developments in international markets and trade of small pelagic fish.

Table 3

Calculation of standard deviation and coefficient of variation on price fluctuations of small pelagic fish in Biaro District

Year	*Types of fish*	*Average (Rp/kg)*	*Standard deviation (Rp/kg)*	*Coefficient of variation (%)*
2023	Mackerel scad	17,500	5,590	31.94
2023	Yellowstripe scad	9,583	3,190	33.30
2023	Eastern little tuna	9,583	3,190	33.30
2024	Mackerel scad	17,500	5,590	31.94
2024	Yellowstripe scad	10,083	3,330	33.03
2024	Eastern little tuna	9,917	3,330	33.60

Source: primary data processing (2025).

Yellowstripe scad had lower average prices (IDR 9,583–10,083/kg), but its coefficient of variation exceeded 33%. Thus, although the average price was lower, the level of fluctuation relative to the mean was higher than that of mackerel scad. This condition indicates that yellowstripe scad and eastern little tuna are more vulnerable to seasonal changes in supply and market demand. According to Quezada-Escalona et al. (2025), high volatility in small pelagic fish is often associated with ecological dynamics, such as fishing seasons, and distribution factors, such as logistics costs.

A comparison of 2023 and 2024 shows a relatively consistent pattern. Average prices remained relatively stable, but volatility remained high. This finding indicates that price fluctuations are not merely an annual phenomenon but are part of the market structure for small pelagic fish in this region.

From a marketing perspective, high price volatility directly affects fishermen's income. When prices fall sharply, for example to IDR 5,000/kg for eastern little tuna in February–March, fishermen's profit margins are severely reduced. Conversely, collectors and industrial consumers are better able to manage risk because they have access to wider markets. Sobariah & Herlambang (2025) emphasized that unequal profit distribution further weakens the bargaining position of small-scale fishermen. This quantitative analysis of volatility reinforces the argument that the marketing efficiency of small pelagic fish depends not only on supply chain structure but also on price stability. Therefore, policy strategies should focus on:

- market diversification to reduce the effects of seasonal fluctuations;
- provision of cold storage facilities so that fishermen can delay sales when prices are low;
- integration of digital marketing to expand direct market access.

Thus, controlling price volatility is important for improving marketing efficiency and the welfare of fishermen on Biaro Island.

Figure 2 presents the monthly price dynamics of mackerel scad, yellowstripe scad, and eastern little tuna during 2023-2024, together with the level of volatility indicated by standard deviation.

Figure 2 further illustrates the price fluctuations and the factors associated with them, as follows:

- mackerel scad appears to be the most stable, with an average price of IDR 17,500/kg, although price spikes occurred in February, October, and December;
- yellowstripe scad and eastern little tuna showed sharper fluctuations, with prices falling to as low as IDR 5,000/kg during certain periods;

- the error bars confirm relatively high volatility (CV > 30%), indicating considerable price risk for fishermen.

Figure 2 illustrates clear seasonal patterns and price risks. This evidence reinforces the argument that policy strategies should focus on market diversification, the provision of cold storage, and direct access to distribution channels to reduce the effects of price fluctuations on fishermen.

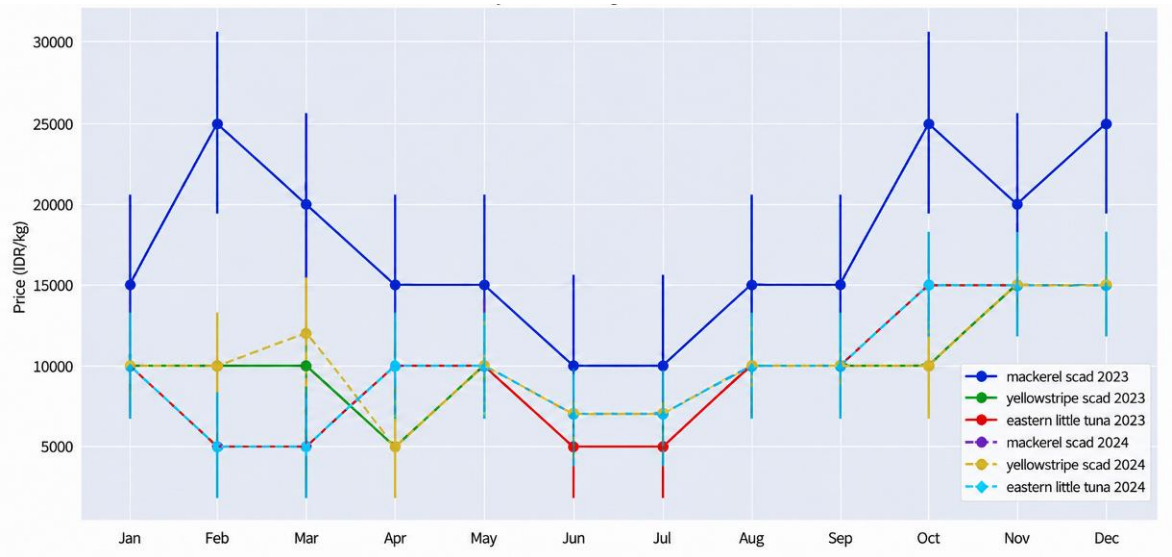


Figure 2. Monthly price fluctuations of mackerel scad (*Decapterus macarellus*), yellowstripe scad (*Selaroides leptolepis*), and eastern little tuna (*Euthynnus affinis*) in Biaro District during 2023-2024.

Marketing efficiency through profit margin and distribution analysis. The marketing efficiency of small pelagic fish in Biaro Subdistrict can be assessed using price margins at each distribution point. These margins reflect the additional costs incurred in the logistics process as well as the profits earned by traders along the supply chain. The data in Table 4 show that price margins increase with distribution distance: IDR 5,000/kg from Buang Village to Likupang, IDR 10,000/kg from Likupang to Bersehati Market, and IDR 15,000/kg from Likupang to the Bitung Factory. This pattern confirms that longer distribution chains generate larger margins, but these higher margins do not necessarily translate into improved fishermen's welfare.

Table 4

Distribution points and price margins of small pelagic fish in Biaro District

Distribution Point	*Price Margin (Rp/kg)*
Buang Village → Likupang	5,000
Likupang → Healthy Market	10,000
Likupang → Bitung Factory	15,000

Asymmetric distribution of profits. Fishermen, as the primary producers, receive the lowest prices, while collectors and industrial consumers capture the greatest added value. This pattern indicates an asymmetric distribution of profits, in which returns are not distributed equitably. According to Sobariah & Herlambang (2025), this phenomenon is common in Indonesia's fisheries marketing system, where collectors have greater control over pricing and distribution. Consequently, fishermen often remain price takers with little ability to determine their selling prices.

Marketing efficiency and supply chain length. Marketing efficiency is closely related to the length of the supply chain. As the number of intermediaries increases, price margins rise while efficiency declines because of higher transaction costs. This pattern is consistent with FAO findings (2020), which state that long supply chains in small pelagic

fisheries increase logistics costs and reduce distribution efficiency. Kahar et al. (2023) also found at Paotere Port in Makassar that long supply chains create price disparities between fishermen and final consumers, keeping fishermen's profits low even when market prices rise.

Price transparency and vertical integration. The margin analysis indicates a need for greater price transparency and vertical integration within the supply chain. Price transparency enables fishermen to understand the added value created at each distribution point and strengthens their ability to seek a fairer share of profits. Vertical integration, for example through fishermen's cooperatives, can shorten the supply chain and increase direct access to industrial markets. According to Kotler & Keller (2016), vertical integration within the supply chain is an effective strategy for improving efficiency and promoting a more equitable distribution of profits.

The role of fishermen's cooperatives. Fishermen's cooperatives can help improve profit distribution. Through cooperatives, fishermen can sell their catch directly to processing plants or industrial consumers, thereby bypassing numerous intermediaries. This strategy can increase fishermen's profit margins while reducing distribution costs. Solihin (2024) emphasized that fishermen's corporations are mandated by the 2020-2024 National Medium-Term Development Plan (RPJMN), which aims to strengthen fishermen's economic institutions through vertical integration and price transparency.

Digital marketing as innovation. In addition to cooperatives, the use of digital technology in marketing is an important factor. Low digital literacy among fishermen in Biaro limits their access to modern markets. However, digital marketing integration can expand direct market access and reduce dependence on middlemen. Ardiatika et al. (2023) showed that implementing digital-based supply chain risk management in Bangka Belitung increased distribution efficiency and reduced losses caused by price fluctuations. Therefore, strengthening fishermen's capacity through digital marketing training is a relevant strategy.

Policy implications. Price margin analysis shows that the marketing efficiency of small pelagic fish depends not only on supply chain structure but also on how profits are distributed among actors. Therefore, policies that support shorter supply chains, price transparency, and stronger fishermen's capacity through cooperatives and digital marketing are essential. These strategies can improve distribution efficiency, stabilize consumer prices, and support fishermen's welfare.

Obstacles and challenges faced by business actors. Business actors in the small pelagic fish sector, particularly fishermen in Biaro Subdistrict, face various structural constraints that affect marketing efficiency. Based on Table 5, limited distribution infrastructure, including cold storage and refrigerated transportation, results in high logistics costs.

Table 5

Main obstacles and impact on small pelagic fishing business in Biaro District

No.	*Main obstacles*	*Impact*
1	Limited distribution infrastructure	High logistics costs
2	Seasonal price fluctuations	Fishermen's income is unstable
3	Fishermen's bargaining position is low	Dependence on collectors
4	Low digital literacy	Barriers to marketing innovation
5	Minimal regeneration of young workforce	Business continuity risks

Seasonal price fluctuations reduce fishermen's incomes, while their bargaining power remains weak because of dependence on middlemen. Low levels of digital literacy and education also constrain marketing innovation. Limited regeneration of the young workforce poses risks to business sustainability.

According to Muslim et al (2023), small-scale fishermen in Indonesia face challenges such as limited market access and dependence on intermediary traders. This situation highlights the need for policy interventions that support capacity building among fishermen. Several policy recommendations can therefore be proposed to improve marketing efficiency and the welfare of fishermen.

Based on Table 6, shortening the supply chain through fishermen's cooperatives can strengthen producers' bargaining power. Training in business management and digital marketing can improve fishermen's capacity to access modern markets. Providing distribution infrastructure, such as cold storage and refrigerated transportation, can reduce logistics costs. Logistics subsidies and access to capital can support business sustainability. Programs to regenerate the young workforce are also important for attracting a new generation to the fisheries sector.

Kotler & Keller (2016) emphasized that supply chain efficiency can be achieved through vertical integration and price transparency. With appropriate policies, fishermen's welfare can be improved, marketing efficiency can be enhanced, and the sustainability of fisheries businesses on Biaro Island can be strengthened.

Table 6

Policy recommendations and objectives for small pelagic capture fisheries businesses in Biaro District

No.	*Policy recommendations*	*Objective*
1	Shortening the supply chain	Increasing prices at the fishermen level
2	Management & digital marketing training	Increasing the capacity of fishermen
3	Cold storage & transportation infrastructure	Reducing distribution costs
4	Logistics subsidies & capital access	Supporting business sustainability
5	Young workforce regeneration program	Attracting a new generation to the fisheries sector

Supply chain length and marketing margin. The small pelagic fish marketing system in Biaro Subdistrict shows variation in supply chain structure among villages. Mapping identified two main distribution channels. The first channel involves more intermediary institutions: fishermen → village-level collectors → sub-district-level collectors → district-level collectors → factory/export. The second channel is shorter: fishermen → sub-district-level collectors → factory/export. These differences in the number of intermediaries have direct implications for marketing margins and distribution efficiency.

Based on Table 7, villages with longer supply chains, such as Karungo, Tope, and Lamanggo, have higher marketing margins (26.8-28.1%) but lower efficiency (71.9-73.2%). Conversely, villages with shorter supply chains, such as Dalinsaheng and Buang, have lower margins (18.9-19.3%) but higher efficiency (80.7-81.1%). This pattern indicates that longer supply chains impose greater transaction costs on consumers, while fishermen continue to receive a relatively small share of the price. Zelasney et al. (2020) documented various approaches to strengthening small-scale fisheries value chains, improving market access, and enhancing the economic opportunities of fishers. In the present study, longer distribution channels were associated with higher marketing margins and lower marketing efficiency.

Marketing margins reflect the price difference between fishermen and final consumers. High margins in villages with long supply chains indicate that middlemen earn greater profits. However, these profits are not distributed equitably because fishermen remain in a weak bargaining position. According to Sobariah & Herlambang (2025), this pattern is referred to as an asymmetric distribution of profits, in which middlemen dominate price determination and profit distribution. This condition adversely affects the welfare of small-scale fishermen who depend on middlemen.

Marketing efficiency is measured by the marketing margin as a percentage of consumer prices. Villages with shorter supply chains show higher efficiency because of lower distribution costs. A study by Kahar et al. (2023) at Paotere Port in Makassar found a similar pattern: shorter supply chains increase marketing efficiency and provide greater

profits for fishermen. Thus, shortening the supply chain is an important strategy for improving the welfare of fishermen in Biaro.

Table 7
Supply chain structure and marketing margins of small pelagic fish in five villages on Biaro Island

Village	*Dominant marketing channels*	*Number of intermediary institutions*	*Marketing margin (%)*	*Marketing efficiency (%)*
Karungo	Fishermen–Local Collectors–Inter-Island Traders–Consumers	3	27.5	72.5
Dalinsaheng	Fishermen–Inter-Island Traders–Consumers	2	19.3	80.7
Tope	Fishermen–Local Collectors–Inter-Island Traders–Consumers	3	26.8	73.2
Buang	Fishermen–Inter-Island Traders–Consumers	2	18.9	81.1
Lamanggo	Fishermen–Local Collectors–Inter-Island Traders–Consumers	3	28.1	71.9

Source: primary data processing (2025).

The analysis of supply chain length and marketing margins has important policy implications. First, shortening the supply chain through fishermen's cooperatives is necessary to promote more efficient distribution and fairer profit allocation. Second, price transparency at each distribution point should be improved so that fishermen can understand the added value generated by intermediaries. Third, digital marketing technology can expand direct market access and reduce dependence on middlemen. According to Ardiatika et al. (2023), implementing digital-based supply chain risk management in Bangka Belitung can improve distribution efficiency and reduce losses caused by price fluctuations.

Beyond the economic dimension, supply chain length also affects the sustainability of fisheries businesses. Long supply chains increase the risk of resource waste because of high logistics costs and inefficient distribution. Conversely, shorter supply chains support sustainability through faster distribution, lower costs, and a more equitable distribution of profits. Solihin (2024) emphasized that fishermen's corporations are one strategy for achieving sustainable capture fisheries businesses through vertical integration and institutional strengthening.

Fishermen's bargaining position. The farmer's share value represents the proportion of the consumer price received by fishermen. A value above 70% indicates that fishermen receive a relatively high proportion of the final consumer price; however, this does not necessarily imply strong price-setting power.

Based on Table 8, the average farmer's share of 74.5% indicates that fishermen in Biaro receive a relatively high proportion of the final consumer price (Asmarantaka, 2012). The average farmer's share of 74.5% indicates that fishermen in Biaro Island received a substantial proportion of the final consumer price. This finding is broadly consistent with the study conducted by Isukadana et al. (2021) on the marketing of scad (*Decapterus* sp.) in Pengambengan Village, Bali, which reported farmer's share values of 71% and 59% for two-level and three-level marketing channels, respectively. The comparison suggests that shorter marketing channels tend to provide fishermen with a greater proportion of the final consumer price. Nevertheless, a relatively high farmer's share does not necessarily imply stronger bargaining power or equitable profit distribution, particularly when fishermen remain dependent on intermediary traders. These findings underscore the importance of strengthening direct market access and reducing unnecessary intermediaries to improve the economic benefits received by small-scale fishermen.

Measurement of marketing efficiency using the farmer's share approach showed that, in the first channel, the share of the price received by fishermen was 63.74% in 2023 and 63.75% in 2024. In the second channel, the corresponding values were 79.96% in 2023 and 79.84% in 2024.

The calculation of the economic efficiency of small pelagic fish marketing yielded an R/C value > 1, indicating that each village obtained a net profit from marketing activities.

Table 8

Farmer's share value in five villages on Biaro Island (%)

Village	*Price at fisherman's (Rp/kg)*	*Consumer price (Rp/kg)*	*Farmer's share (%)*	*Efficiency category*
Karungo	20,000	27,500	72.7	Efficient
Dalinsaheng	21,500	28,200	76.2	Efficient
Tope	20,200	27,800	72.7	Efficient
Buang	21,600	28,000	77.1	Efficient
Lamanggo	20,300	27,600	73.6	Efficient
Average			74.5	Efficient

Source: primary data processing (2025).

Based on Table 9, the R/C ratio ranged from 1.31 to 1.40, indicating profitable marketing activities across all five villages.

Table 9

Revenue-cost (R/C) ratio of small pelagic fish marketing in five villages in Biaro Subdistrict

Village	*Total cost (Rp/kg)*	*Total revenue (Rp/kg)*	*R/C ratio*	*Information*
Karungo	24,000	31,500	1.31	Efficient
Dalinsaheng	23,500	32,000	1.36	Efficient
Tope	23,800	31,900	1.34	Efficient
Buang	23,200	32,400	1.40	Efficient
Lamanggo	23,600	32,000	1.36	Efficient

Source: primary data processing (2025).

Based on Table 9, the R/C ratios of small pelagic fish marketing activities ranged from 1.31 to 1.40 across the five study villages. Since all ratios exceeded 1.00, the findings indicate that marketing revenues were sufficient to cover the associated costs, suggesting that these activities were economically profitable. However, profitability alone does not necessarily indicate a high level of marketing efficiency, as it does not fully reflect the distribution of economic benefits among supply chain actors. Aryani & Rosiana (2024) demonstrated that fish marketing efficiency can be evaluated more comprehensively by considering marketing margins, fishermen's share, and profitability indicators. Therefore, the R/C ratios obtained in the present study should be interpreted in conjunction with marketing margins and farmer's share to provide a more comprehensive assessment of marketing performance and the distribution of economic benefits among fishery supply chain participants.

Analysis of marketing margins - the difference between the selling price and purchase price at each level - showed that the main marketing costs affecting margins were inter-island logistics, cold storage, and fish handling at the district-collector level. Logistics and storage costs contributed relatively little to the total price but still affected the margins.

The distribution of margins among marketing actors shows that fishermen receive a substantial share, particularly in the second channel. The involvement of village-level collectors in the first channel tends to reduce fishermen's share compared with the second channel. District- and regency-level collectors account for most of the marketing margin.

Temporal patterns indicate persistent seasonal price fluctuations, with coefficients of variation exceeding 30%, indicating substantial price volatility throughout the study period.

Quantitative analysis using Microsoft Excel to calculate farmer's share, marketing margins, and the revenue-cost ratio showed that the small pelagic fish marketing system on Biaro Island was efficient. Both distribution channels had Farmer's Share values > 50%, indicating that fishermen obtained an adequate share of the consumer price.

Conclusions. Based on the results and discussion, the following conclusions were drawn:

- layered supply chain structure: the small pelagic fish supply chain in Biaro involves multiple actors (fishermen, middlemen, collectors, industrial consumers, and traditional markets). This multi-tiered structure increases distribution costs and weakens fishermen's bargaining power;
- substantial price fluctuations: prices of mackerel scad, yellowstripe scad, and eastern little tuna show high volatility associated with fishing seasons, weather, industrial demand, and distribution costs;
- effects of price volatility on fishermen: standard deviation and coefficient of variation indicate considerable price risk, particularly for fishermen without direct market access;
- unequal distribution margins: collectors and industrial consumers earn higher profits than fishermen. Margins increase as the supply chain becomes longer, reducing marketing efficiency;
- marketing efficiency and profitability: the average farmer's share of 74.5% indicates that fishermen receive a relatively high proportion of the final consumer price, while R/C ratios > 1 indicate profitable marketing activities. However, disparities in profit distribution among actors persist

Acknowledgements. The authors would like to express their sincere gratitude to the Faculty of Fisheries and Marine Sciences, Sam Ratulangi University, and all fishermen, traders, and stakeholders who participated in and supported this research.

Authors Contributions. JAA: conceptualization, research methodology, investigation, data analysis, and writing of the original manuscript; DRRA: investigation, data collection, interpretation of research findings, and manuscript review and editing; JFP: research methodology, data analysis, interpretation of results, and manuscript review and editing. All authors have read and approved the final version of the manuscript.

Conflict of Interest. The authors declare that there is no conflict of interest.

Data Availability. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Funding. This research was financially supported by Sam Ratulangi University through its Research and Community Service funding program (Contract No. 787/UN12.27/LT/2025).

References

Ardiatika, Y., Mahjoub, M. B., & Novieningtyas, A. (2023). The application of supply chain risk management assessment in small-scale fisheries in Bangka Belitung, Indonesia using probabilistic risk analysis (PRA) method. *Jurnal Manajemen Indonesia, 23*(3), 332-349. https://doi.org/10.25124/jmi.v23i3.6773

Asmarantaka, R. W. (2012). [Agribusiness marketing (agrimarketing)]. Department of Agribusiness, Faculty of Economics and Management, Bogor Agricultural University, Bogor, Indonesia, 435 pp. [in Indonesian]

Aryani F., & Rosiana, N. (2024). [Marketing analysis to improve the efficiency of capture fish markets]. *Jurnal Ilmiah Membangun Desa dan Pertanian, 9*(1), 45-53. https://doi.org/10.37149/jimdp.v9i1.755 [in Indonesian]

Baldacchino, G. (2005). The contribution of 'social capital' to economic growth: lessons from island jurisdictions. *The Round Table, 94*(1), 31-46. DOI: 10.1080/00358530500033075
Crona, B., Nyström, M., Folke, C., & Jiddawi, N. (2010). Middlemen, a critical social-ecological link in coastal communities of Kenya and Zanzibar. *Marine Policy, 34*(4), 761-771. https://doi.org/10.1016/j.marpol.2010.01.023
FAO (2024a). International markets for fisheries and aquaculture products. Fourth issue 2024, with January–June 2024 statistics. GLOBEFISH Highlights No. 4-2024, FAO, Rome. 100 pp. https://doi.org/10.4060/cd3727en
FAO (2024b). The state of world fisheries and aquaculture 2024. Blue transformation in action. FAO, Rome, 264 pp. https://doi.org/10.4060/cd0683en
Ferse, S. C. A., Knittweis, L., Krause, G., Maddusila, A., & Glaswer, M. (2012). Livelihoods of ornamental coral fishermen in South Sulawesi/Indonesia: implications for management. *Coastal Management, 40*(5), 525-555. https://doi.org/10.1080/08920753.2012.694801
Isukadana, D. D. A., Restu, I. W., & Negara, I. K. W. (2021). Marketing channels efficiency analysis of scad (*Decapterus* sp.) catches of traditional fishermen in Pengambengan Village, Jembrana, Bali. *Advances in Tropical Biodiversity and Environmental Sciences, 5*(1), 34-39. https://doi.org/10.24843/ATBES.2021.v05.i01.p06
Kahar, K., Amiluddin, & Tahang, H. (2023). [A study of the fish supply chain at the Paotere Fishing Port of Makassar City]. *Jurnal Ponggawa, 3*(1), 28-41. https://doi.org/10.35911/ponggawa.v3i1.18660 [in Indonesian]
Kotler, P., & Keller, K. L. (2016). Marketing management. 15th edition. Pearson Education, 692 pp.
Manik, H. M. (2009). Quantification of tuna fish target strength using quantitative echo sounder. *E-Jurnal Ilmu dan Teknologi Kelautan Tropis, 1*(1), 33-38. https://doi.org/10.29244/jitkt.v1i1.7936
Muslim, A. I., Fujimura, M., Kazunari, T., & Salam, M. (2023). Small-scale marine fishers' possession of fishing vessels and their impact on net income levels: a case study in Takalar District, South Sulawesi Province, Indonesia. *Fishes, 8*(9), 463. https://doi.org/10.3390/fishes8090463
Ode, R., Nanlohy, A. C., Hehanussa, K. G., Tuhumury, J., & Tuapetel, F. (2023). [Characteristics of small pelagic fish marketed at Arumbai Market, Ambon City]. *Amanisal: Jurnal Teknologi dan Manejemen Perikanan Tangkap, 12*(2), 78-85. https://doi.org/10.30598/amanisalv12i2p78-85 [in Indonesian]
Oppier, H., Ramly, F., Matdoan, A., & Hahury, H. D. (2024). [Livelihood assets and the efficiency of supply chain-value chain model of small pelagic capture fisheries of coastal communities of Saparua Island]. *Jurnal Kebijakan Sosial Ekonomi Kelautan dan Perikanan, 141*(1), 65-79. http://dx.doi.org/10.15578/jksekp.v14i1.13609 [in Indonesian]
Purcell, S. W., Crona, B. I., Lalavanua, W., & Eriksson, H. (2017). Distribution of economic returns in small-scale fisheries for international markets: a value-chain analysis. *Marine Policy, 86*, 9-16. https://doi.org/10.1016/j.marpol.2017.09.001
Quezada-Escalona, F. J., Tommasi, D., Kaplan, I. C., Hernvann, P. Y., Frawley, T. H., Garcia, D., Ibaibarriaga, L., Sánchez-Maroño, S., de Moor, C., Beckensteiner, J., Schueller, A. M., Feijó, D., Ciorciaro, D., Kurota, H., Oliveros-Ramos, R., Wildermuth, R. P., Mroch, R., Wise, L., Baker, R. R., Hansen, C., Hemed, S. A., Brochier, T., Stohs, S. M., Enciso-Enciso, C., & Jacobsen, N. S. (2025). Socio-economic impacts and responses of the fishing industry and fishery managers to changes in small pelagic fish distribution and abundance. *Reviews in Fish Biology and Fisheries, 35*, 1063-1093. https://doi.org/10.1007/s11160-025-09949-4
Sobariah, & Herlambang, T. (2025). Market access and value chain efficiency in small-scale fisheries: a case study from Indonesia. *The Journal of Academic Science, 2*(6), 1639-1646. https://doi.org/10.59613/3kjnnx91

Solihin, A. (2024). [The urgency of fishers' corporations in improving the welfare of capture fisheries business operators]. *Policy Brief Pertanian, Kelautan, dan Biosains Tropika, 6*(1), 796-800. https://doi.org/10.29244/agro-maritim.0601.796-800 [in Indonesian]
Sugiyono (2019). [Research methods: quantitative, qualitative, and research and development (R&D)]. Alfabeta, Bandung, 444 pp. ISBN 978-602-289-533-6. [in Indonesian]
Zelasney, J., Ford, A., Westlund, L., Ward, A., & Riego Peñarubia, O. (eds) (2020). Securing sustainable small-scale fisheries: showcasing applied practices in value chains, post-harvest operations and trade. FAO Fisheries and Aquaculture Technical Paper No. 652, FAO, Rome, 186 pp. https://doi.org/10.4060/ca8402en

Received: 18 April 2026. Accepted: 22 July 2026. Published online: 09 November 2026.
Authors:
Jardie Androkles Andaki (JAA), Fisheries Agribusiness Study Program, Faculty of Fisheries and Marine Sciences, Sam Ratulangi University, Kampus Street, UNSRAT, Bahu, 95115 Manado, North Sulawesi, Indonesia, e-mail: jardieandaki@unsrat.ac.id https://orcid.org/0000-0002-1243-7731
Djuwita Rosthati Ruth Aling (DRRA), Fisheries Agribusiness Study Program, Faculty of Fisheries and Marine Sciences, Sam Ratulangi University, Kampus Street, UNSRAT, Bahu, 95115 Manado, North Sulawesi, Indonesia, e-mail: djuwita.aling@gmail.com https://orcid.org/0009-0009-7190-5732
Jeannette Femmy Pangemanan (JFP), Fisheries Agribusiness Study Program, Faculty of Fisheries and Marine Sciences, Sam Ratulangi University, Kampus Street, UNSRAT, Bahu, 95115 Manado, North Sulawesi, Indonesia, e-mail: annetepangemanan@unsrat.ac.id https://orcid.org/0009-0002-2813-9381
This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.
How to cite this article:
Andaki, J. A., Aling, D. R. R., & Pangemanan, J. F. (2026). Navigating archipelagic constraints: price volatility and marketing efficiency of small pelagic fish in Biaro Island. *Aquaculture, Aquarium, Conservation & Legislation, 19*(6), 2683-2696. https://doi.org/10.67784/1020