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The Philippine Fisheries Postharvest and Marketing Sector: Status, Challenges, and Prospects Toward a Sustainable Value Chain

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ABSTRACT

Postharvest activities are an integral part of the fisheries value chain as they not only convert raw catch into safe, consumable, and marketable products to satisfy the diverse needs of a rapidly growing population but also serve as critical engines of employment generation and economic growth. The fisheries postharvest sector in the Philippines is structurally diverse because it ranges from traditional household- and community-based processing to highly industrialized, export-oriented facilities. Notwithstanding its critical role in value creation and food security, the sector has received comparatively limited policy attention and investment support relative to capture fisheries and aquaculture. As a result, longstanding structural barriers remain unaddressed, thereby delaying progress and constraining the realization of its full development potential. The Philippines has a strong production base but has yet to fully leverage this capacity by means of more efficient postharvest, logistics, and marketing systems. Drawing on national statistics, policy documents, and recent empirical studies, this review provides a thorough analysis of the current status of the Philippine fisheries postharvest and marketing sector, highlighting structural challenges, emerging opportunities, and prospects for sustainable development. It synthesizes developments in postharvest systems, food safety compliance, trade performance and outlook, research and development initiatives, as well as institutional and governance frameworks. A clearer understanding of these dimensions is important to

Transactions NAST PHL Vol. 48 (2026)
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deal with persistent constraints while strategically harnessing technological, institutional, and market-based opportunities to steer the sector toward a more inclusive, sustainable, resilient, and globally competitive fisheries value chain.

Keywords: Fish processing, value chain, postharvest losses, food safety, trade and marketing

Abbreviations: ASEAN, Association of Southeast Asian Nations; BAFS, Bureau of Agriculture and Fisheries Standards; BFAR, Bureau of Fisheries and Aquatic Resources; CFI, Coastal Fisheries Initiative; CFLC, Community Fish Landing Center; CFP, Ciguatera Fish Poisoning; CNFIDP, Comprehensive National Fisheries Industry Development Plan; CPHMAIDP, Comprehensive Postharvest, Marketing and Ancillary Industries Development Plan; DOST, Department of Science and Technology; DTI, Department of Trade and Industry; ESBL, extended-spectrum β-lactamase; EU, European Union; FAOs, Fisheries Administrative Orders; FAO, Food and Agriculture Organization; FDA, Food and Drug Administration; FISHCORE, Philippine Fisheries and Coastal Resiliency; GMP, Good Manufacturing Product; HAV, Hepatitis A Virus; IUU, Illegal, Unreported, and Unregulated; LGUs, Local Government Unit; NFRDI, National Fisheries Research and Development; MSME, Micro, Small, and Medium Enterprise; PFDA, Philippine Fisheries Development Authority; PhilMech, Philippine Center for Postharvest Development and Mechanization; PNS, Philippine National Standards; PSP, Paralytic Shellfish Poisoning; R&D, Research and Development; SDG, Sustainable Development Goal; USA, United States of America; WCPFC, Western and Central Pacific Fisheries Commission, WHO, World Health Organization

1. Introduction

The Philippines' extensive marine and inland resources play a critical role in food security, employment, and rural development. In 2022, the country produced approximately 4.34 million metric tons (MT) of fisheries output valued at USD 5.7 billion, with aquaculture contributing the largest share, followed by municipal and capture fisheries (BFAR 2023). In economic terms, fishing and aquaculture generated USD 4.7 billion in Gross Value Added (GVA) and maintained a trade surplus of approximately USD 292.25 million. Despite this strong production base, the country continues to face challenges in translating output into higher value across the fisheries value chain.

The postharvest and marketing sector serves as a critical link between production and consumption, encompassing handling, preservation, processing, storage, and distribution. These activities directly influence product quality, safety, and competitiveness (Akintola et al. 2022; Gopal et al. 2014). However, similar to other developing economies, the sector is constrained by persistent bottlenecks, including postharvest losses, climate-related risks, infrastructure deficiencies, technological limitations, and food safety concerns. Compared with neighboring ASEAN countries such as Vietnam and Thailand, the Philippines has yet to fully leverage its production capacity through efficient and integrated postharvest and marketing systems.

With seafood demand expected to rise alongside population growth and changing dietary patterns, international markets are becoming increasingly stringent in enforcing requirements on traceability, food safety, and sustainability (FAO 2024). In response, government agencies, research institutions, and development partners have implemented various initiatives aimed at improving postharvest technologies, infrastructure, and regulatory systems. However, the scaling and widespread adoption of these interventions remain limited, while trade rejections and market access constraints persist. At the same time, global policy frameworks, including the Sustainable Development Goals (SDGs), circular economy approaches, and climate-resilient value chains, underscore the urgency of strengthening the country's postharvest development agenda (Kurniawan and Fernando 2023; Valverde and Avilés-Palacios 2021).

This review examines the Philippine fisheries postharvest and marketing sector by analyzing its current status, key challenges, and prospects. It synthesizes developments in governance, postharvest systems, food safety compliance, trade and marketing, as well as research and development (R&D), with the aim of informing strategies that enhance efficiency, resilience, and inclusivity while strengthening the sector's competitiveness in global markets.

Transactions NAST PHL Vol. 48 (2026)
doi.org/10.57043/transnastphl.2026.6367

2. Overview and Status of the Philippine Fisheries Postharvest Sector

2.1 Industry structure

The Philippine fisheries postharvest sector is structurally diverse, reflecting differences in commodity composition, market orientation, scale of operation, and access to capital and technology. Major commodities include seaweeds, tuna, milkfish, tilapia, small pelagics, shellfish, and crustaceans (BFAR 2023). It includes both traditional household- and community-based processing systems and highly industrialized, export-oriented facilities. Small-scale processors primarily supply low-cost products to local markets, whereas MSMEs and cooperatives produce semi-processed and value-added products for regional and national distribution (Tahıluddın and Kadak 2022). At the industrial end, large processing hubs in Metro Manila, Cebu, General Santos City, and Zamboanga City are more tightly integrated into global seafood value chains and are better positioned to meet volume, quality, and compliance requirements.

2.2 Institutional and policy framework

Several agencies perform complementary roles in regulation, research, infrastructure development, and enterprise support. The Bureau of Fisheries and Aquatic Resources (BFAR) serves as the lead authority for regulatory compliance, licensing, and extension services. Research and innovation are led primarily by the National Fisheries Research and Development Institute (NFRDI), while the Philippine Center for Postharvest Development and Mechanization (PHilMech) supports mechanization and technology development. The Department of Science and Technology (DOST) facilitates product innovation and technology transfer, and the Department of Trade and Industry (DTI) supports enterprise development. The Food and Drug Administration (FDA) regulates the safety, quality, and labeling of processed products, while the Philippine Fisheries Development Authority (PFDA) provides infrastructure support, mainly fish ports, ice plants, and cold storage facilities.

These institutional functions are supported by a broad set of laws, plans, and regulatory instruments. The Philippine Fisheries Code (Republic Act No. 8550), as amended by RA 10654, provides the legal basis for fisheries management and development, while the Republic Act No. 10611 or the Food Safety Act of 2013 adopts a risk-based, farm-to-fork approach and defines the responsibilities of the Department of Agriculture, Department of Health, and local government units in regulating fishery products. Strategic direction is provided by the Comprehensive National Fisheries Industry Development Plan (CNFIDP) and the Comprehensive Postharvest, Marketing and Ancillary Industries Development Plan (CPHMAIDP), together with commodity-specific roadmaps. Philippine National Standards (PNS) and Fisheries Administrative Orders (FAOs) further establish product specifications, handling requirements, and export compliance measures.

2.3 Postharvest systems and processing pathways

Philippine postharvest operations are shaped by a complex value chain in which intermediaries play a central role in aggregation, financing, and price formation (as summarized in Figure 1). This figure illustrates the flow of fishery products across production, processing, and marketing stages, and situates these pathways within the broader regulatory and institutional environment that influences postharvest performance and market access.

In small-scale fisheries, traders, brokers, and consolidators exercise substantial influence over market access and pricing. Although these actors facilitate product movement across dispersed production areas, they also perpetuate dependency and asymmetrical power relations within the chain. As a result, postharvest performance depends not only on technical efficiency but also on how products, risks, and margins are distributed among actors.

2.3.1 Handling and on-board preservation

Delayed or inadequate chilling accelerates biochemical and microbiological degradation in fish, resulting in sensory deterioration, reduced shelf life, and food safety risks such as histamine formation (Akintola et al. 2022; Duarte et al. 2020). This constraint

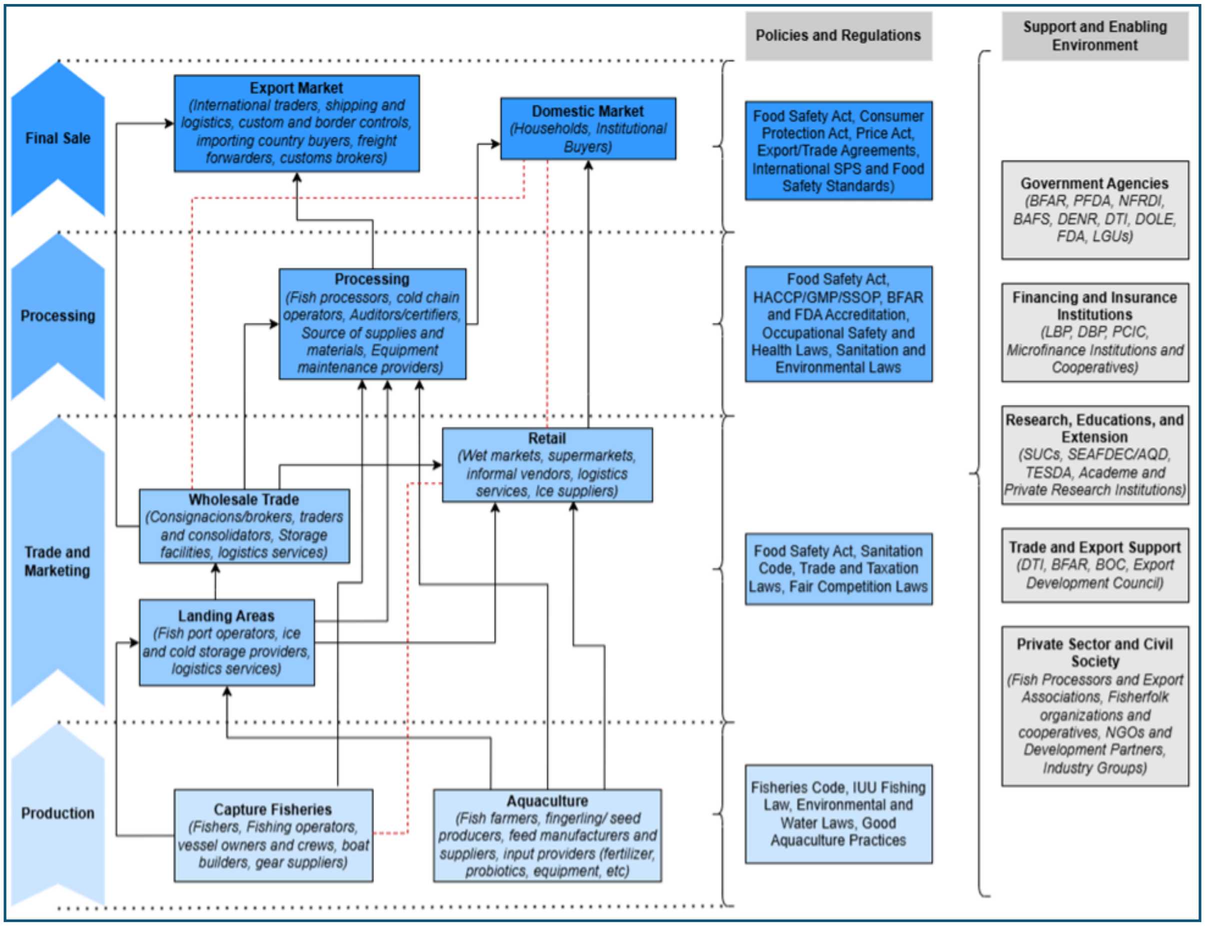

Figure 1. The Philippine fisheries value chain.

is not only confined to small-scale fisheries. Philippine-flagged carrier vessels operating in High Seas Pocket 1, for instance, are restricted to ice-chilled storage under Western and Central Pacific Fisheries Commission (WCPFC) conservation measures, a condition associated with declining tuna quality and postharvest losses estimated at 17.25% (Montojo et al. 2020b).

Among small-scale and artisanal fishers, preservation is further constrained by limited access to clean ice, insulated containers, and potable water. Wet icing with crushed ice is the most common practice, yet storage often relies on poorly insulated and unhygienic containers, increasing exposure to temperature fluctuations, physical damage, and microbial contamination (Espejo-Hermes 2004). Although postharvest infrastructure has expanded through PFDA and BFAR programs, the level of service provided differs widely across locations. As shown in Table 1, major ports such as Navotas and General Santos are equipped with higher berthing capacity and supporting facilities, including ice plants and market halls, whereas others operate with more limited capacity. At the municipal level, several fish ports and associated cold chain facilities are non-operational or lack complementary services (Table 2). A similar pattern is observed in Community Fish Landing Centers (CFLCs), where a large number of sites have been established, although not all are fully operational (Table 3).

Transactions NAST PHL Vol. 48 (2026)
doi.org/10.57043/transnastphl.2026.6367

Table 1. Available facilities and annual maximum capacities of PFDA regional fish ports in the Philippines

Facilities	**Regional Fish Ports** (Annual Maximum Capacity)								
	Sual Fish Port	Lucena Fish Port Complex	Camaligan Fish Port	Bulan Fish Port Complex	Navotas Fish Port Complex	Iloilo Fish Port Complex	Zamboanga Fish Port Complex	Davao Fish Port Complex	General Santos City Fish Port Complex
Pier/Quay									
Commercial Vessel (*No. of berthing days*)	5,339	8,640	-	4,000	51,830	16,000	2,184	6,036	33,000
Municipal Banca (*No. of vessel arrival*)	9	14,400	-	12.5	11,460	34	14,400	24	105
Cold Storage (Room[1]/Cubicle[2]/Area in sq.m[3])	-	5[1]	3[1]	-	-	360[3]	-	7[2]	126[s]
Ice Making Plant (*MT*)	-	-	-	-	-	-	-	17,820	21,900
Market Hall									
Broker's Bay (*No. of bay*)	-	32	-	12.5	217	35	24	24	105
Retailer's Stall/ Table (*No. of table*)	-	35	-	-	-	-	-	-	-
Building Spaces, Commerical and Industrial Area									
Building Spaces (*Area in sq.m*)	428	3,065	-	450.9	339,116	4,041	-	5,547	-
Building Spaces – Refrigeration Facility (*Area in sq. m*)	-	-	-	-	-	4,328	-	-	-
Commercial and Industrial Area (*Area in sq.m*)	16,266	6,058	-	260	-	96,409	31,320	4,014	121,552
Processing Area (*Area in sq.m*)	-	-	942.3	-	-	-	-	513	2,243
Ongoing Rehabilitation/ Construction/ Improvement	X	-	X	X	X	X	X	-	X

Source: PFDA (unpublished data) 2025.

Transactions NAST PHL Vol. 48 (2026)
doi.org/10.57043/transnastphl.2026.6367

Table 2. Regional distribution and operational status of PFDA city/municipal fish ports ice plant-cold storage facilities.

Region	City/Municipality Fish Port			Ice Plant and Cold Storage	
	Operational	Non-Operational	For Turn-over	Operational	For Turn-over
CAR	-	1	-	-	-
NCR	1	-	-	-	-
I	4	1	-	-	1
II	2	6	-	-	-
III	9	3	-	1	-
IV-A	8	5	-	-	-
IV-B	9	3	-	4	1
V	12	3	-	-	1
VI	9	3	-	1	-
VII	7	9	-	-	-
VIII	10	2	-	-	-
IX	6	1	-	1	-
X	3	1	-	-	-
XI	3	-	2	-	1
XII	3	1	-	-	-
XIII	2	2	1	-	-
BARMM	3	5	-	-	-
TOTAL	91	46	3	7	4

Source: PFDA (unpublished data) 2025.

Table 3. Regional distribution and operational status of Community Fish Landing Centers (CFLCs),.

Region	Operational	For Operation	For Completion	Damaged	Total
CAR	1	-	-	-	1
I	41	-	-	-	41
II	8	16	-	-	24
III	25	1	-	-	26
IV-A	24	25	-	-	49
IV-B	27	19	-	2	48
V	67	7	-	2	76
VI	42	12	-	4	58
VII	34	5	1	1	41
VIII	43	24	-	-	67
IX	41	1	-	-	42
X	34	13	-	-	47
XI	15	5	-	-	20
XII	5	4	-	1	10
CARAGA	23	10	-	-	33
TOTAL	40	142	1	10	583

Source: BFAR (unpublished data) 2025.

Transactions NAST PHL Vol. 48 (2026)
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2.3.2 Fish processing technologies

Fish processing in the Philippines can be broadly categorized into traditional and modern systems. Traditional methods such as smoking, drying, and salting are still widely practiced in small-scale fisheries, where they provide low-cost preservation and support household livelihoods (FAO 2021; Tahiluddin and Kadak 2021). Table 4 summarizes the major fishery commodities and their corresponding product forms. High-value species tend to have more diversified and value-added outputs, while small pelagics are more commonly associated with traditional processed forms. However, these systems are often constrained by uneven value distribution, raw material variability, and weather dependence. For instance, dried sardine value chains in the Bicol region show that processors capture higher returns, while fisherfolk incur losses due to declining supply and reliance on traders (Amado and Mojanos 2021). Product quality is also affected by improper handling, with studies reporting elevated microbial loads and histamine accumulation in dried fish from Zamboanga del Sur and Cavite (Andot and Pobar 2017; Ching et al. 2024).

Technological interventions in drying have demonstrated improvements in efficiency and product quality, including hybrid solar–hot-air systems, heat-sensor dryers, and solar–AC dryers (Trondillo et al. 2018; Macabutas et al. 2018; Escoto et al. 2024). IoT-enabled solar dryers further enhance process control through real-time monitoring and temperature regulation under variable weather conditions (Miano et al. 2023). Despite these advances, adoption at industry scale is still limited due to high capital requirements and technical constraints.

Developments in smoking technologies include integrated systems that combine boiling, drying, and smoking, semi-automated brining devices, and solar-powered smokehouses equipped with temperature and humidity sensors (Bartolome et al. 2022; Taduran 2024; Abella and Cruz 2025). Ergonomic improvements using digital simulation tools have also been explored to improve workstation efficiency (Macaraig 2024). In marination and fermentation, process optimization has focused on improving product stability and functional properties. Studies show that marination combined with drying or refrigeration can extend shelf life and enhance sensory quality (Simora et al. 2021; San Juan et al. 2024; Sorio and Inolino 2018), while innovations in fermentation, including irradiation pretreatment and extended fermentation, have improved microbial safety and nutritional attributes (Mojica et al. 2005; Peralta et al. 2008). Attempts to modernize fermentation through automated processing systems have emerged, although their operational viability has yet to be established (Bajet and Esguerra 2008; Enriquez and Ballo 2022).

At the industrial scale, freezing and canning are the most advanced segments of the sector. Frozen seafood, particularly tuna, dominates exports to major markets such as Japan, the United States of America (USA), and the European Union (EU) (Castro et al. 2017). The canning industry, primarily processing tuna, sardines, mackerel, and blue swimming crab, continues to be one of the most technologically developed subsectors, with the Philippines recognized as one of the major producers of canned tuna in the Western and Central Pacific Ocean and globally (BFAR 2025). Product innovation also reflects changing consumer preferences; for instance, tuna products with vegetable-based formulations show potential for reducing raw material use while maintaining demand (Castro et al. 2021). Bottling has also emerged as a niche processing pathway for small- and medium-scale enterprises, particularly in Zamboanga del Norte (Narvaez et al. 2018; Bigueja et al. 2020).

2.3.3 Value-addition and by-product utilization

Rising demand for convenient, fortified, and functional seafood products has driven increased emphasis on value addition and waste reduction across fishery commodities. These approaches not only diversify product offerings and enhance competitiveness but also reduce postharvest losses by converting low-value and underutilized materials into higher-value products (Torres et al. 2007). Product innovation has expanded across species, with tilapia processed into dumplings, cakes, and ice cream (Najera et al. 2024; Crisologo and Naelga 2022), milkfish into sausages, nuggets, and ready-to-eat meals (Salayo et al. 2021), and green mussels into noodles, spreads, and meat-based products (Doncillo and Combras 2017; Sorio and Arcales 2022).

By-product valorization is one of the core strategies for advancing circular resource use, with increasing applications for fish skin, bones, scales, viscera, and shellfish residues. Shrimp head waste has been

Table 4. Major Philippine fishery commodities and product forms.

Commodity	Fresh whole	Frozen	Canned	Bottled	Dried	Smoked	Fillet	Value-added	Live
Tuna	x	x	x	x	x	x	x	x	
Roundscad	x				x	x			
Sardines	x		x	x	x	x			
Other Small Pelagics (Mackerel, Anchovy, Slipmouth, Fusilier, etc.)	x		x	x	x	x			
Milkfish	x		x	x	x	x	x	x	
Tilapia	x				x	x		x	x
Shrimp/Prawn	x	x						x	
Blue Swimming Crab	x		x					x	x
Mussels/Oysters	x			x	x				x
Octopus/Squid	x	x		x	x				
Other High-Value Fish (Grouper, Snapper, Rabbitfish, Lobster, Mud Crab)	x	x					x		x
Seaweed	x				x			x	

developed into fortified food powder (Bassig et al. 2021), while oyster and squid by-products have been utilized as aquafeed ingredients (Pan et al. 2022; Serrano et al. 2016). Oyster-processing residues from *Magallana bilineata* exhibit antioxidant, antibacterial, and anticancer properties, highlighting their potential for nutraceutical and pharmaceutical applications (Simora et al. 2025). Biopolymer extraction from wastes of *Scylla serrata* and *Perna viridis* has yielded high-purity chitin and chitosan suitable for packaging and biomedical use, while collagen, gelatin, and protein hydrolysates derived from milkfish (*Chanos chanos*), yellowfin tuna (*Thunnus albacares*), and oneknife unicornfish (*Naso thynnoides*) demonstrate strong functional, antioxidant, and bioactive properties (Alolod et al. 2019; Bautista et al. 2023; De Asis et al. 2023; Pimentel et al. 2024; Rayos et al. 2025). Fish waste has also been explored as a substrate for enzyme production, as shown by the generation of thermostable protease from *Pseudomonas sp.* PD14 using viscera-derived materials (Armada and Simora 2022). In addition, market-derived fish wastes present significant potential for conversion into collagen, gelatin, silage, and biodegradable packaging materials (Bayson et al. 2022).

At the industry level, zero-waste approaches are increasingly adopted, particularly in the sardine sector, where full utilization of raw materials, from fishmeal and silage production to oil extraction and composting, has improved resource efficiency while reducing environmental impacts. These practices demonstrate the feasibility of integrating circular and resource-efficient strategies into large-scale seafood processing.

2.4 Market distribution and trade dynamics

Fish is a major component of the Filipino diet, contributing 11.7% of daily food intake or about 93.9 g per person per day, and supplying around 42% of total animal-source protein (BFAR 2024). Despite its dietary importance, per capita fish consumption declined from 36 kg yr^{-1} in 1993 to 14.3 kg yr^{-1} in 2018–2019 (MRAG Asia Pacific 2022). Domestic distribution typically involves multiple stages, with products passing through buying stations and consolidation hubs before reaching markets or processors. Transport systems vary widely, ranging from refrigerated trucks in major ports to motorcycles and small boats in island municipalities (BFAR 2018). The concentration of processing and trading hubs in urban centers lengthens supply routes from remote production areas, while repeated handling and inconsistent temperature control contribute to quality deterioration and postharvest losses, with implications for both domestic supply and export compliance.

Figure 2 presents trends in total fisheries production, exports, and imports from 2014 to 2023, showing a gradual decline in production, fluctuating export volumes, and a general increase in imports. Fishery exports are a substantial source of foreign exchange, with tuna as the leading commodity in the form of frozen loins, canned products, and sashimi-grade fillets (BFAR 2024). The Philippines is also a major global supplier of carrageenan derived from red seaweeds Eucheuma and Kappaphycus. Figure 3 presents the top export destinations of Philippine fishery products and the composition of export commodities by value and volume, indicating that export markets are mainly concentrated in North America, Europe, as well as East and Southeast Asia.

However, export performance is constrained by product rejection linked to quality defects, food safety violations, including Salmonella, Listeria monocytogenes, Escherichia coli, heavy metals, and histamine, as well as regulatory non-compliance. Table 5 summarizes the annual record of trade rejections from 2019 to 2025, indicating that most cases are consistently linked to microbial contamination, histamine, and related food safety concerns, with fewer instances attributed to adulteration, labelling issues, and certification gaps. Additional barriers include stringent sanitary and phytosanitary requirements, complex certification procedures, and price volatility in international markets. The rejection of Sardinella lemuru in the EU due to its exclusion from Codex standards illustrates how technical regulations can restrict market access. The subsequent amendment of CXS 94-1981 in 2024 marked a significant step in addressing this trade barrier (CAC 2024).

Increasing imports under ASEAN trade integration further intensify competition in domestic markets.

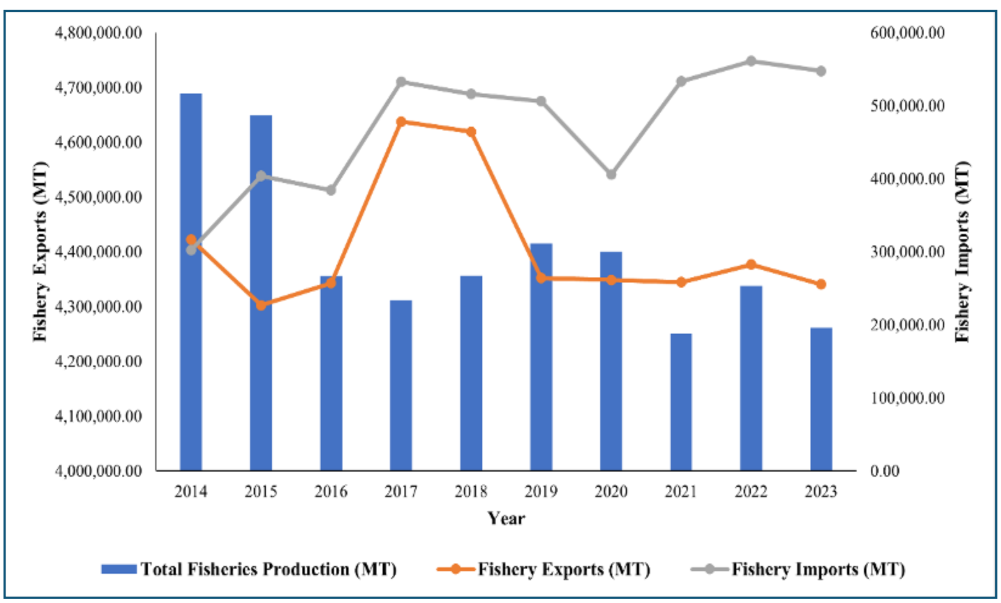

Figure 2. Total fisheries production, exports, and imports, 2014–2023
Source: Compiled and illustrated by the authors from Philippines Fisheries Profile data.

Transactions NAST PHL Vol. 48 (2026)
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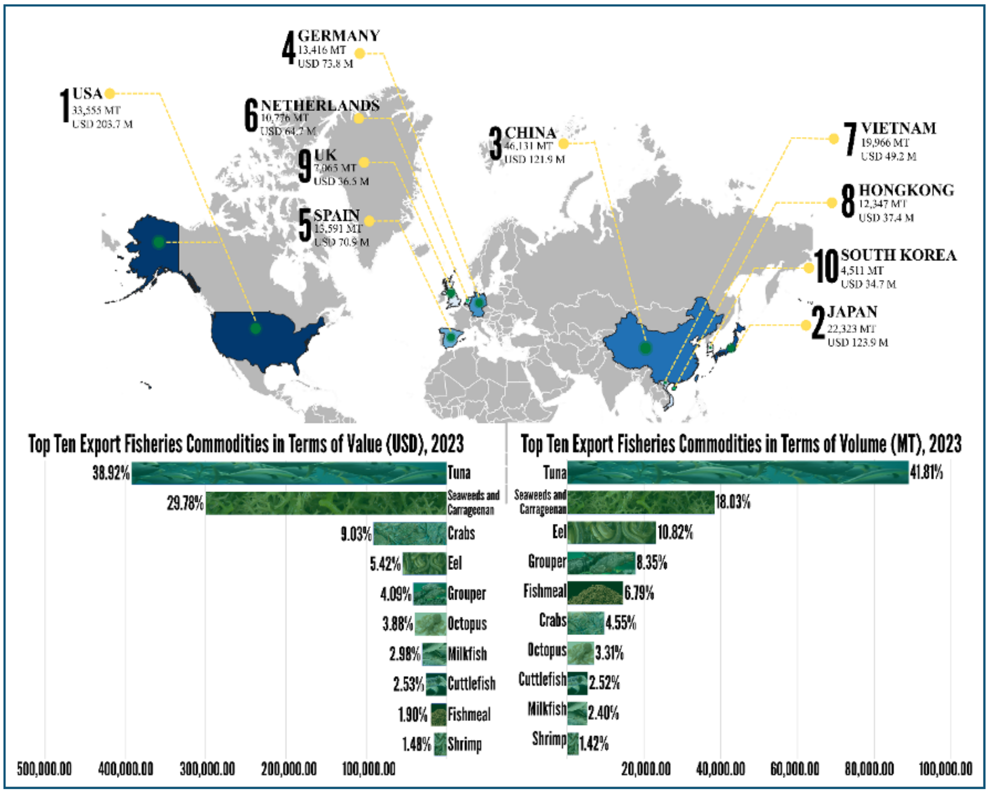

Figure 3. Top 10 export destinations and leading fishery commodities by volume and value, 2023. Source: map adapted and bar charts prepared by the authors using data from the Philippines Fisheries Profile 2023.

Table 5. Annual record of trade rejections in the Philippines from 2019-2025

Reasons	Year						
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Filthy/ Decomposed Substance/ Adulteration	5	1	5	5	3	5	7
Microbial, Histamine Heavy Metal, Carbon Monoxide Contamination/ Disease Detection	10	3	4	6	5	9	4
Insanitary Manufacturing Practices/ Lapse on Product Formulation/ Issue with Product Labelling	3	-	2	5	1	4	4
Issue with Health Certificate	-	-	2	-	-	-	-

Source: BFAR (unpublished data) 2025.

Although imports help stabilize supply and prices, they also place pressure on local processors facing higher production costs and limited support mechanisms (BFAR 2018). Digital platforms and e-commerce systems are emerging as alternative distribution channels that can shorten supply chains, improve price transparency, and expand market access. Their effectiveness, however, will depend on improvements in logistics, cold chain systems, and traceability to ensure product quality and compliance with evolving market requirements.

3. Safety and Quality of Philippine Fishery Products

Food safety and quality issues have been documented across a broad range of fishery commodities and production settings. Annex Table 1 consolidates these reported hazards and summarizes the associated contaminants, affected products, study areas, and key findings. Biological hazards are the most documented, with bacterial pathogens such as *E. coli*, *Vibrio* spp., *Salmonella* spp., and *Staphylococcus aureus* frequently isolated from both raw and processed fishery products. Elevated levels of *E. coli* in mussels, shrimp, tilapia, and oysters from Manila Bay were traced to poor water quality (Rana et al. 2017). This presents an increasingly alarming public health concern due to the emergence of antibiotic-resistant strains. Kang et al. (2020) found that 60% of E. coli isolates from tilapia obtained in Metro Manila markets were producers of extended-spectrum β-lactamase (ESBL), while almost half exhibited resistance to carbapenems, including imipenem and ertapenem, which are regarded as last-resort treatments for Gram-negative infections. *Salmonella* and *Vibrio* spp. have also been documented in finfishes, shellfish, and crustaceans (Dumaloan-Canini et al. 2024; Tanyag et al. 2021a), whereas *S. aureus* levels in dried fish products, including anchovies from Iloilo, were above safety limits (Simora and Peralta 2018).

Viral risks, though under-monitored, pose a substantial concern in the Philippines where filter-feeding shellfish are cultivated in nearshore waters susceptible to fecal contamination. The 2016 Hepatitis A Virus (HAV) outbreak in Hawaii, traced to raw scallops imported from the Philippines, points to the absence of HAV-specific surveillance and limited analytical capacity because current monitoring programs still rely on bacterial indicators (Rustia et al. 2024; Viray et al. 2019). Parasites are also prevalent, specifically helminths found in demersal fishes from Manila Bay (Gustilo et al. 2022), ascaridoids in *Decapterus* spp. from Balayan and Tayabas Bays (Dela Cruz et al. 2022), nematodes and trematodes in certain market-sold fish in Cotabato (Ali 2021; Salcedo et al. 2009), as well as protozoan *Toxoplasma gondii* with virulent Type I genotype in oysters from Central Luzon (Paraoan et al. 2023).

Histamine accumulation is common in dried and fermented fishery products, as levels increase from catch to retail under conditions of temperature abuse or delayed processing (Amascual et al. 2023; Banicod et al. 2024). Dried-salted anchovies, sardines, and mackerel sold in local markets of Samar, Marinduque, and Iloilo surpassed the 200 mg/kg regulatory limit (Amascual et al. 2020; Simora and Peralta 2018; Villavicencio 2022), while shrimp paste from Northern Mindanao also has elevated biogenic amine concentrations owing to variable fermentation practices (Pilapil et al. 2016).

Marine biotoxins pose recurrent risks, especially paralytic shellfish poisoning (PSP) and ciguatera fish poisoning (CFP), which are the most well-documented in the Philippines. PSP outbreaks have brought 146 fatalities between 1983 and 2010, with the latest case in Western Samar in 2013. Studies show variability in toxin accumulation across shellfish species and habitats, with the thorny oyster exhibiting year-round toxicity above regulatory limits and epifaunal species in Sorsogon Bay showing levels over 1,000 times higher than infaunal species (Montojo et al. 2006, 2012; Ching et al. 2015). CFP has likewise caused multiple outbreaks as it accounted for 63% of foodborne illnesses between 1995 and 2004, and recent studies confirmed toxic *Gambierdiscus* spp. in Pangasinan and Eastern Samar (Azanza et al. 2024; Malto et al. 2022; Vacarizas et al. 2018), with roughly 45% of reef fish from the West Philippine Sea and Sulu Sea exceeding the US FDA thresholds (Tanyag et al. 2021b) and 4.46% testing positive in the Visayan and Sibuyan Seas (Montojo et al. 2020a).

Heavy metal contamination is very common in aquatic systems, with mercury (Hg), cadmium (Cd), lead (Pb), and arsenic (As) reported beyond safety limits in bivalves, finfish, and processed products. Mercury contamination has been documented in tilapia from Bulacan and Metro Manila, shrimp from Pampanga, and fishes from the Agusan River and Laguna de Bay, with hotspot exposures presenting health risks despite some products, like dried sardines, remaining within tolerable limits (Benitez et al. 2019; Molina 2011; Roa 2010; Rustia et al. 2022). Cadmium contamination is especially concerning, with tilapia from Metro Manila and scallops from the Visayan Sea surpassing World Health Organization (WHO) and EU thresholds, respectively, whereas a canned sardine export to Norway also failed compliance standards (Benitez et al. 2021; Hove et al. 2019; Perelonia et al. 2021; Solidum et al. 2013). Lead levels in fishes from Manila Bay, Batangas Bay, Northern Samar, and Laguna Lake exceeded regulatory limits, with assessments deeming several freshwater species unfit for human consumption because of high non-carcinogenic health quotient values (Dagalea et al. 2022; Molina 2011; Perelonia et al. 2017; Sangalang and Quinay 2015; Solidum et al. 2013). Arsenic has also been reported in several aquatic species from Laguna de Bay, with inorganic forms posing possible risks to vulnerable groups such as children and toddlers (Dwiyitno et al. 2024; Molina et al. 2011).

Other pollutants of concern include pesticide and veterinary drug residues, which remain poorly characterized in Philippine fishery products owing to inadequate surveillance and analytical capacity, though FAO reports accentuate that improper aquaculture practices have led to detections of chloramphenicol, fluoroquinolones, tetracyclines, and malachite green, thus resulting in export rejections and economic losses (Bondad-Reantaso et. al. 2012). Benitez et al. (2024) revealed that smoked fish products, including roundscad, mackerel, and sardines, exceeded the 12 ng/g EU limit for PAH4. In addition, persistent organic pollutants (POPs) including organophosphorus compounds, organochlorine pesticides, polybrominated diphenyl ethers (PBDEs), dioxin-like substances, butyltins, and emerging compounds such as benzotriazole ultraviolet stabilizers have been detected in fish and shellfish from Manila Bay, with localized elevations indicating bioaccumulation risks among frequent consumers of marine fish despite most levels being below international thresholds (Kim et al. 2011a, b; Mackintosh et al. 2015; Ramaswamy et al. 2011). Microplastic contamination has likewise been reported in milkfish, rabbitfish, goatfish, and green mussels, especially in urbanized waters such as the Pasig and Marikina Rivers, with fibers (polypropylene and polyethylene) being the most common type, even though associated health risks remain under investigation (Abiñon et al. 2020; Bersaldo et al. 2024; Bilugan et al. 2021; Bucol et al. 2019; Espiritu 2023).

In response to growing food safety risks and increasingly stringent trade requirements, food safety governance for Philippine fishery products is implemented through a multi-agency framework under the Food Safety Act of 2013. BFAR oversees fresh seafood and aquaculture products, while the FDA regulates processed, pre-packaged, and value-added fishery products, with LGUs responsible for community-level enterprises. This system is supported by national standards, administrative issuances, laboratory services, and postharvest infrastructure programs. The Bureau of Agriculture and Fisheries Standards (BAFS) leads standards development, PFDA strengthens postharvest and cold chain infrastructure, and the Food Development Center provides accredited testing, research, and technical support. Despite these institutional mechanisms, overlapping mandates, limited fishery-specific regulatory capacity within the FDA, and continued recognition of BFAR-issued certificates by some importing countries create implementation gaps and regulatory ambiguity for both industry and trade partners.

4. Research, Development, and Innovation

Research and development (R&D) initiatives have contributed to the development of new products, processes, and systems that enhance preservation, packaging, value addition, and food safety management (Lisboa et al. 2024). Advances in biotechnology, engineering, and food science have improved the efficiency of postharvest operations, while innovations in equipment design and processing protocols have strengthened quality control standards (Ninama et al. 2024).

The NFRDI spearheads postharvest R&D efforts aimed at reducing losses and enhancing the competitiveness of fishery products. Its priority areas include improved handling and preservation systems, hazard characterization and quantitative health risk assessment, as well as value addition from underutilized species, bycatch, and processing by-products. The Institute has generated baseline data on postharvest losses (Banicod et al. 2021; Montojo et al. 2020b; Montojo et al. 2025; Tadifa et al. 2022) as well as on biotoxin occurrence and heavy metal contamination in commercially important species (Benitez et al. 2019, 2021; Montojo et al. 2020a; Perelonia et al. 2017, 2021; Tanyag et al. 2021b).

The DOST supports fisheries R&D through funding, facility development, and industry–academia partnerships. This has led to the development of technologies such as hybrid dryers for fish, sea cucumber, and seaweed; portable smoking kilns for artisanal processors; low-salt fermented mussel sauce (De Vergara et al. 2022; Peralta et al. 2021); and bioactive collagen and gelatin extracts from fish processing wastes (Eleccion et al. 2025; Rafael et al. 2021). The nationwide network of Food Innovation Centers (FICs) further enables startups and small enterprises to access modern processing equipment, thereby facilitating product development and technology adoption (Flores 2025).

Academic institutions also contribute through research on food safety, product innovation, and market dynamics, including the development of ready-to-eat seafood for disaster response and value-added products from tilapia, milkfish, mussels, squid, and sardines (Bigueja et al. 2022a; Pagatpatan et al. 2017; Saclot et al. 2024). Packaging research has likewise gained prominence, with studies demonstrating that optimized vacuum packaging and refrigeration conditions improve microbial stability and shelf life, while consumer preferences highlight packaging as a critical determinant of market acceptance (Bigueja et al. 2021; Castro et al. 2016; De Vera et al. 2015; Simora et al. 2021)

Private sector participation in fisheries R&D is gradually expanding, particularly among large processors investing in automation, eco-friendly packaging, and by-product valorization. However, similar to other developing economies, private investment in agricultural R&D remains limited, accounting for only about 6% of total research expenditure compared with over 50% in developed countries. International experiences, such as Vietnam's government–industry partnerships in aquaculture and the Coastal Fisheries Initiative (CFI), demonstrate how coordinated public–private efforts can accelerate innovation, improve resource efficiency, and enhance value chain sustainability (FAO 2022; Weirowski and Hall 2008).

Despite these advances, the translation of research outputs into widespread industry practice is limited. Many technologies, including improved dryers, smoking kilns, packaging systems, and process guidelines, have been developed and piloted, yet adoption at scale is modest. This reflects persistent gaps in aligning innovations with local conditions, limited integration of user perspectives in technology design, insufficient demonstration and mentoring, and weak after-sales support and maintenance systems (Bhatt and Singh 2020; Giné and Klonner 2008). Adoption is further constrained by short-term, project-based funding that prioritizes prototype development over iterative refinement, long-term field validation, and systematic assessment of uptake and impact (Pujotomo et al. 2025). Socio-cultural factors, including strong reliance on traditional practices and skepticism toward externally introduced technologies, also influence uptake, particularly when innovations require substantial investment or alter established roles.

These challenges highlight the need to shift from predominantly top-down technology transfer models toward more participatory and demand-driven innovation systems that emphasize co-design with users, sustained engagement, and complementary support in financing, market access, and regulatory alignment (Jamaal 2018).

5. Sectoral Challenges, Opportunities, and Future Perspectives

The SWOT analysis (Figure 4) synthesizes the main internal strengths and weaknesses of the Philippine fisheries postharvest sector, as well as external opportunities and threats, by drawing primarily on national planning documents (e.g., CNFIDP, CPHMAIDP), commodity-specific roadmaps, and related policy frameworks. The sector's strengths include a rich aquatic resource base, a diverse product portfolio, and growing policy, R&D, extension support, and national plans that explicitly prioritize loss reduction, food safety, and market competitiveness. On the opportunity side, the sector can take advantage of the high demand for processed, value-added, and convenience seafood products, which can be supported by new fisheries investment programs like the Philippine Fisheries and Coastal Resiliency (FISHCORE) project, as well as expanding global partnerships. Advancements in artificial intelligence, IoT, data analytics, and digital platforms create opportunities to modernize operations. However, these prospects are offset by structural weaknesses and external threats. The following subsections deal with the key challenge domains identified in the SWOT and discuss context-sensitive, realistic pathways for postharvest upgrading.

STRENGTHS	WEAKNESS	OPPORTUNITIES	THREATS
• Rich and diverse aquatic resource base • High per-capita fish consumption and strong nutritional relevance of seafood • Diverse product portfolio • Established export markets and trade linkages • Established industrial capacity in freezing, canning, and bottling • Existing postharvest infrastructure (public/private fish ports, ice plants, cold storage, processing hubs) • Active government and academic R&D and extension support • Strong base of traditional knowledge and artisanal skills • Localized lexicons and community-specific techniques that support cultural identity and product diversity • National plans explicitly prioritizing postharvest loss reduction and increased market competitiveness • Established food safety and quality assurance framework • Emerging innovation ecosystem (e.g., Food Innovation Centers, technology incubators) that supports product development and technology adoption	• Over-reliance on common-pool, climate- sensitive wild fishery resources • Postharvest losses and limited product competitiveness driven by variability in practices, unfulfilled targets on national plans, and uneven adoption of national standards • Food safety, hygiene, and sanitation gaps in traditional processing and handling • Low adoption of appropriate postharvest developed by technologies institutions R&D • Resource constraints for R&D and extension that limit continuity, scaling, and wider uptake of innovations • Low compliance with national and international food safety and marketing regulations • Archipelagic geography and logistics constraints that weaken cold chain integrity • Lack of robust traceability systems for fish and fishery products • Highly fragmented, small-scale processing units with limited mechanization, economies of scale, and access to modern equipment and maintenance services • Market power imbalances within value chains (weak bargaining position of fishers and small processors) • High poverty, income volatility, and limited access to credit, insurance, and other financing schemes among small-scale fisherfolk, processors, and MSMEs • Limited empirical value chain analyses and monitoring on performance, margins, and distribution of benefits • Weak institutional coordination and partnerships, and bureaucratic delays in program implementation	• Expanding domestic and export markets for processed, value-added, and convenience seafood products • Product diversification and niche market development for premium, ready-to-eat, and functional seafood items • Availability of local and international funding (e.g., Official Development Assistance) for postharvest upgrading and innovation • New fisheries investment programs (e.g., FISHCORE) allocating resources for postharvest infrastructure, cold storage, innovation, and capacity building • Advancements in artificial intelligence, IoT, data analytics, and remote sensing for monitoring, optimization, and decision support • Digital platforms for marketing, logistics, and end-to-end traceability of fish and fishery products • Scaling up green, energy-efficient, and climate-resilient postharvest and cold chain technologies • Systematic by-product and waste valorization into higher-value ingredients and bio-based products • Progressive harmonization • With international food safety standards, such as Codex • Regional and global trade, research, and technology partnerships • Organizing small-scale processors into cooperatives, clusters, and community-based enterprises	• Overfishing, IUU fishing, and habitat degradation accelerating stock depletion • Climate change and natural hazards damaging infrastructure and disrupting supply chains • Intensifying import competition from lower-cost seafood producers • Stricter international trade, food safety, traceability, and sustainability requirements • Volatile fuel and energy prices raising operating costs • Economic downturns and market volatility affecting government funding, production costs, and consumer demand • Public health crises and global logistics disruptions • Urbanization and labor migration • Changes in administration and shifting policy priorities that delay or disrupt project implementation • Public skepticism or resistance towards scientific evidence and newly developed technologies • Rapid technological change outpacing the sector's capacity to adapt

Figure 4. SWOT analysis of the Philippine fisheries postharvest and marketing sector. Source: Authors' own work

5.1 Raw material supply variability and climate-related risks

The performance of the postharvest sector is closely linked to upstream resource availability. Coastal degradation, overexploitation, and illegal, unreported, and unregulated (IUU) fishing, compounded by climate change, have contributed to stock depletion and shifts in species composition (Fernandez 2009; Luna et al. 2004; Geronimo 2018). These changes result in increasingly variable and seasonal raw material supply, leading to underutilization of processing capacity, inefficiencies in facility operations, and instability along the value chain. Climate-related disruptions further exacerbate postharvest losses, increase production costs, and constrain the reliability of supply chains, particularly for small-scale processors with limited access to cold storage, transport, and alternative sourcing strategies (ADB 2014; Cheung et al. 2018; Karr et al. 2021). Strengthening adaptive capacity through improved resource management, diversified sourcing, and better postharvest infrastructure is therefore critical to enhancing sector resilience.

5.2 Postharvest losses, product quality, and safety concerns

Baseline studies indicate that postharvest losses can reach up to 17% of landed catch (Montojo et al. 2020b), although actual rates vary by species, value chain configuration, and market destination (Banicod et al. 2021; Tadifa et al. 2022). These losses reduce both the physical availability and economic value of fishery products, increase production and transaction costs, and intensify pressure on already stressed fishery resources (Akande and Diei-Ouadi 2010). The sector also continues to face challenges in resource valorization and waste management, despite the significant potential of processing by-products for conversion into higher-value food, nutraceutical, and industrial products (Cadano et al. 2021).

Food safety and quality issues are also persistent, particularly among MSMEs that rely on traditional processing methods and have limited access to technical knowledge, certification systems, and laboratory services (Ragasa et al. 2017). Weak regulatory enforcement, low consumer awareness, and limited demand for certified products in domestic markets further reduce incentives for compliance (Manalili et al. 2017).

Addressing these constraints requires scaling up loss-reduction interventions at critical value chain nodes, including improved handling practices and the standardization of traditional processing methods supported by appropriate facilities. Strengthening capacity-building programs for MSMEs on food safety management, documentation, and compliance, alongside enhancing regulatory capabilities in risk-based inspection, sampling, and auditing, is equally important (BFAR 2021; Tadifa et al. 2022). Harmonizing national standards with Codex and other international benchmarks, while adapting them to local contexts through risk-based approaches and expanding access to shared testing facilities, can help reduce compliance costs (Fink 2023). These efforts are more effective when complemented by incentive-based mechanisms, such as improved access to finance and market linkages for compliant enterprises. However, strategies for product diversification and value addition must be carefully designed to ensure that they do not compromise the affordability and accessibility of staple fishery products for low-income consumers, given evidence that market-driven upgrading can exacerbate inequalities and reduce access to low-cost fish (Odoli et al. 2019; Standen 2025).

5.3 Technological, infrastructure, and logistical constraints

Many fish processors, particularly those engaged in dried fish production, continue to operate in open-air and minimally mechanized settings that are highly vulnerable to typhoons, sudden rainfall, and other weather-related disruptions. Limited access to sanitary workspaces, appropriate equipment, and food-grade packaging further constrains their ability to consistently meet product quality and safety standards (BFAR 2021; Tahıluddın and Kadak 2022). Core postharvest facilities such as ice plants, warehouses, cold storage units, and shared service facilities are often lacking, poorly maintained, or inaccessible because of cost and location barriers. These constraints are compounded by the country's archipelagic geography and fragmented transport system, which increase travel time, raise freight and fuel costs, and create inefficiencies in product movement, resulting in supply surpluses and losses in some areas and shortages in others (BFAR 2018).

Priority should be given to assessing existing facilities to determine which are functional, accessible, and responsive to local needs, and which require rehabilitation, reconfiguration, or repurposing. Improving and optimizing existing infrastructure may be more practical than constructing new facilities. Support for small-scale processors may be directed toward GMP-compliant shared service facilities managed by cooperatives, associations, or clustered MSMEs under viable cost-sharing arrangements. At the logistics level, route coordination, product consolidation, and the establishment of regional distribution hubs could help reduce transport inefficiencies and improve the stability of fish supply across markets.

5.4 Economic volatility and cost pressures

Profitability in the postharvest sector is highly sensitive to fluctuations in fuel, electricity, and raw material prices, with MSMEs particularly vulnerable because of their limited working capital and narrow profit margins (Taghizadeh-Hesary et al. 2019). Global oil price shocks, peso depreciation, and inflation in essential inputs raise operating costs that are rarely offset by higher product prices, thereby weakening the competitiveness of domestic processors relative to lower-priced imports. These pressures also constrain public investment in postharvest infrastructure, extension, and enterprise support. Mitigating these effects requires easier access to microfinance and value chain financing, simplified loan arrangements, collective input purchasing, and cost-sharing mechanisms for shared facilities, alongside stronger public–private partnerships to sustain critical postharvest services during periods of fiscal constraint (Casaburi and Willis 2024; Weirowski and Hall 2008).

5.5 Market access constraints and trade pressures

Limited demand for certified products in domestic markets, where affordability often outweighs safety considerations, weakens incentives for processors to upgrade their practices and allows non-compliant operators to compete on price (Buckley 2015). Access to supermarkets and export markets requires compliance with strict standards on documentation, process control, labelling, traceability, and product consistency, which many MSMEs struggle to meet because of financial, technical, and administrative constraints. These difficulties are compounded by competition from lower-priced imports, the strong influence of middlemen and consolidators in domestic marketing chains, and evolving tariff and non-tariff requirements in international trade, all of which raise transaction costs and heighten the risk of market exclusion or shipment rejection (BFAR 2018; Nuraini et al. 2024). These will require practical support measures such as simplified product specifications and labelling, affordable packaging and transitional certification pathways, collective marketing and transport arrangements, and stronger traceability and conformity systems for firms targeting higher-value domestic and export markets.

5.6 Social, institutional, and governance constraints

A large share of postharvest work is informal, often characterized by irregular wages, limited social protection, and reliance on piece-work arrangements, while many processors also operate without formal registration, restricting their access to government programs, financing, insurance, and training. This informality also contributes to the absence of a reliable and up-to-date registry of postharvest enterprises, making it difficult to identify sectoral needs and target support effectively. These vulnerabilities are compounded by the dispersion of responsibilities across multiple agencies without a sufficiently integrated implementation mechanism, resulting in overlapping services, weak coordination, and limited scalability of interventions. Regulatory enforcement tends to be stronger in export-oriented value chains but remains weak in domestic markets, while many LGUs continue to face capacity limitations in facility maintenance, monitoring, and enterprise development (BFAR 2018). Strengthening cooperatives and producer associations, harmonizing governance, streamlining service delivery, improving inter-agency coordination, and enabling LGUs to integrate postharvest support into local plans and budgets are essential to improving labor conditions, expanding access to assistance, and sustaining long-term sectoral development (Sumalde et al. 2015; Barbosa 2024).

6. Conclusion

The postharvest sector is a vital component of the fisheries value chain, serving as a critical link between production and consumption by converting raw catch into safe, consumable, and marketable products. It plays a substantial role in value creation via processing, logistics, marketing, and distribution activities. In the Philippines, the fisheries postharvest sector is geographically and structurally varied, shaped by species composition, economic conditions, and consumer preferences. While large export-oriented hubs dominate industrial operations such as canning, freezing, and bottling, MSMEs engaged in traditional drying, smoking, salting, and related practices are regarded as the backbone of the industry, central to rural livelihoods and domestic food supply.

The SWOT analysis shows that the sector benefits from a rich aquatic resource base, a diverse product portfolio, strong domestic and export demand, established industrial capacity, and an expanding policy, research, and extension support system. National plans and investment programs increasingly prioritize loss reduction, food safety, and market competitiveness, whereas growing interest in circular bioeconomy approaches, digital tools, and climate-resilient postharvest technologies presents important opportunities for modernization and upgrading. Systematic byproduct valorization and the organization of small-scale fisherfolk and processors into cooperatives or clusters can further enhance value capture and inclusion.

Notwithstanding these advantages, the sector's potential is constrained by interconnected challenges, including over-reliance on wild stocks in the context of environmental degradation and climate change, postharvest losses, food safety and hygiene gaps in traditional processing, limited research adoption, infrastructure and logistical bottlenecks, limited access to finance, and weak inter-agency coordination and traceability systems. These are intensified by volatile fuel and energy costs, stricter trade and regulatory requirements, and increasing competition from lower-cost imports. Even though policy reforms, technological innovations, and capacity building initiatives have delivered incremental gains, more coherent and sustained efforts are needed that link enterprise-level improvements with supportive investments, institutions, and markets.

Achieving the sector's full potential will require collective effort, long-term commitment, and better alignment of programs, investments, and capacities across government, academia, industry, and communities toward a more sustainable, resilient, and globally competitive fisheries value chain.

Statements and Declarations

Competing Interests:

The authors declare no conflict of or competing interest.

Contribution of authors:

Ulysses M. Montojo: Conceptualization, Supervision, Writing – review & editing, Resources, Investigation, Data curation;

Riza Jane S. Banicod: Conceptualization, Writing – original draft, Investigation, Visualization, Data curation;

Gezelle C. Tadifa: Writing-review and editing, Visualization

Data availability:

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Consent for publication:

The authors approve the publication of this article.

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Annex Table 1. Summary of documented hazards in Philippine fish and fishery products.

Hazard Type	Contaminants	Product	Study Area	Findings	References
Pathogenic bacteria	*Vibrio parahaemolyticus, V. cholerae, V. alginolyticus, Staphylococcus aureus, Salmonella* spp.	Clams, shrimp, squid, anchovy, oil sardines	Misamis Occidental	Detected in 9-47% of samples with APC levels classified as medium–high risk	(Dumaloan-Canini et al. 2024)
	Salmonella spp.	Mussel, oyster, crab, shrimp, tilapia, and milkfish	Manila Bay	Detected in 16.26% of aquaculture commodities, with highest prevalence in mussels (55.55%); contaminated samples exceeded BFAR FAO 210 (2001) and EC No. 2073/2005 limits	(B. Tanyag et al. 2021)
	Escherichia coli (ESBL- and carbapenemase-producing strains)	Tilapia	Metro Manila	Of 25 isolates, 96% resistant to at least one antimicrobial, 60% multiple drug resistant; 60% ESBL producers; 48% carbapenem resistant; metallo-β-lactamase-positive isolates carried the blaIMP gene	(Kang et al. 2020)
	S. aureus	Dried anchovy	Iloilo	Most samples exceeded the FDA limit	(Simora & Peralta 2018)
	Escherichia coli	Mussel, shrimp, tilapia, oyster, crab, and milkfish	Manila Bay	*E. coli* levels in mussel (25%), shrimp (24.4%), tilapia (16%), oyster (14.67%), crab (8.89%), and milkfish (6.67%) exceeded FDA regulatory limit	(Raña et al. 2017)

Hazard Type	Contaminants	Product	Study Area	Findings	References
Parasite	*Toxoplasma gondii* (Type I genotype)	Oysters	Central Luzon	Detected in 9.09% of oyster samples; phylogenetic analysis confirmed clustering with virulent Type I genotype	(Paraoan et al. 2023)
	Helminths *(Acanthocephala, Nematoda)*	Ponyfish, goatfish, threadfin bream, and grunters	Manila Bay	52.7% of fish infected; highest prevalence and dual infection in *Leiognathus equulus*	(Gustilo et al. 2022)
	Ascaridoid nematodes	Roundscad	Balayan and Tayabas Bay	Overall infection rate 22%	(Dela Cruz et al. 2022)
	Trematodes *(Clinostomum sp., Posthodiplostomum sp.),* Nematodes *(Camallanus sp., Neocamallanus sp., Order Spirurida), Acanthocephalan*	Mudfish, climbing perch, tilapia, catfish, and gourami	Ligawasan Marsh	Parasites detected with prevalence rates ranging from 6.7% to 86.7% depending on species and site; highest in climbing perch and gourami at Datu Piang	(Ali 2021)
Biogenic amine	Histamine	Bullet tuna (Auxis rochei)	Metro Manila	Despite the occurrence of low histamine levels, potential histamine forming bacteria displayed multidrug resistance to antibiotic	(Santos et al. 2024)
	Histamine	Dried anchovy	Marinduque	41.67% of samples exceeded Codex limit	(Villavicencio 2022)
	Histamine	Dried-salted fish	Samar	81.3% of samples exceeded BAFS-PNS; histamine concentration generally increased over time in retail storage	(Amascual et al. 2020)
	Histamine	Dried-salted fish	Iloilo	47.6% of samples exceeded US-FDA limit; seven histamine-forming strains identified	(Simora & Peralta 2018)
	Histamine, putrescine, cadaverine, tyramine, biogenic amine index (BAI)	Shrimp paste	Agusan del Norte & Misamis Oriental (traditional), Navotas/ Metro Manila (commercial)	Histamine levels well below Codex limit; very high putrescine and cadaverine; BAI indicated some samples fell into Class 3 (decomposed) quality	(Pilapil et al. 2016)

Transactions NAST PHL Vol. 48 (2026)
doi.org/10.57043/transnastphl.2026.6367

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Biotoxin	44-methylgambierone (MTX analog), other secondary metabolites	Reef fishes	Bolinao, Pangasinan & Guiuan, Eastern Samar	*G. carpenteri* showed highest toxicity; all strains produced 44-methylgambierone and exhibited diverse metabolite profiles	(Malto et al. 2022; Vacarizas et al. 2018)
	Ciguatoxin	Reef fishes	West Philippine Sea & Sulu Sea	44.66% tested positive for CTX; viscera had higher toxicity than flesh; all positive samples exceeded US FDA (0.01 ppb) and BFAR "negative" guideline	(B. E. Tanyag et al. 2021)
	Ciguatoxin	Reef fishes	Visayan and Sibuyan Seas	4.46% tested positive for ciguatoxins; more frequent in the dry season; fish weight was not a reliable predictor of toxicity	(Montojo et al., 2020)
	Saxitoxin (from Pyrodinium bahamense var. compressum)	Green mussel	Tarangnan, Western Samar	31 cases, 2 deaths in July 2013 outbreak. Eating >1 cup of mussel broth strongly associated with illness	(Ching et al., 2015)
		Various shellfish	Sorsogon Bay	Epifaunal and benthic species accumulated saxitoxin far above international limit of 80 µg STX eq/100 g	(Montojo et al., 2012)
		Various shellfish	Masinloc Bay	Thorny oyster and penshell retained saxitoxin almost year-round, while green mussel became toxic only during blooms but cleared rapidly afterward	2006)
Heavy metals	Arsenic, barium, copper, iron, manganese, mercury, zinc	Grouper, mackerel, and milkfish	Palawan	Health risk assessment indicated negligible risks, but mercury warrants continuous monitoring because levels were close to EU safety limit	(Senoro et al., 2023)

Transactions NAST PHL Vol. 48 (2026)
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	Lead	Milkfish	Northern, Samar	Meat tested positive for lead	(Dagalea et al., 2022)
	Methylmercury	Dried sardines	Major sardine fishing grounds	Dried sardines were found not to pose a significant health risk to adults, though other dietary sources of MeHg may add to cumulative exposure	(Rustia et al., 2022)
	Cadmium	Scallops (Bractechlamys vexillum)	Iloilo, Cebu, Masbate	Exceeded EU regulatory limit	(Benitez et al., 2021; Perelonia et al., 2021)
	Lead, mercury, cadmium	Mud crab, milkfish, green mussel, oyster, shrimp, and tilapia	Manila Bay landing sites	All commodities complied with limits for lead and cadmium. However, 2.04% of tilapia and 5.00% of shrimp exceeded the mercury regulatory limit	(Benitez et al., 2019)
	Lead, cadmium, mercury	Milkfish, tilapia, crab, shrimp, oyster, and mussel	Manila Bay aquaculture farms	Lead exceeded permissible limits in some milkfish and tilapia; mercury exceeded limits in some milkfish and oysters	(Perelonia et al. 2017)
	Lead	Roundscad	Batangas Bay	Lead concentrations were highest in the internal organs, moderate in the head, and lowest in the flesh	(Sangalang & Quinay 2015)
	Lead, cadmium, chromium	Commercially important fish species	Wet markets in Metro Manila	Cadmium exceeded the allowable limit in most samples, including meat, head, and organs of several species; chromium exceeded the 0.10 ppm limit in all samples	(Solidum et al. 2013)
	Lead	Barracuda, sardines, yellowstripe scad, and mullet	Manila Bay	All fish muscle samples contained lead above the permissible food safety limit	(Su et al. 2013)

Transactions NAST PHL Vol. 48 (2026)
doi.org/10.57043/transnastphl.2026.6367

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	Cadmium, lead, mercury, arsenic, chromium	Milkfish, bighead carp, mudfish, kanduli, and tilapia 1qw	Laguna de Bay	Lead was the most urgent pollutant, with elevated non-carcinogenic health risks across all sites; arsenic posed the highest carcinogenic risk	(Molina 2011)
Persistent Organic Pollutants (POPs) and emerging contaminants	Organophosphorus compounds (OPCs)	Commercially important fish species	Manila Bay	OPCs were detected in most samples; demersal species had higher levels, with triphenyl phosphate accumulation linked to benthic food webs	(Kim et al. 2011)
	Benzotriazole ultraviolet stabilizers	Commercially important fish species	Manila Bay	All samples contained BUVSs, with UV-328 predominant; UV-P concentrations correlated with fish size and trophic level	(Kim et al. 2011b)
	Personal care products (PCPs): parabens (methyl, ethyl, propyl, butyl) and antimicrobial agents (triclosan, triclocarban)	Commercially important fish species	Manila Bay	All compounds detected; total parabens were an order of magnitude higher than antimicrobials in most species; paraben levels correlated with fish size and weight	(Ramaswamy et al. 2011)

Hazard Type	Contaminants	Product	Study Area	Findings	References
Physical hazards	Microplastics (MPs)	Yellow striped goatfish	Davao Occidental	96.7% of 30 fish sampled ingested microplastics; fibers dominated, mostly black (56%)	(Bersaldo et al. 2024)
		Nile tilapia, kanduli, and janitor fish	Pasig and Marikina Rivers	Detected microplastics in all species, mainly polypropylene and polyethylene; fragments were often <50 µm and contained pigments; riverine plastic debris were determined as a source of MPs	(Espiritu et al. 2023)
		Milkfish	Butuan Bay	Microplastics were found in 97% of samples; fibers were the dominant shape, with blue the most common color	(Similatan et al. 2023)
		Green mussel	Cavite	Higher concentrations in the inner bay; fibers comprised 61% of particles, mostly red in color	(Bilugan et al. 2021)
		Bullet tuna, Indian mackerel, milkfish	Major public markets, Cebu	97.3% of samples contained MPs, totaling 635 particles; majority were transparent microfibers; milkfish had the highest ingestion rate	(Abiñon et al. 2020)
		Rabbitfish	Negros Oriental	Gut samples from rabbitfish contained diverse polymer types	(Bucol et al. 2020)