RESEARCH ARTICLE

Structural Assessment of the Philippine Sardine Value Chain: Implications for Policy Action

Bernajocele Jalyn S. Baldoza*, **Reymark C. Busalla**, **Janine T. Ametin**, **Angellie G. Fernandez**, **Ulysses M. Montojo**

Fisheries Postharvest Research and Development Division, National Fisheries Research and Development Institute (NFRDI), Quezon City, Philippines 1128

ABSTRACT

The Philippine sardine industry is integral to national food security, rural employment, and export earnings, producing an annual average of 341,000 metric tons valued at PHP 10.74 billion since 2014. Despite its significance, the sector is becoming increasingly vulnerable to ecological pressures, climate variability, and economic risks. Thus, this study employed a value chain analysis that encompasses 86% of the country's national sardine production areas, along with interviews conducted with 421 fishers, traders, and processors. Findings revealed unequal value distribution: fishers recorded high returns on investment (83%) yet remained income-constrained, largely dependent on traders for operating capital. Traders earned the highest income per trading cycle but were exposed to price volatility and high operating expenses, whereas processors exhibited uneven profitability across scales and product types. Policy recommendations emphasize strengthening economic resilience through collateral-free credit, cooperative input purchasing, and risk insurance in typhoon-prone provinces. Operational adaptability requires additional investments in cold storage, ice plants, and modernized processing technologies, alongside alternative livelihood programs during closed seasons to safeguard fisher incomes. Governance improvement should prioritize digitalized one-stop licensing, harmonized local and national market regulations, streamlined fee structures, stricter enforcement of Illegal, Unreported, and Unregulated (IUU) fishing, and improved traceability systems to enhance compliance and competitiveness across the sardine value chain.

*Corresponding Author: *bernajocele.baldoza@nfrdi.da.gov.ph*
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1. INTRODUCTION

The escalating global demand for sustainable food systems, particularly those dependent on marine resources, has intensified focus on small pelagic species, such as *Sardinella* spp. *(Sardinella lemuru, Sardinella fimbriata)*, which play a critical role in global food security and livelihoods (Natarajan et al. 2023; Plaza-Vega and Araya 2024). In the Philippines, the sardine industry is a crucial component of the capture fisheries sector, generating an average annual value of PHP 10.74 billion (approximately USD 187 million), accounting for about 3.90% of the fisheries sector's total earnings (PSA 2025). While this share may appear modest, the industry remains socioeconomically significant, contributing to the national economy, supporting food security, and providing employment for the fisherfolk (BFAR 2020).

Fisheries management in the Philippines operates under a decentralized governance framework established by the Philippine Fisheries Code of 1998 (Republic Act 8550), as amended by RA 10654, which allocates regulatory authority between the national government and local government units (LGUs). The Bureau of Fisheries and Aquatic Resources (BFAR) is responsible for national fisheries policy, stock assessment, and the regulation of commercial fisheries, while LGUs manage municipal waters (within 15 km from the coastline) where the majority of small-scale fishers operate. These responsibilities include issuing fishing permits, enforcing local fisheries ordinances, and establishing marine protected areas. Recent reforms have further strengthened science-based and ecosystem-based fisheries management through the establishment of Fisheries Management Areas (FMAs) by the BFAR, which aim to coordinate

stock management, improve monitoring systems, and enhance alignment between national and local governance institutions.

Despite its economic importance and evolving governance framework, the Philippine sardine industry has faced persistent structural and environmental vulnerabilities. Production has fluctuated over the past decades. Sardine production generally increased in the early 2000s, reaching a peak of 461 thousand MT in 2009. However, a significant decrease of approximately 110,000 MT was observed in 2011, prompting the implementation of closed fishing seasons in major sardine fishing grounds (BFAR 2013; Napata et al. 2020). Although production showed signs of recovery until 2020, it began to decline again in 2021, with an average reduction of approximately 25,000 MT annually (PSA 2025). Recent studies attribute these fluctuations to a combination of fishing pressure, climate variability, and management challenges affecting sardine stocks and harvesting patterns (Labaria et al. 2021; Muallil et al. 2024).

Climate-related changes in ocean conditions, including marine heatwaves, further affect sardine distribution and access to fishing grounds, potentially altering landing patterns and supply availability (Muhling et al. 2025). Economically, fishers, traders, and processors face persistent issues, including inadequate postharvest facilities, which lead to postharvest losses and market unreliability, directly eroding their profitability (Tadifa et al. 2022; Muallil et al. 2024). Policy implementation issues, particularly regarding the closed-season policy, exhibit mixed effectiveness, with reported decreases in catch per unit effort (CPUE) and issues of non-compliance due to economic consequences (Napata et al. 2020). Persistent challenges, including the limitations of standardized postharvest processes and the limited regulatory-compliant postharvest facilities, have contributed to substantial postharvest losses, reducing profitability across the value chain, particularly among small-scale operators. These limitations also affect product quality and compliance with international food safety standards, which in turn contribute to restricted access in key export markets (FAO/WHO 2020), thereby weakening the sector's international competitiveness and revenue-generating potential.

Recognizing the critical need for a holistic understanding, the Philippine government has emphasized the need for comprehensive supply and value chain analyses through the Comprehensive National Fisheries Industry Development Plan (CNFIDP) 2021-2025 (BFAR n.d.). However, existing value chain analysis (VCA) or sardine intervention–related studies are often confined to specific geographic areas or selected sardine products, limiting their capacity to capture the full spectrum of challenges and opportunities across diverse producing regions (Montaño et al. 2017; Rosales et al. 2017; Muyot et al. 2021; Napata et al. 2021). Therefore, this study addresses this gap by conducting a holistic VCA of the Philippines' sardine industry. Moreover, this study contributes to the literature by examining how spatial fragmentation of fishing communities and diverse institutional and governance arrangements interact to influence value distribution and economic performance within the sardine value chains. In particular, the study explores whether these structural conditions may result in a paradox wherein actors with higher capital investment experience relatively lower income shares compared to intermediary actors, and how governance and market coordination gaps may contribute to value loss along the chain (Blanchard 2017; Nicole et al. 2021; Babus and Parlatore 2022). Product stages and how bottlenecks manifest among different key actors, which will provide a guide to enhance the value of the fish products and value chain development interventions, will also be illuminated (Kaplinsky and Morris 2000; Brown et al. 2010; Kakerissa et al. 2024; Mangubhai et al. 2024). Likewise, this will identify specific areas where interventions can have the greatest impact, particularly in the context of current sardine industry dynamics (Kakerissa et al. 2024; Mangubhai et al. 2024). Lastly, this will further situate the sardine industry within broader discussions on food security, poverty reduction, and climate resilience, ensuring that improvements are aligned with both national development priorities and international sustainability commitments.

2. METHODOLOGY

2.1 Methodological framework

The analytical concept for this study is rooted in the widely recognized value chain definition of Kaplinsky and Morris (2000), which encompasses the full range of activities required to bring a commodity from its point of origin to the final consumer. Drawing on this foundation, the research design employed the conceptual frameworks of Brown et al. (2010) and Ramirez et al. (2020), integrating structural mapping, performance assessment, and intervention recommendations. As shown in Figure 1, the framework employed a multi-step approach designed to capture both structural characteristics

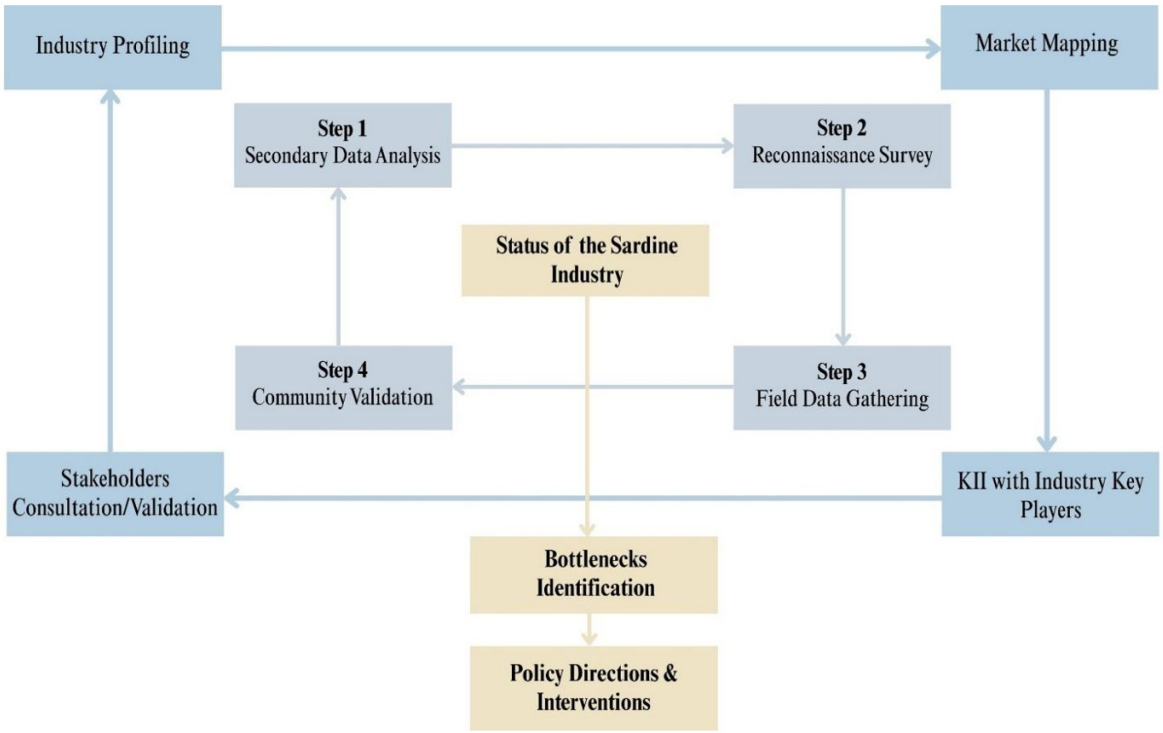

Figure 1. Conceptual framework modified from Brown et al. (2010) and Ramirez et al. (2020).

and performance bottlenecks. It began with industry profiling through secondary data to establish a baseline of production, trade, and processing structure. A reconnaissance survey was then conducted to map the market and identify preliminary supply chain linkages. This was complemented by field data collection through key informant interviews (KIIs) and focus group discussions (FGDs) with key industry players, which captured bottlenecks. The findings were then validated with stakeholders. The final step was the policy directions and intervention recommendations, which aimed to enhance industry performance and long-term sustainability.

2.2 Study area

The study purposively followed the sardine value chain, from production to processing and distribution. The major sardine-producing provinces across different FMAs and regions, where interviews with fish catchers began, are presented in Table 1. The production hubs were identified using the production statistics from the Philippine Statistics Authority (PSA). To address the limited geographical coverage of previous value chain studies, this research expanded the site selection to include key production, processing, and trading nodes across the Philippines. A total of 28 provinces were covered in this study, substantially expanding beyond the geographic scope of previous studies conducted in Sorsogon and Northern Samar, Taal Lake in Batangas, and the Northern Zamboanga Peninsula. The primary production node included Zamboanga del Sur, which contributes about 44% of the country's total sardine production. Other key nodes covered in the study include Sorsogon (11%), Metro Manila (8%), Zamboanga del Norte (6%), and Capiz (2%), representing both major production areas and important processing and trading hubs along the sardine supply chain. Collectively, the provinces where fish catchers were interviewed account for approximately 86% of national sardine production in 2024.

Beyond production nodes, the study covered the processing hubs where sardines are being transformed into canned, bottled, smoked, and dried products. These included Zamboanga del Sur, Zamboanga del Norte, Cavite, and Bataan. Traders, as intermediaries, were examined within top-producing provinces, as their role is integral in connecting production with processing hubs.

2.3 Data collection

A mixed-methods approach, combining primary and secondary data collection, was employed to ensure a comprehensive understanding of the Philippine sardine industry. Primary data were collected between January 2023 and June 2024 through

Table 1. Study Areas and Number of Key Actors Interviewed

FMA	Region	Province	Contributions (%)	Fish Catchers	Traders	Processors
1	V	Catanduanes	0.09	7	6	-
		Camarines Norte	0.07	3	-	-
1,7		Albay	0.30	3	2	8
		Camarines Sur	0.35	1	1	1
		Sorsogon	11.44	12	7	5
1,7,12	IV-A	Quezon	0.44	1	2	4
2	XI	Davao del Sur	0.28	8	7	-
3	XII	South Cotabato	0.31	2	-	-
3,4,5	BARMM	Tawi-tawi	0.95	1	1	-
3,4,9	IX	Zamboanga del Sur	44.09	4	19	7
4,11	VI	Iloilo	1.21	7	1	11
		Negros Occidental	0.83	10	10	8
4,9,10	IX	Zamboanga del Norte	6.35	18	6	9
5	IV-B	Palawan	0.92	6	-	2
5,6,12		Oriental Mindoro	0.30	7	2	3
6	III	Bataan	0.16	8	9	15
	IV-A	Cavite	0.25	13	4	12
	NCR	Metro Manila	8.15	2	4	1
	III	Zambales	0.06	4	-	-
6,12	IV-A	Batangas	0.30	9	8	1
7,10,11,12	V	Masbate	1.64	9	6	3
9,10	VII	Bohol	0.16	6	8	0
8,9	VIII	Samar	1.08	2	6	9
9	X	Misamis Occidental	0.52	7	1	3
		Misamis Oriental	0.53	4	1	3
		Lanao del Norte	1.58	2	5	3
10,11	VII	Cebu	1.68	14	14	7
11,12	VI	Capiz	2.13	3	-	3
		Total	86.15	173	130	118

Note. Fisheries Management Areas (FMA) refer to fishery areas that were delineated for fishery resource management as per BFAR Fisheries Administrative Order No. 263 s.2019. Meanwhile, the region refers to the classification of Philippine geographic areas, as outlined on https://psa.gov.ph/classification/psgc/regions. The contribution indicates each province's share of total national sardine production, based on data from the Philippine Statistics Authority (2025). The study coverage accounts for 86% of the national production, ensuring representativeness of the production areas in the country. The number of fish catchers, traders, and processors represents respondents interviewed during field data collection. They were identified through purposive sampling (fishers) and chain-referral (traders and processors), capturing direct transactional linkages.

KIIs and FGDs. A total of 421 industry players were interviewed, comprising 173 fish catchers, 130 traders, and 118 processors (Table 1). Structured questionnaires were tailored to each actor group, covering respondent profile, operational details, economic performance, value chain linkages, constraints and opportunities, and policy and institutional support. It is important to note that the data collected through the semi-structured questionnaires, particularly the cost-return estimates, are subject to various limitations, including recall bias, seasonal effects, and confidentiality constraints. The identification of fish catchers was conducted through purposive sampling with the assistance of the BFAR. Subsequent actors, including traders and processors, were traced through their direct transactional linkages to the interviewed fish catchers. This chain-referral approach enabled the mapping of embedded relationships between production, trade, and processing. Additionally, FGDs were conducted with local government officials in each

of the identified major producing provinces listed in Table 1. These stakeholders were included, given their regulatory and facilitative roles in the industry. These discussions provided insights into the area-specific governance practices, operational challenges, and policy enforcement, while capturing an institutional perspective on how regulations intersect with the economic realities of chain actors. Furthermore, the integration of KIIs and FGDs captured top-down policy perspectives.

To complement the primary data, secondary data were collected through a comprehensive review of published reports, government statistics, and peer-reviewed journal articles. Particular emphasis was placed on macro-level indicators, including national and regional production trends and international trade flows. Secondary data sources also provided foundational information for assessing existing markets, particularly regarding export and import trends in the country. Lists of actors involved in the chain, initially drawn from KIIs and FGDs, were further validated and expanded through stakeholders' consultation.

2.4 Data analysis

This study employed a qualitative descriptive approach to examine the structure, dynamics, and governance of the Philippine sardine value chain. Data obtained from KIIs and FGDs were encoded and tabulated into Microsoft Excel spreadsheets, providing a foundation for data analysis. The analyses began with structural mapping, which involved identifying and characterizing actors across the chain, from fishers to traders and processors, each mapped according to their roles and functions. Particular attention was given to the linkages that connect actors, including input flows, marketing channels, and institutional interfaces. This process enabled the construction of a structural map of the industry, covering production, trading, and processing nodes across major sardine-producing provinces. Secondly, the analysis examined transactional relationships and product flows from a specific production area to its end market. Thirdly, the study identified constraints and performance bottlenecks by grouping stakeholder responses on economic, operational, and governance-related challenges. These were grouped into thematic categories, such as rising input costs, market volatility, inadequate postharvest facilities, and weak policy enforcement. Finally, the influence of governance structures was assessed, drawing on insights from FGDs with local government units. This included evaluating the role of enabling institutions in facilitating market linkages.

3. RESULTS

The structure and dynamics of the Philippine sardine industry revealed a multifaceted structure, primarily segmented from input provision to production, trading, and processing. This foundational structure shows the movement of sardines from harvest to various end markets, including local, national, and international destinations.

3.1 Structure of the Philippine fresh sardine value chain

The Philippine fresh sardine value chain is structured in four primary segments: input provision, production, trading, and processing (Figure 2). Each stage involves interlinked actors and activities that sustain the continuous flow of sardines from capture to market. The chain began with input provision, where fishers received support in the form of gear, fishing boats, fuel subsidies, and financial assistance from the national government through the BFAR, LGUs, and Non-governmental Organizations (NGOs). Similarly, established fisherfolk organizations and other industry players complement these supports, particularly to small-scale fisherfolk. The production segment comprises both municipal and commercial fishers. Their catch flows into two principal marketing pathways: (i) directly to traders, and (ii) directly to processors. Some fishers are vertically integrated with local markets, traders, and processors, allowing them to bypass intermediaries. Regulatory oversight is carried out by BFAR through licensing, boat registration, and enforcement of closed seasons, while the Philippine Coast Guard and the Maritime Industry Authority (MARINA) ensure maritime safety and compliance with fishing-vessel standards. The Philippine Fisheries Development Authority (PFDA) plays a complementary role in the operation of fish ports and postharvest facilities.

The trading segment functions as the intermediary link, facilitating the collection and distribution of raw sardines between fish catchers and producers, the wet market, processing companies, and institutional buyers such as the Hotels, Restaurants, and Catering (HORECA) sector. Traders encompass various types of intermediaries, including consignment, brokers, wholesalers, retailers, and importers. Consignment and brokers facilitated the distribution of the catch to wholesalers and

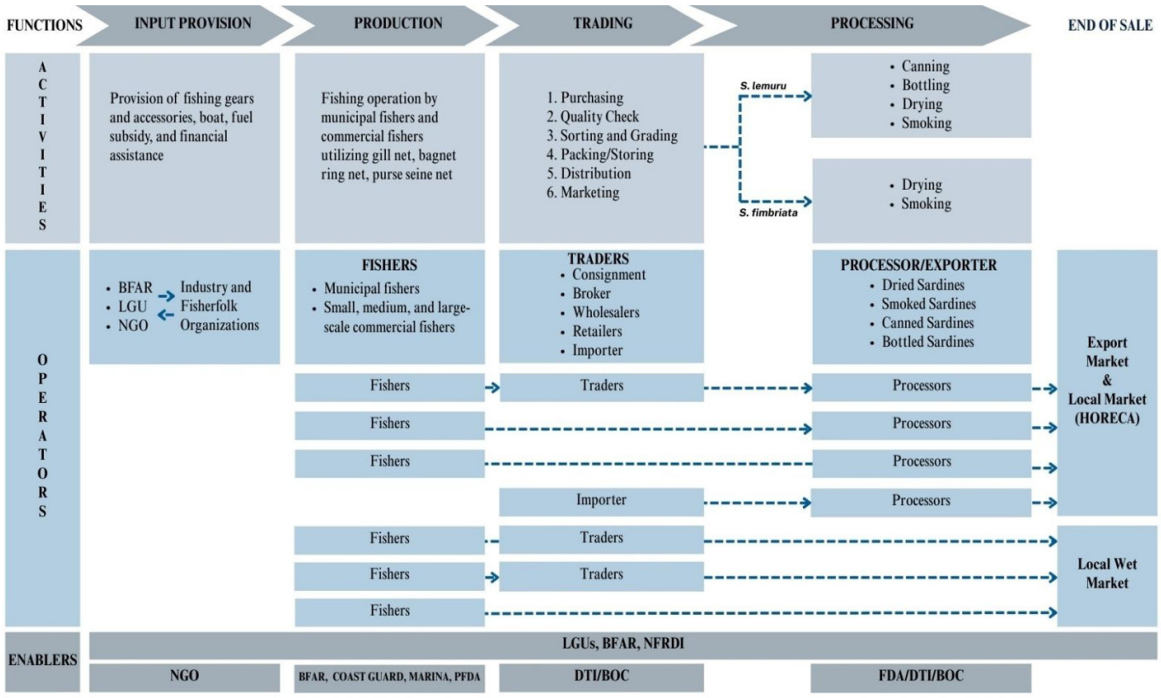

Figure 2. Structure of the Philippine fresh sardine value chain

Note. LGU refers to Local Government Unit. The diagram also showed the enablers, such as Non-Government Organization (NGO), Bureau of Fisheries and Aquatic Resources (BFAR), MARINA (Maritime Industry Authority), Philippine Fisheries Development Authority (PFDA), Department of Trade and Industry (DTI), Bureau of Customs (BOC), and Food and Drug Administration (FDA). HORECA refers to Hotels, Restaurants, and Catering. Fishers to processors and trades without an arrow show a vertically integrated relationship. Commercial fishing vessels are classified into small-scale (3.1 to 20 GT), medium-scale (20.1 to 150 GT), and large-scale operations (>150 GT), as per BFAR Fisheries Administrative Order 198-1 series of 2018.

retailers on a commission basis. Meanwhile, brokers were commonly engaged in distributing catches of commercial fishers. The retailers are those considered small-scale traders, including vendors and peddlers who market sardines in their communities. Importers also operated in this segment, serving as institutional buyers that procured fresh/frozen sardines from other countries and supplied them exclusively to processing facilities regulated under BFAR Fisheries Administrative Order No. 195, series of 1999 (BFAR 1999). The Department of Trade and Industry (DTI) and the Bureau of Customs (BOC) serve as key enablers of trade. Furthermore, the processing segment transforms fresh sardines into dried, smoked, canned, and bottled sardines, which are then directed toward either local or export markets. Processing pathways are species-specific: *S. lemuru* is primarily used for both canning and bottling, whereas *S. fimbriata* is commonly used for drying and smoking. Some backyard processors at times utilize *S. lemuru* in drying and smoking. Value addition is supported by regulatory agencies, including the DTI, BOC, and the Food and Drug Administration (FDA), which ensure food safety, quality standards, and facilitate market access.

3.2 Value chain of fresh sardines across provinces

Figure 3 illustrates the overall geographical distribution of fresh sardines, highlighting the major production areas, processing plant locations, and trade routes of both locally sourced and imported fresh sardines. Meanwhile, Figure 4 presents the distribution pathways of fresh sardines across the Philippines, with lines representing product movement among production areas, traders, processors, and destination markets. The succeeding discussion follows these pathways to provide a clearer interpretation of the movement and market flow of fresh sardines across regions.

In western Luzon, sardine distribution involves both local and interprovincial trade flows. In Zambales, fishers distribute their catch to traders, processors, and local wet markets within the province. Traders subsequently redistribute sardines to processors and wet markets within the province, while a portion of the supply is transported to Metro Manila (vertical line 6, Fig. 4). In Bataan, sardines follow similar marketing pathways, with fishers supplying traders, smoked, dried, and bottled sardine processors, and wet markets within the province, while some

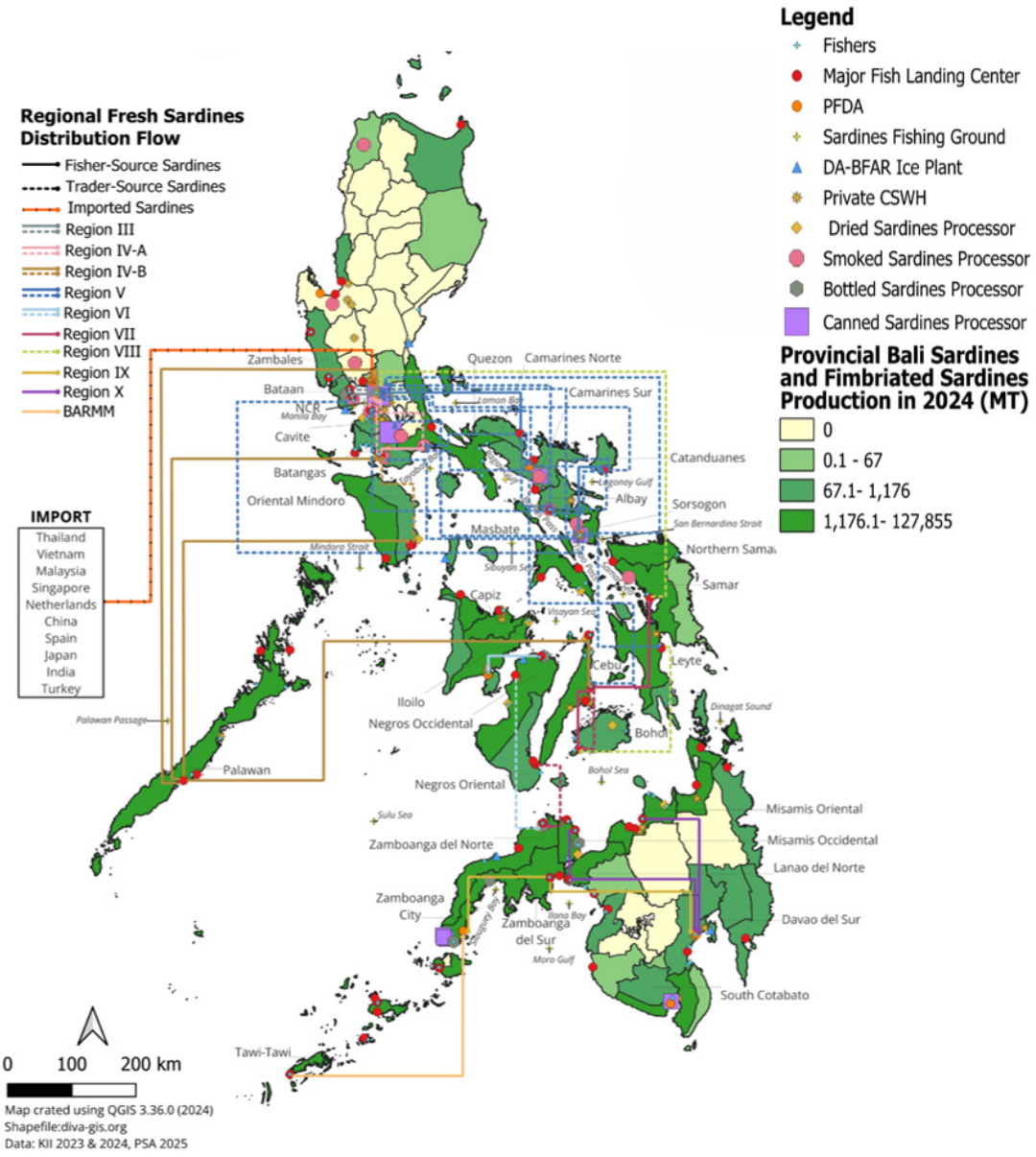

Figure 3. Geographical distribution flows of fresh sardines in the Philippines

Note: This map presents the 2024 distribution flow of fresh sardines in the Philippines, showing fisher- and trader-sourced movements, import channels, and provincial production of Bali Sardines (*S. lemuru*) and Fimbriated Sardines (*S. fimbriata*). It also identifies major landing centers, fishing grounds, and processing facilities (including drying, smoking, bottling, and canning), as well as other relevant facilities. The data sources included the BFAR, KIIs, FGDs, and PSA (2025).

of the catch is transported directly to Metro Manila (vertical line 1, Fig. 4).

In Batangas, sardines are marketed by both fishers and traders, with fishers supplying Quezon, while traders distribute sardines to processors within the province and to Metro Manila, and to smoked fish processors in Quezon (vertical line 7, Fig. 4). Traders in Batangas are also sourcing additional supply from fishers in Palawan (vertical line 3, Fig. 4) and Oriental Mindoro. In Cavite, fishers supply traders and processors of smoked and dried sardines, as well as local wet markets within the province, while traders distribute sardines to Metro Manila (vertical line 8, Fig. 4), in addition to supplying local processors and local wet markets.

In the province of Quezon, fishers supply traders, processors, and local wet markets, while part of the catch is transported to Metro Manila (vertical line 2, Fig. 4). Traders in the province also source additional sardine supply from fishers of Batangas

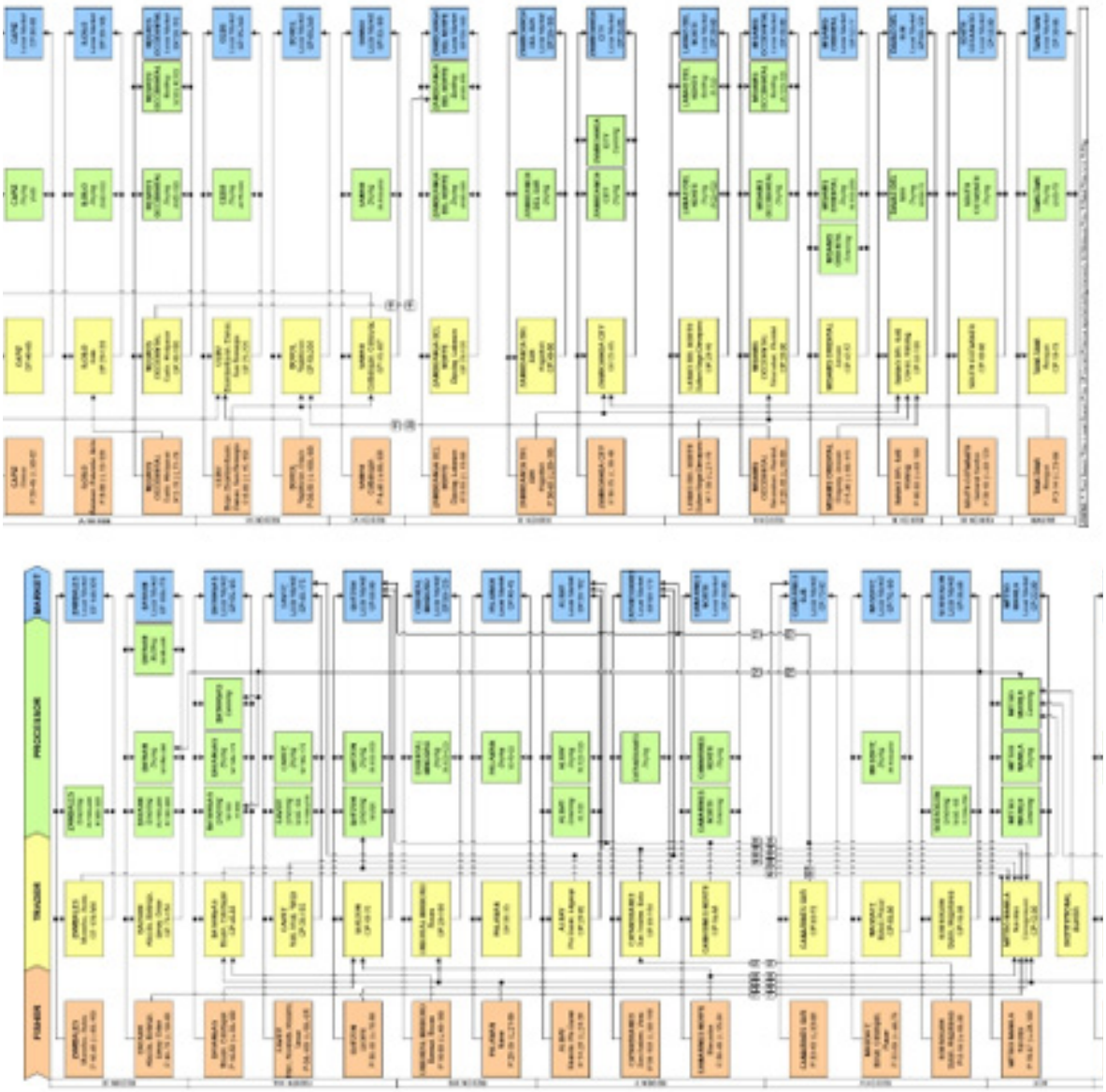

Figure 4: Provincial distribution and price transmission of fresh sardines in the Philippines.

Note: The figure illustrates the flow of sardines from producing provinces to various chains, traders, processors, and markets, along with indicative price transmission at each stage. An arc in the line signifies that the line is only passing through a node without representing a transaction, while a bullet indicates that multiple chains originate at that point. For a clearer, more visual version of this figure, please refer to this link: Provincial distribution of fresh sardines in the Philippines. *Consignacion* is a fish trading facility in which a fish broker/trader sells fish on behalf of a fisher/producer and receives a certain percentage (2%-10%) of the gross profit. Data sources were KIIs.

and Camarines Norte to sustain supply for processor operations and local markets. Smoked sardine processors in the province of Quezon likewise source additional supply from Batangas (vertical line 7, Fig. 4), while local wet markets obtain supplementary supply from traders in Camarines Norte and Camarines Sur, as represented by the pathways associated with vertical lines 11 and 13, respectively (Fig. 4).

The sardine distribution network also extends to Region IV-B. In Oriental Mindoro, fishers supply sardine traders, processors, and local markets within the province, and extend their distribution to traders in Batangas. However, sardine traders in Oriental Mindoro source additional supply from Palawan (vertical line 3, Fig. 4) to support dried-sardine processors and local wet markets. Palawan functions as an important distribution node, as fishers supplying fresh sardines to Metro Manila, Cebu, Oriental Mindoro, and Batangas (vertical line 3, Fig. 4), while local supply is distributed to traders, dried fish processors, and wet markets within the province.

In the Bicol Region, in the province of Albay, sardine catch from fishers is distributed within the provinces, while traders distribute sardines to local markets in Cavite and Catanduanes, and to sardine canneries in Metro Manila (vertical line 9, Fig. 4). In Catanduanes, traders supplement local catch by sourcing sardines from Sorsogon (vertical line 5, Fig. 4), which are then distributed to local markets in Albay and to *consignacion* trading centers in Navotas (vertical line 10, Fig. 4), Metro Manila. In Camarines Norte, fishers supply traders in Quezon and *consignacion* outlets in Navotas City (vertical line 4, Fig. 4), while traders distribute aggregated sardines to local markets in Quezon, Albay, and Camarines Sur (vertical line 11, Fig. 4). Both fishers and traders also supply smoked and dried sardine processors and local wet markets within the province. In Camarines Sur, fishers primarily supply traders and local markets, while traders distribute sardines to local markets in Quezon and Catanduanes, and *consignacion* trading centers in Metro Manila (vertical line 13, Fig. 4). In Masbate, sardines are primarily distributed locally by fishers and traders to dried fish processors and wet markets. Moreover, in Sorsogon, sardine fishers supplied the traders in the province and in Catanduanes (vertical line 5, Fig. 4). Then, traders and fishers supply both the smoked sardine processors and the local market within the province. The traders from this province likewise supply sardines to canned processors in Metro Manila and to some processors in Batangas and Bataan (vertical line 12, Fig. 4).

S. lemuru is the dominant species caught by commercial and municipal fishers in Sorsogon. The high production of *S. lemuru* in Sorsogon was evident, as this species dominated the waters of Ticao Pass, located in the northern part of FMA 7. During the peak season (March–May), small-scale commercial fishers using drift gill nets harvested 1,000–2,000 kg/trip, operating for approximately 24 days per month. By contrast, in the lean season (July–October), catch rate drops to 30-500 kg/trip.

Metro Manila serves as the primary hub for the aggregation and redistribution of fresh sardines. Fishers from Bataan, Quezon, Palawan, Camarines Norte, together with traders from Zambales, Batangas, Cavite, Catanduanes, and Camarines Sur, supply sardines to *consignacion* trading centers in Navotas. These *consignacion* outlets redistribute sardines to local markets, smoked and dried sardine processors, and large sardine canneries in the metropolitan area. During periods of domestic supply shortages, sardine canneries in Metro Manila also supplement supply through imported sardines.

Inter-island trade flows are also evident in the Visayas. Fishers in Negros Occidental supply sardines to wet markets in Iloilo, where fisher prices range from PHP 3.00–70.00 per kilogram during the peak season and PHP 11.00–78.00 per kilogram during the lean season. Traders from Negros Occidental also supply bottled sardine processors in Zamboanga del Norte at wholesale prices ranging from PHP 40.00–100.00 per kilogram (vertical line 16, Fig. 4). Sardines from Cebu are distributed to traders in Bohol and Samar. Conversely, some fishers in Bohol also supply sardines to traders in Cebu. The observed two-way trade between Cebu and Bohol is largely influenced by price differentials between markets, with fishers directing their catch to buyers that offer more favorable prices. Furthermore, some Bohol fishers sell their catch directly to Cebu-based traders at sea immediately after harvest, allowing them to secure buyers without returning to Bohol's landing sites and thereby reducing marketing time and transaction costs.

In Samar, traders distribute sardines to canneries in Metro Manila, while local supply supports a dried fish processing sector and local wet markets. In Catbalogan City, small-scale commercial fishers using ring nets, a fishing gear prohibited within municipal waters under Section 95 of Republic Act No. 10654, harvest approximately 200–500 kg per trip during the peak season from February to June, while catch rates decline to about 50 kg per trip during the lean season from July to January. The marketing and distribution of fresh sardines are coordinated by fish brokers operating *consignacion* outlets, which charge

a 5% commission on gross sales. In 2024, Samar produced approximately 3,000 metric tons of sardines (PSA, 2025). Based on auxiliary permits issued by the local government of Catbalogan City, around 184 MT of fresh sardines were distributed locally and supplied to canneries in Metro Manila, while dried *S. fimbriata* production reached 115.1 MT.

Mindanao represents the most important production center for sardines in the country. Fishers in Zamboanga del Sur supply sardines to Zamboanga City and Davao del Sur, with fisher prices ranging from PHP 30.00–60.00 per kilogram during peak season and PHP 80.00–100.00 per kilogram during the lean season. Commercial fishing vessels using semi-purse seine gear can harvest approximately 300 MT per month during the peak season from May to August, declining to about 100 MT per month during lean periods. Fresh sardines are landed at major landing centers, such as the Zamboanga Fish Port Complex, and distributed to regional processors.

In Zamboanga City medium- and large-scale canneries are often vertically integrated with commercial fishing fleets. Medium-sized canneries produce approximately 600–6,000 cases per day, while large canneries produce around 12,000–24,000 cases per day, consuming roughly 11,700–23,400 MT of fresh sardines annually. In 2022, Zamboanga City produced approximately 11,150 MT of canned sardines valued at PHP 1.6 billion, which were distributed nationwide and exported to international markets. In addition to canned products, the region also produced about 667 MT of bottled sardines valued at PHP 73.3 million. Most canning factories are vertically integrated with fishing fleets, allowing them to secure a stable supply of sardine raw materials for processing. In the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM), sardines from Tawi-Tawi are supplied to Zamboanga City, and to the local processors and wet market in the province.

Furthermore, sardine price patterns show clear differences across seasons and regions (Fig. 4). Prices tend to rise during the lean season and fall during the peak fishing season. For instance, the lowest fisher prices were observed in Sorsogon (PHP 2.00–14.00/kg peak; PHP 10.00–30.00/kg lean) due to oversupply, limited demand, inadequate ice, and a non-functional cold storage warehouse. Conversely, Bohol recorded the highest lean-season prices (PHP 100.00–180.00/kg). Although seasonal supply shortages contributed to higher prices, the oligopolistic market structure in the province, characterized by two dominant industry players with exclusive procurement arrangements with small-scale fishers, likely reinforced the observed price levels. Increased fish prices in Bohol were attributed to excessive permits and fees imposed on traders at the Causeway Fish Landing Site. Traders reported paying monthly fees for special permits (PHP 500.00) and stall rentals (PHP 300.00), plus a fish landing fee (PHP 50.00) and an additional PHP 5.00 on each box of fish. However, vertically integrated hubs like Zamboanga City experienced narrower seasonal fluctuations, with fish prices ranging from PHP 30.00-35.00/kg during the peak season and PHP 38.00-48.00/kg during the lean season.

3.3 Cost structure and value addition within the sardine value chain

The cost–return analysis of the sardine value chain (Figure 5) demonstrates differences in profitability and capital efficiency across actors. Small-scale commercial fishers recorded an ROI of 83%, driven by minimal capital requirements despite high labor intensity and transactional deductions. Traders, in return, generated the highest income (PHP 157,550 per cycle) but recorded a lower ROI (40%). Further, among processors, performance varies depending on product type and scale. Dried sardine processors displayed strong financial efficiency with an ROI of 56%, benefiting from relatively lower capital requirements and cost-effective recovery rates. In contrast, bottled sardine processors recorded the lowest profitability, with an ROI of 30%, constrained by the high cost of raw materials and packaging materials. On the other hand, large canning manufacturers have the resources and capability to buy raw materials in bulk, resulting in having more bargaining power, hence less constraints on raw material pricing. Cost constraints for these large enterprises often come from labor and overhead costs. Generally, processors are selective in sourcing raw materials, prioritizing quality and specific fish sizes to meet market standards.

3.4 Constraints faced by key actors and policy implications

The analysis of constraints experienced by the key actors in the Philippine sardine supply and value chain, shown in Table 2, reveals economic, operational, and governance challenges that affect industry performance, sustainability, and livelihoods. One of the primary economic issues for small-scale sardine fishers is their persistent reliance on financiers (boat owners, traders, or processors) for operating capital. Limited access to formal financial institutions due to lack of collateral, absence of credit history,

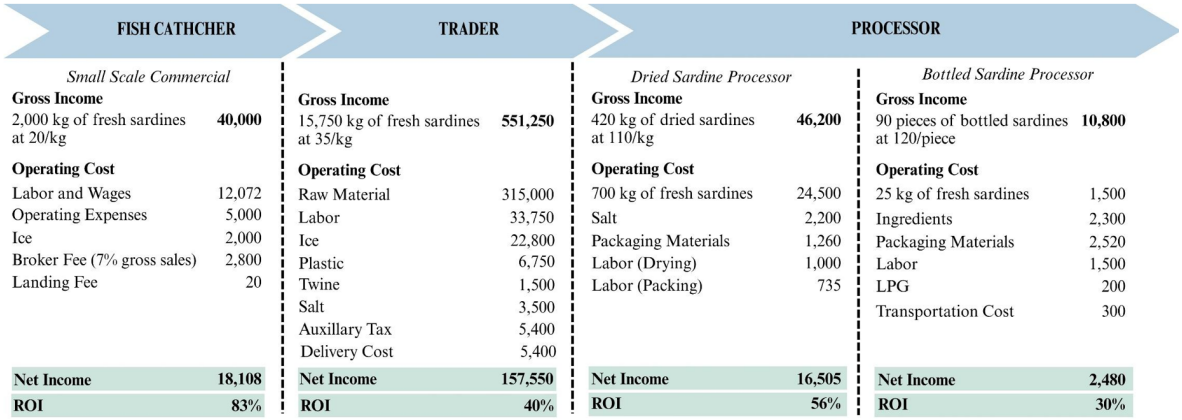

Figure 5. Cost return per activity cycle of each key actor

Note. The figure illustrates the cost and returns structure of selected sardine value chain actors during the peak season. The illustrated cost and income estimates represent typical cases during the peak season. Labor costs for traders include hauling, unloading, and packing, while delivery costs cover drivers' fees, food allowance, fuel, and toll charges. LPG refers to cooking fuel used in processing, and bottled sardines are priced at PhP 60 per bottle to meet processor quality standards. The canning sector is excluded due to data privacy and its established industry status. The data reflect only the key actors who provided direct information.

inflexible repayment terms, and irregular or seasonal cash flow forces fishers to rely on informal credit. These arrangements often require fishers to sell all their catch at predetermined prices hence reducing their bargaining power. This credit dependency is exacerbated by the rising costs of fuels, ice, gears, and other inputs, as well as the loss of capital and income when they suddenly experience typhoons or strong winds. Some fish catchers were also raising concerns about the dependency on brokers or traders, as there is no existing processing plant in the landing areas, resulting in the discarding of surplus if the brokers or traders cannot handle the supply. The issue of oversupply in major producing areas, such as Sorsogon, particularly its municipality of Bulan, underscores an urgent need for enhanced postharvest infrastructure. The absence of large-scale processing facilities in some landing areas also forces fishers to depend on brokers, further reducing their share of the final market value.

Economic constraints for traders and processors encompass restricted access to credit, coupled with price volatility and unpredictable sardine availability, as well as increasing market uncertainty due to the unpredictable nature of sardine availability during the lean season. Differences in operating costs and market requirements between formal market outlets and informal marketing channels, such as roadside stalls, *talippa,* and peddlers, contributed to variations in pricing and market competitiveness. For processors, the situation is further complicated by dependence on external inputs. Many processors are forced to rely on imported sardines as raw material, supplementing domestic supply gaps and traceability issues. At the same time, the rising cost of processing inputs, including fuel, packaging, and labor, compresses already narrowed margins. Smaller processors, especially those in drying and smoking industries, are further disadvantaged by the variable quality of landed sardines, which restricts opportunities for higher-value production and limits access to premium markets.

Among the primary operational constraints for fishers were typhoons and strong winds that affected their fishing operations. Sardine fishers, particularly in the municipal sector, reported that even a single day without fishing has a significant impact on their livelihoods. Damage to boats and gear further reduces operational capacity. While the Philippine Crop Insurance Corporation (PCIC) offers insurance for registered fisherfolk against calamity-related losses, coverage is limited, and many remain underinsured. Some fishers suggest that cash subsidies for post-disaster recovery and alternative livelihood options during fishing downtime could help mitigate these impacts. In addition, fish catchers viewed closed seasons, lean seasons, fish bans, and the demarcation of fishing areas as operational challenges, which limited their fishing days and harvest volumes. Competition among fishers due to increasing fleet sizes reduces catch per capita.

Beyond capture fisheries, processing remains operationally constrained by outdated technologies. Many operators continue to rely on traditional drying and smoking methods that are highly weather-dependent, thereby limiting efficiency, quality, and market reliability. For some processors, this reliance mainly stems from reluctance to adopt

Table 2. Constraints and Recommended Policy Directions for the Philippine Sardine Value Chain

Category	Fishers & Boat Operators	Traders	Processors	Recommended Intervention/Policy Direction
Economic	• Credit dependency of small-scale fishers on boat owners, traders, and large-scale processors for operating capital, creating credit lock-in where financiers dictate landing prices • Rising input costs (fuel, ice, gear, etc.) • Loss of capital and income due to typhoons or strong winds • No large-scale processing in some landing areas (dependence on brokers)	• Limited access to credit/financial resources • Unpredictable sardine availability leading to price fluctuations • Competition from informal marketing channels (e.g., talipapa, peddlers)	• Limited access to credit/financial resources • Unpredictable sardine availability affecting processing operations • Reliance on imported sardines as raw materials for some processing canneries • Rising cost of processing inputs • Low quality of sardines	• Expand fishers/traders/processors' access to collateral-free and lower interest rate credit facilities • Establish a policy that stabilizes fuel and other production and processing input prices through cooperative bulk purchasing schemes and targeted subsidies specifically for small-scale key actors • Introduce risk insurance for fishing, specifically in typhoon-prone areas such as the Bicol Region, Eastern Visayas • Prioritize investment in government owned ice plants and operationalize CSWH, particularly in Bulan, Sorsogon and Palawan, to help absorb peak season landings and stabilize raw material supply for processors • Establish post harvest facilities (CSWH) in Bohol to reduce price spikes during lean season. Increase storage capacity of CSWH in PFDA of Zamboanga City.. • Strengthen domestic production linkages to address reliance on imported sardines, such as link Bulan, Sorsogon, to processing provinces • Prioritize the establishment of regulated market systems, such as transparent pricing mechanisms, and stricter enforcement against illegal trade
Operational/ Environmental	• Limited fishing operations (closed season, lean season, fish bans) • Demarcation of fishing areas • Typhoon and strong wind disruptions • Competition due to the increased number of fishers		• Processing technologies remain traditional, and weather and climate dependent • Lack of appropriate operational facilities	• Enhance the fishers accessibility to weather forecasting systems to reduce operational risks • Scale up the modernization of traditional drying and smoking techniques through low-cost solar dryers and hybrid smokehouses to reduce dependence on weather conditions, particularly in Samar • Upgrade and establish a community-based/ cooperative managed processing facility supported by LGU and BFAR, designed to meet GMP and HACCP standards in processing provinces such as Samar • Provide alternative livelihood programs to ensure income continuity for fishing households during the close season affecting fishers in Western Visayas, Zamboanga Peninsula, and other provinces implementing a close season or fishing ban
Governance	• Weak enforcement of fisheries laws (IUU fishing, juvenile catch) • Delayed issuance of permits and licenses affecting fishing operations	• Delayed issuance of permits causes missed opportunities in markets • Inconsistent policy implementation • Double taxation, excessive fees, questionable fees	• Traceability concerns for backyard processing production	• BFAR and LGUs should establish one-stop licensing centers and digitalized permit systems to streamline transactions and reduce operational delays • Strengthen law enforcement through community-based monitoring and stricter penalties against IUU fishing • BFAR and LGU should harmonize local and national policies on market regulation and streamline fees structures to reduce transaction costs and eliminate double taxation • Strengthen the traceability system so even backyard processors can meet market and export standards • Strengthen science-based fisheries management to ensure the biological sustainability of sardine stocks through stricter enforcement of harvest regulations and continued implementation of sardine closed seasons.

Note. The constraints and interventions/policy directions are based on the experiences and recommendations of stakeholders who participated in the study, and this is still framed with considerations for alignment with local resource conditions and institutional policies. *Talipapa* is an informal roadside stall where fresh fish are sold. CSWH means cold storage warehouses, GMP means good manufacturing practices, and HACCP means hazard analysis and critical control points. Western Visayas comprises the provinces of Iloilo and Capiz. The Zamboanga Peninsula (Region IX) is composed of the provinces of Zamboanga del Sur and Zamboanga del Norte, together with Zamboanga City as its highly urbanized center.

new technologies and to change prevailing practices. However, for the majority, it is the lack of financial resources and limited technical capacity that prevents them from adopting improved methods. The lack of appropriate operational facilities further exacerbates these challenges. In Bulan, Sorsogon, non-functional cold storage and insufficient processing capacity result in discarded catch. A similar constraint in Palawan, where ice supply deficiencies further restrict effective postharvest handling, intensifying spoilage risks and increasing transaction costs for both fishers and traders. In Samar and other sardine-producing provinces, where drying and smoking are primary postharvest activities, backyard processors often lack proper facilities and continue to rely on traditional household methods. This reliance on backyard processing often results in inconsistent quality, limited compliance with food safety standards, and constrained market reach.

Governance-related bottlenecks were reported by actors across the supply chain. The slow and untimely issuance of necessary permits and licenses leads to operational delays and income losses, particularly for laborers on commercial vessels whose earnings depend on daily catch. Under RA 10654, vessel operators have a 60-day window before license expiration to renew their licenses; however, fish catchers reported that processing delays remain a major constraint. Respondents indicated that licensing delays sometimes postpone fishing operations and reduce the number of active fishing days. Existing laws and policies, such as the closed fishing season, municipal–commercial fishing demarcations, and mandatory Vessel Monitoring System (VMS) installation, were frequently mentioned by fishers during interviews. The delineation of municipal waters under the Fisheries Code was also identified as a contested issue between commercial operators and municipal fishers. For traders, governance-related issues were reflected in policy implementation differences across provinces. Traders reported that variations in licensing requirements, permit procedures, and local enforcement practices affect trading operations. Some traders indicated that sourcing locations and trading routes were influenced by the presence of additional permits or fees in particular landing sites. Multiple and overlapping fees were also reported, including cases described by respondents as double taxation or additional charges imposed at landing sites or trading areas. Processors, particularly those operating on a backyard or small-scale level, also reported governance-related constraints linked to compliance with food safety and market requirements. Weak enforcement of traceability systems was noted as a challenge in monitoring raw material sources across trading networks. Small-scale processors reported difficulties in demonstrating raw material traceability, thus limiting their market expansion. Overall, governance-related issues identified by respondents include licensing delays, overlapping fees, differences in local regulatory practices, and limited enforcement of traceability systems. These conditions were reported to affect fishing operations, trading routes, compliance practices, and access to markets among actors in the sardine value chain.

4. DISCUSSION

The sardine fishery plays a critical role in supporting coastal livelihoods and ensuring the availability of affordable fish for local consumption, making it a key contributor to both food security and local economies. Ensuring its long-term socioeconomic viability, however, requires a more effective policies and structural interventions that address the economic and institutional conditions shaping the industry. This discussion examines the current landscape of the sardine fishery by analyzing operational arrangements, cost structures, and the challenges experienced by key stakeholders across the sardine value chain. In contrast to many value chain studies that focus primarily on production efficiency or market linkages, this study highlights the role of governance fragmentation, particularly overlapping institutional mandates and coordination gaps, in shaping the constraints and opportunities faced by actors within the sardine sector.

The value chain of fresh sardines in the Philippines is highly fragmented and geographically interconnected, reflecting the mobility of marine resources and the spatial distribution of fishing communities, trading hubs, and processing centers. The Bicol Region holds the second largest sardine production at 40.3 thousand MT in 2024, with the province of Sorsogon contributing about 82 percent of the regional production or approximately 33.2 thousand MT (PSA 2025). Meanwhile, the Zamboanga Peninsula accounted for approximately 51 percent of national sardine production in 2024, with Zamboanga del Sur producing around 127,000 MT (PSA 2025). High production in this region is largely attributed to commercial fishing operations in the Sulu Sea, Moro Gulf, Pagadian Bay, and Ilana Bay.

Fishers remain the backbone of the sardine supply chain, providing the raw material upon which all downstream activities depend. Yet, they also

represent the most vulnerable segment and have lower incomes than traders (Asiedu et al. 2022; Bassett et al. 2022; Lucas et al. 2024). Small-scale fishers are heavily dependent on traders for operating capital, creating conditions of credit dependency that reduce their bargaining power. This dynamic locks fishers into relationships where financiers dictate price at landing sites, limiting their ability to capture value even during times of high production. The cost and return analysis reveal that small-scale commercial fishers recorded the highest ROI at 83%. However, their absolute net income per activity cycle remains modest compared to traders and processors. This demonstrates that while small-scale fishing can be efficient in capital terms, it does not guarantee livelihood security under conditions of volatile markets, high operational risks, and weak institutional protection. This efficiency is what Béné and Friend (2009, 2011) described as the poverty trap of small-scale fisheries. Rising input costs combined with recurrent typhoons and unpredictable wind patterns intensify this vulnerability. The poverty trap extends beyond economic pressures into social dimensions of marginalization. Economically, the majority of fishers, particularly in Asia, face unstable income, indebtedness, and limited access to formal financial institutions (Mozumder et al. 2024; Taniu et al. 2024). These pressures compel them to maintain or even increase fishing intensity, often leading to the exploitation of dwindling resources and further reinforcing the cycle of poverty (Lammers et al. 2020). Socially, the situation is exacerbated by limited access to education, healthcare, and alternative livelihood opportunities. As D'agata et al. (2020) emphasize, such deprivations are not due to market inefficiencies but are embedded within wider structures of exclusion, reinforcing long-term vulnerability.

On the other hand, traders occupy a central position in the sardine value chain, acting as intermediaries bridging geographically dispersed production zones with centralized processing hubs. Fishing is concentrated in coastal and island provinces, while mechanized processing industries are clustered in urbanized areas, specifically, Zamboanga City and Metro Manila. This gap between scattered production areas and centralized processing hubs explains the presence of traders, who serve as key intermediaries bridging producers and processors (Coronado et al. 2020; Straume et al. 2024). In an archipelagic country, where inter-island transport is costly and logistically complex, dependence on traders becomes more pronounced. Distance acts as a trade barrier for fish catchers. According to Mao et al. (2024), 1% increase in distance reduces trade by 61%, highlighting how geography exacerbates transaction costs and shapes market access. While traders facilitate the movement of fresh sardines across regions, they also reinforce limited bargaining power for producers and offer processors higher raw material costs (Sandy et al. 2024; Babu et al. 2025). Although postharvest pathways, drying and smoking, exist in some producing provinces, they remain largely backyard-scale enterprises with limited capacity to absorb the surplus catch, amplifying the role of traders. In this context, traders not only facilitate distribution but also provide financing to fishers and absorb risks such as spoilage (Drury O'Neill et al. 2019). However, this dominance is double-edged. The results show that traders generated the highest absolute net income of PHP 157,550 per activity cycle by handling large volumes of sardines, but their 40% ROI is substantially lower than that of fishers. This reflects the heavy capital exposure associated with bulk procurement, where raw material purchases account for the majority of total costs. Moreover, traders face price volatility and unpredictable supply flows, both of which constrain profitability. Competition from informal markets such as *talipapa* stalls and peddlers erodes margins, while inconsistent policy implementation and redundant taxation increase transaction costs. The presence of traders also illustrates the broader governance dynamics of the chain. By controlling capital and market access, they exercise significant influence over both upstream and downstream actors. Comparable patterns are observed in other Asian countries, where traders dominate fish marketing (Apituley et al. 2019; Devi and Anitha 2021).

Key challenges, such as typhoons, overfishing, limited infrastructure, limited financial resources, and insufficient government support, are constant problems for a developing country (Okeke-Ogbuafor et al. 2021; Vishva and Gayathiri, 2025). Addressing these vulnerabilities of Philippine sardine fishers requires targeted improvement in credit access and input cost stabilization, as well as better government support and programs, such as but not limited to sustainable alternative livelihoods, and centralized and accessible postharvest infrastructures. In addition, strict implementation of existing laws and regulations on fisheries would help address problems on the sustainability of fishery resources. At present, dependence on trader-financiers perpetuates exploitative patron–client dynamics and weakens fishers' bargaining power. A clear policy direction is to expand fisherfolk access to formal, collateral-free credit, strengthen cooperatives to negotiate fairer terms of trade, and promote financial literacy (Grace

et al. 2019; Pomeroy et al. 2020). Success stories from Norway demonstrate how cooperative financing and collective marketing transformed small-scale fisheries by reducing reliance on middlemen and stabilizing producer incomes (Jentoft and Finstad 2018). Similarly, as seen in Mexican lobster cooperatives, it supports sustainability and economic benefits, suggesting similar potential in the Philippines (Elsler et al. 2022). Moreover, tailored models like the Responsible Market Systems (RMS) have been proposed to enhance financial inclusion through Community Revolving Funds (CRFs) and cooperatives, which help in providing affordable loans and improving market access to coastal fishing communities (Khan and Sano, 2025). Microfinance has already been used to stabilize the incomes of farmers in some provinces in the Philippines, suggesting similar potential benefits for fishers (Fronda 2024).

On the operational and environmental fronts, the sardine sector remains highly vulnerable to seasonal oversupply, climate shocks, and lean-season scarcity, resulting in sharp price fluctuations and postharvest losses. Cold storage facilities have been shown to significantly reduce postharvest losses by maintaining optimal temperature and humidity levels critical for preserving perishable commodities, including fish (Cheng et al. 2024; Opara 2024). For instance, studies in Africa demonstrated that low-cost technologies, such as solar-powered communal cold storage, extended the shelf life of crops (Elolu et al. 2025), and reduced fish spoilage to nearly zero when properly refrigerated (Carlsson et al. 2025). By enabling fishers to store their catch during periods of abundance and sell it when prices are higher, cold storage not only reduces waste but also stabilizes rural incomes by mitigating seasonal price fluctuations (Carlsson et al. 2025; Setiawan et al. 2021). In India, the profitability of ice production for fish preservation has been demonstrated, with benefit-cost ratios indicating that ice production is a viable economic activity. This supports the need for adequate ice supply to reduce postharvest losses and stabilize income (Seenivasan et al. 2025). Aside from cold chain infrastructure, insurance should also be focused to help producers manage environmental risks and adapt to climate-related challenges. It can facilitate a managed retreat from vulnerable areas and support long-term resilience (Hobday et al. 2025). For the Philippines, scaling up fisheries insurance through the PCIC, promoting adaptive co-management of closed seasons, and investing in localized cold chain systems are critical strategies to align livelihood security with ecological sustainability.

Effective governance is central to the long-term sustainability of the Philippine sardine industry. Like many small-scale fisheries worldwide, existing governance frameworks struggle to balance social, economic, and ecological objectives (Aguión et al. 2022). In the Philippines, fisheries governance involves shared authority between national agencies and local government units, which often results in variations in licensing procedures, enforcement practices, and regulatory implementation across provinces. These differences create fragmented governance conditions that influence how actors participate in the sardine value chain and shape market transactions. Weak enforcement of fisheries regulations has allowed noncompliance and the harvest of juvenile sardines to persist, leading to resource overexploitation and income instability for fishing households (Bose 2021). At the same time, regulatory inconsistencies such as delays in permit issuance, overlapping market fees, and differences in enforcement practices can increase transaction costs for traders and processors. These additional costs are often transmitted upstream through lower landing prices offered to fishers, thereby contributing to value erosion and income instability along the value chain. While seasonal fishery closures (SFCs) have proven effective in conserving sardine stocks, their long-term success depends on strict implementation, clear operational guidelines, and the provision of alternative livelihoods to mitigate short-term economic losses (Ungkakay-Bagsit et al. 2023). In contexts where enforcement capacity varies across jurisdictions and livelihood alternatives remain limited, compliance may decline as fishers attempt to stabilize income during restricted fishing periods. Strengthening institutional coordination and regulatory consistency is therefore critical not only for resource sustainability but also for stabilizing market conditions and ensuring a more equitable distribution of value among actors in the sardine industry.

International experience demonstrates that fisheries governance reforms can improve sustainability when institutions are strengthened and policies are better coordinated. While high-income regions such as the European Union illustrate how harmonized regulatory frameworks, science-based quotas, and coordinated enforcement mechanisms can stabilize fish stocks and reduce regulatory uncertainty (Diekert et al. 2021; EU 2025), lessons from middle- and lower-income fisheries systems are particularly relevant for developing countries. For example, China's recent fisheries governance reforms under its "ecological civilization" policy framework aim to harmonize regulations across provinces, strengthen monitoring

systems, and improve traceability in marine resource management. These measures seek to reverse declining fish stocks while promoting more sustainable fishing practices, although implementation challenges remain (Cao et al. 2017). Similar institutional and socioeconomic challenges are observed in South Asian fisheries, including Bangladesh, India, and Sri Lanka, where small-scale fisheries dominate production and livelihoods. In these contexts, policy responses have emphasized livelihood diversification, capacity development, and community-based management approaches to reduce pressure on fish stocks while sustaining fisher incomes (Rashid et al. 2020; Rana et al. 2025). These experiences suggest that fisheries reforms in developing economies often require a combination of strengthened regulatory institutions, improved monitoring and traceability systems, and complementary socioeconomic interventions that support the resilience of small-scale fishing communities.

Beyond governance reforms, ensuring the biological sustainability of sardine stocks is fundamental to the industry's long-term viability. Biological sustainability underpins the stability of raw material supply, which in turn sustains the economic performance of downstream actors such as traders and processors. Science-based fisheries management, supported by regular biological assessments, plays a critical role in determining sustainable harvest levels and preventing overfishing. Stock assessments provide essential information on stock health, reproductive patterns, and biological reference points such as maximum sustainable yield, which guide management decisions and help maintain ecological balance (Yongchuang et al. 2021; Huang et al. 2022; Taufani and Matsuishi 2025). Continuous monitoring also allows policymakers to evaluate the effectiveness of management interventions and adapt regulations based on scientific evidence (Huang et al. 2022).

Integrating biological data with socioeconomic strategies is therefore essential for sustainable fisheries governance. Combining stock monitoring with interventions such as alternative livelihood programs, improved market infrastructure, and value chain development can help mitigate the short-term economic impacts of conservation measures while strengthening long-term resource sustainability (Napata et al. 2020). In this context, biological sustainability contributes to the broader "triple bottom line" of fisheries management by balancing ecological integrity, economic productivity, and community well-being (Anderson et al. 2015; Suharno et al. 2019).

Therefore, the policy agenda for the Philippine sardine industry should be anchored on the interconnected pillars: economic resilience, operational adaptability, governance coherence, and biological sustainability. Economically, expanding fisherfolk access to formal credit, stabilizing input prices, and providing fisheries insurance can reduce financial vulnerability and enhance productivity. Operationally, investments in localized processing hubs, decentralized cold chain systems, and climate-resilient fishing technologies can reduce postharvest losses, smooth seasonal fluctuations, and generate value-added opportunities. From a governance perspective, streamlining permit processes, harmonizing fragmented policies, and strengthening enforcement against illegal, unreported, and unregulated (IUU) fishing are crucial for improving regulatory predictability. Complementing these measures, science-based fisheries management, including regular stock assessments, harvest controls, and sustained implementation of sardine closed seasons, will ensure the biological sustainability of sardine stocks that support the entire value chain.

5. CONCLUSION AND MANAGEMENT OPTIONS

The Philippine sardine industry remains a foundation of food security, employment, and rural livelihoods, yet persistent economic, operational, and governance bottlenecks constrain its performance. Small-scale fishers face the most severe vulnerabilities, being trapped in credit lock-in relationships, exposed to rising input costs, and lacking access to processing facilities in major landing areas. Small-scale traders and backyard processors also face structural disadvantages, including limited access to formal credit, inadequate cold chain and processing infrastructure, and difficulties complying with regulatory and food-safety standards. In contrast, larger traders and industrial processors operate with greater capital, storage capacity, and established market linkages, allowing them to manage supply volatility and comply more easily with regulatory requirements, although they remain exposed to high procurement costs, labor expenses, and market price fluctuations. Traders, though central to distribution, operate with high capital exposure, volatile supply flows, and competition from informal markets (e.g., *talipapa*, peddlers), while processors struggle with uneven profitability, high input costs, and quality constraints tied to both raw materials and outdated technologies.

Addressing these challenges requires a policy framework that is both area-specific and nationally coordinated. At the policy level, improvements are recommended to improve the enabling environment for the sardine value chain. These include expanding access to collateral-free and affordable credit, stabilizing input prices through cooperative purchasing mechanisms, strengthening fisheries insurance schemes in typhoon-prone regions, and harmonizing licensing systems and trading regulations across local and national levels. Policy interventions should also consider the differing capacities of actors across the value chain. Support programs that improve financial access, regulatory compliance, and market participation for small-scale traders and processors are particularly important to ensure that value chain development remains inclusive. Additional policy improvements should focus on streamlining fee structures, strengthening enforcement against illegal, unreported, and unregulated (IUU) fishing, and establishing inclusive traceability systems that extend to small-scale and backyard processors.

Complementing these policy improvements, targeted management options are necessary to improve operational efficiency within the value chain. These include investments in cold-storage facilities, government-supported ice plants, and modernized drying and smoking technologies, as well as the establishment of cooperative-managed processing facilities that comply with food-safety and quality standards. Such interventions are particularly critical for small-scale actors who currently lack access to adequate infrastructure and market facilities, while larger processors may benefit from improved supply stability and reduced postharvest losses across the chain. Such management interventions can help reduce postharvest losses, stabilize supply flows, and enhance value addition across the chain.

By implementing both policy improvements and practical management interventions, the sardine industry will be a more resilient**,** competitive, and socially equitable value chain. This will not only stabilize the incomes of fishers, traders, and processors but also reinforce national food security and drive sustainable economic growth in coastal areas. In general, strengthening the Philippines' sardine value chain requires integrated governance that simultaneously addresses resource sustainability, market coordination, and infrastructure gaps. Aligning policy improvements with targeted value-chain management interventions will be essential to ensure the industry remains both economically viable and ecologically sustainable amid rising climate and market uncertainties.

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AUTHOR CONTRIBUTIONS

Bernajocele Jalyn S. Baldoza: Visualization, Formal analysis, Writing - original draft. **Reymark C. Busalla**: Data Curation, Methodology, Writing – review and editing. **Janine T. Ametin:** Project administration, Methodology. **Angellie G. Fernandez:** Project Administration, Methodology. **Ulysses M. Montojo**: Conceptualization, Funding Acquisition, Writing – review editing.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICS STATEMENT

All participants were fully informed about the purpose and objectives of the study, the procedures involved, and the voluntary nature of their participation. Prior to each interview, written informed consent was obtained after participants received clear explanations of the study and had the opportunity to ask questions. Participants were assured that there would be no penalties or loss of benefits for declining or withdrawing at any stage. To protect confidentiality, all responses were anonymized for analysis and reporting. Although an institutional ethics committee did not formally review this study, the research adhered to widely accepted ethical principles for social science research, including respect for persons and confidentiality.

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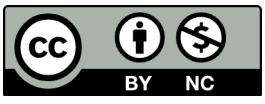

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