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Original Research Paper

Technology Utilization, Processing Practices, and Commercialization of Marine-Based Products in Samar, Philippines

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Abstract

Despite its abundant marine resources, the Philippines continues to face major challenges in developing its marine industry. Weak fisheries governance, inadequate enforcement, limited institutional capacity, and increasing pressure on marine resources have contributed to resource overexploitation, restricted fishing opportunities, and growing competition among coastal communities. Hence, this study explored the technology utilization, processing practices, and potential large-scale commercialization of marine-based products from Samar, Philippines to assess opportunities and challenges. A total of 50 purposively sampled participants, such as processors, entrepreneurs, cooperative members, and local government representatives, participated in the study. The findings revealed that Samar possesses abundant marine resources, particularly fish, mollusks, crustaceans, and seaweeds, which provide a strong foundation for the development of the marine-based food industry. The marine food processing in the region rely primarily on traditional technologies and labor-intensive preservation practices, particularly sun drying, smoking, and fermentation. The adoption of modern processing technologies and value-added production remains limited, resulting in low product diversification and reduced competitiveness. Several marine-derived products exhibited high commercialization potential due to the availability of raw materials, processing feasibility, and favorable market demand. Nevertheless, strengthening technology utilization, promoting value-added processing, improving infrastructure, enhancing technical capacity, and expanding market access can increase the competitiveness of marine-based products, generate greater economic opportunities for coastal communities, and support the sustainable development of the marine-based economy in Samar.

Keywords: commercialization, food processing, marine-based food products; technology utilization

INTRODUCTION

The Philippines is situated at the heart of the global epicenter of marine biodiversity, making the country exceptionally rich in marine resources that are vital to fisheries, food security, and economic development. However, Binobo et al. (2024) pointed that the effectiveness of fisheries governance in the Philippines is hindered by inadequate law enforcement, limited financial and technological capacity, insufficient equipment, a lack of trained personnel, weak coordination among responsible agencies, and political influence.

The purpose of this study was to explore the status of marine industry in Samar, Philippines to assess technological utilization, processing practices, and commercialization in the region. Understanding these aspects would provide valuable evidence to support the formulation of effective and sustainable strategies for marine economic development, not only in Samar but also at the national level.

Recent trends indicate that continued growth across various marine sectors showed increasing investments, technological advancement, and the expanding role of the marine economy in supporting sustainable industrial and economic development (Guo et al., 2022).

In China, the continuous exploration and sustainable utilization of marine resources have driven the expansion of both traditional and emerging marine industries. Traditional sectors, such as capture fisheries, aquaculture, and salt production, remain important contributors to the marine economy, while newer industries—including marine biotechnology, marine equipment manufacturing, renewable marine energy, offshore engineering, marine transportation, and marine-based chemical and pharmaceutical production—have experienced substantial growth (Guo et al., 2022; Wang, 2024). This diversification has expanded employment opportunities in coastal regions and strengthened the contribution of marine industries to economic development (Wang, 2024).

In Thailand, Madhavan et al. (2024) found that industry readiness significantly enhanced the

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participation of marine food processing small- and medium-sized enterprises in global value chains, improved business competitiveness, and promoted sustainable business growth. Business competitiveness also served as a key mediator, strengthening the relationship between industry readiness and sustainable growth. Adopting human-centered, sustainable, and technology-driven practices can improve the market position, operational performance, and long-term sustainability of marine food processing enterprises while increasing their competitiveness in domestic and international markets.

Despite its abundant marine resources, the Philippines continues to face significant challenges in developing its marine industry compared with some of its neighboring countries. In many coastal areas, particularly in the southern Philippines, small-scale fisheries are constrained by weak governance, inadequate enforcement of fisheries regulations, limited accountability, and increasing pressure on marine resources (Sumalpong & Embornas, 2024). These challenges contribute to the overexploitation of fisheries, reduced access to traditional fishing grounds, and growing competition and conflicts among coastal fishing communities (Binobo et al., 2024).

This paper recognized the need to advance the marine economy in the Philippines by promoting the sustainable utilization of marine resources through technological innovation, improved processing practices, value-added product development, and strengthened commercialization. It was expected to identify existing opportunities and constraints within the marine-based industry to support evidence-based policies, strategic investments, and capacity-building initiatives. The study seeks to contribute to the development of a more competitive, resilient, and sustainable marine economy that can enhance food security, create employment opportunities, improve the livelihoods of coastal communities, and increase the economic value of the abundant marine resources in the Philippines.

LITERATURE REVIEW

The Philippines is located within the Coral Triangle, a region widely recognized as the global center of marine biodiversity, highlighting its exceptional marine resources and their importance for fisheries, food security, and economic development (Fabinyi & Barclay, 2022). This positions Philippines as one of the world's leading producers of fisheries and marine products. In 2022, the country ranked among the top global fish-producing nations, recording a total production of 4.11 million metric tons of fish, crustaceans, mollusks, and seaweeds (BFAR, 2023). It also ranks among the leading countries in marine capture fisheries, reflecting the significant contribution of its fisheries sector to global seafood production (FAO, 2020). Tuna remains one of the country's major fishery exports in terms of production volume and international trade (Tahiluddin & Terzi, 2021), while seaweed farming is recognized as one of the country's most important mariculture industries and a major source of export revenue (Binobo et al., 2024).

Globally, the marine economy has evolved through a long process of maritime development, trade expansion, industrialization, and economic advancement, ultimately becoming a major component of global economic growth and sustainable development. Over the past few decades, the sector has expanded considerably and has played an increasingly important role in supporting economic transformation, industrial development, and national competitiveness (Shi et al., 2025). As a result, the marine economy has become a strategic priority within the global economic system and has been incorporated into the industrial and development policies of many countries (Shi et al., 2025). The combined value of goods and services generated by the global marine economy is estimated at approximately USD 2.3 trillion, placing it among the world's largest economic sectors (UNDP, 2022).

The marine economy has also become a significant driver of growth for developing countries and small island states. The implementation of national marine strategies, marine spatial planning, and international maritime partnerships has further strengthened economic cooperation and trade across countries (Gacutan et al., 2022). Furthermore, advances in marine industries have facilitated large-scale production and more efficient transportation systems, reshaping global trade patterns, industrial specialization, and national development pathways (Abspoel et al., 2021). These expanding economic activities, however, have also increased the complexity of coastal governance and highlighted the need for more effective marine resource management and evidence-based decision-making.

Technological innovation, efficient processing methods, and commercialization are essential to the sustainable marine-based food industry. The adoption of digital technologies, including automation, robotics, blockchain, and big data analytics, has improved production efficiency, product traceability, quality assurance, and sustainability in seafood processing (Subash et al., 2024). Likewise, effective processing techniques, such as thermal processing, curing, high-pressure processing, and ultrasonic treatment, play a crucial role in extending shelf life, preserving nutritional quality, ensuring food safety, and enhancing the overall quality of aquatic products (Siewe et al., 2024). While conventional heating remains widely practiced, emerging technologies offer significant advantages in minimizing nutrient loss, improving

preservation, and maintaining desirable sensory characteristics (Wang et al., 2023). The commercialization of marine resources through value-added processing, biotechnology, and product innovation creates opportunities to produce high-value food and non-food products, strengthen food security, generate employment, reduce processing waste, and stimulate economic growth (Das & Mondal, 2024; Lal et al., 2023; Schneider et al., 2023).

However, the Philippines had several persistent challenges affecting marine fisheries governance in the Philippines. Effective fisheries management is constrained by weak law enforcement, limited financial and technological resources, inadequate equipment, insufficient personnel training, poor inter-agency coordination, and political interference, all of which reduce the capacity to monitor and regulate marine resources (Binobo et al., 2024). In addition, socioeconomic pressures, including livelihood dependence and economic constraints among coastal communities, continue to encourage illegal fishing practices, highlighting the need for stronger institutional collaboration, sustainable livelihood programs, and participatory governance to achieve effective marine resource management (Fabinyi & Barclay, 2022).

There is a need to strengthen the utilization of marine products through improved processing technologies, value-added product development, and commercialization initiatives to address the systematic challenges in marine economy in the Philippines. Examining the current status of technology utilization, processing practices, and commercialization of marine-based food products can provide context for developing appropriate interventions that enhance product competitiveness, increase market opportunities, improve the livelihoods of coastal communities, and support the sustainable growth of the marine-based economy.

METHODOLOGY

Research Design

Descriptive-exploratory research design was applied to explore the current technology utilization, processing practices, and commercialization potential of marine-based products in Samar, Philippines. The descriptive component documented the availability of marine resources, existing processing methods, and market practices, while the exploratory component investigated opportunities, challenges, and emerging strategies for developing value-added marine products. Descriptive exploratory designs are used when a phenomenon is not yet well understood, but the study seeks to provide scope of its current characteristics, patterns, or conditions (Armayadi et al., 2025; Salain, 2026). This design is appropriate for identifying gaps, trends, and opportunities in marine-based food processing and supports evidence-based decision-making for local development initiatives (Cerna, 2026).

Participants of the Study

The participants of the study consisted of individuals directly involved in marine-based food production and related activities in Samar, Philippines. These included fishers, processors, micro-entrepreneurs, cooperative members, and representatives from local government units and relevant agencies. Purposive sampling technique was employed to ensure that respondents possessed the necessary knowledge and experience relevant to the study objectives. A total of 50 respondents were selected from identified coastal municipalities in Samar known for marine-based activities. Selection criteria included active engagement in fishing, processing, or product marketing, as well as willingness to participate in the study. This sampling approach enabled the researcher to gather rich, relevant, and context-specific information necessary for resource profiling and product evaluation.

Research Instrument

Data were collected using a structured survey questionnaire supplemented by interview guides and observation checklists. The questionnaire was divided into four major sections: (1) profile of marine-based resources in terms of category and availability, (2) documentation of existing marine-derived food products, (3) processing methods and technologies used, and (4) assessment of potential products based on criteria such as availability of raw materials, market demand, feasibility, and development potential. The instrument utilized a combination of multiple-choice items, Likert-scale questions, and open-ended responses.

Data Gathering Procedure

Data collection was conducted through face-to-face administration of a structured questionnaire among the identified respondents. To enrich and validate the survey data, informal interviews and direct observations were also undertaken to document existing marine-based product processing practices, technologies, equipment, and production facilities.

Before administering the questionnaire, participants were informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality of the information they provided. They were given adequate time to complete the questionnaire, and clarifications were provided whenever necessary to ensure that each item was clearly understood and that the responses accurately reflected their experiences and perspectives.

Upon completion of the survey and interviews, the collected data were reviewed for completeness and consistency before being encoded

and prepared for subsequent analysis.

Data Analysis

The collected data were organized, coded, and analyzed using appropriate statistical and analytical techniques. Descriptive statistics such as frequency counts, percentages, and weighted mean were used to summarize data on resource availability, existing products, and processing practices.

For product evaluation and commercialization, a multi-criteria assessment approach was employed, considering factors such as raw material availability, market demand, and feasibility. Each criterion was assigned corresponding weights, and composite scores were computed to rank the identified products.

Qualitative responses from open-ended questions were analyzed using thematic analysis to identify recurring patterns and insights related to challenges and opportunities in marine-based food processing (Bagood et al., 2026; De La Cruz, 2026).

RESULTS

Available Marine-Based Resources

Study participants were asked to identify the marine resources commonly found in Samar, Philippines, including fish, mollusks, crustaceans, and seaweeds. Fish emerged as the most abundant and widely accessible marine resource such as sardines (hawol-hawol), galunggong, and tuna. Mollusks, particularly mussels and oysters, were likewise reported to be readily available in several coastal municipalities.

Crustaceans, including crabs and shrimps, were perceived to be moderately abundant and commonly harvested for local consumption and livelihood. In contrast, although seaweeds were recognized as naturally occurring marine resources within the province, participants consistently noted that these resources remained relatively underutilized compared with other marine commodities.

Table 1. Exploration of marine-based resources available in Samar

Marine Resources	Examples	*n*	%	Availability Description
Fish	Sardines, Galunggong, Tuna	48	96 %	Year-round availability
Mollusks	Mussels, Oysters	42	84 %	Mostly year-round
Crustaceans	Crabs, Shrimps	35	70 %	Seasonal availability
Seaweeds	Eucheuma, Kappaphycus	28	56 %	Limited utilization

Note: n – means the number of participants who mentioned the marine resources during interviews

In terms of availability, participants believed that marine resources are accessible throughout the year, with seasonal variations affecting only specific species. This finding suggests a stable supply of raw materials that can support continuous processing and product development. However, despite the abundance of these resources, their utilization remains largely limited to fresh consumption or basic preservation methods.

Marine-Derived Food Products and Processing Practices

In **Table 2**, the study identified several existing marine-derived food products produced within the selected communities. These include dried fish, smoked fish, fermented products such as *ginamos* (fish paste), and simple preserved seafood products. Among these, dried fish emerged as the most common product due to its simplicity and low processing cost. Smoking and fermentation were also widely practiced as traditional preservation methods.

Table 2. Marine-derived food products and their processing type

Product Type	Processing Method	*n*	%	Processing Type
Dried Fish	Sun drying	50	100 %	Traditional
Smoked Fish	Smoking	38	76%	Traditional
Fish Paste (Ginamos)	Fermentation	30	60%	Traditional
Fish Balls	Grinding/Frying	18	36%	Semi-processed
Bottled Sardines	Cooking/Packaging	12	24%	Value-added

***Note**: n – the number of participants who mentioned the marine resources during interviews*

Furthermore, as shown in **Table 3**, the results showed that processing practices in the region remain traditional and labor-intensive. Participants reported using open sun-drying methods, which are highly dependent on weather conditions and prone to contamination. Similarly, smoking practices were conducted using improvised facilities with limited control over temperature and hygiene conditions. Only a small percentage of respondents reported the use of improved technologies or standardized processing methods.

Table 3. Processing practices and technology utilization

Processing Method	Description	*n*	%	Perceived Technology Use

Open Sun Drying	Exposure to sunlight	50	100 %	Low
Traditional Smoking	Use of improvised smoke chambers	38	76 %	Low
Fermentation	Natural microbial process	30	60 %	Low
Mechanized Processing	Use of machines/equipment	10	20 %	Moderate
Solar Dryer Technology	Controlled drying system	5	10 %	High

***Note**: n – the number of participants who mentioned the marine resources during interviews*

This reliance on traditional processing techniques limits the quality, shelf life, and marketability of marine products. It also constrains the potential for scaling up production and accessing higher-value markets. Small-scale fisheries often lack access to modern processing technologies and technical support, resulting in low-value outputs and reduced competitiveness.

Despite these limitations, some communities demonstrated innovative practices, such as the production of fish balls, bottled sardines, and flavored dried fish. These value-added products showed higher market demand and profitability compared to traditional products, indicating the potential benefits of product diversification and innovation.

Potential Marine-Based Food Products for Commercialization

In **Table 4**, the product availability, processing feasibility, and market potential, several marine-based food products were analyzed. Food products included bottled sardines, fish jerky, mussel-based spreads, crab paste, and seaweed-based products such as chips and beverages. Bottled sardines emerged as the top-ranked product due to its high availability of raw materials, strong market demand, and relatively established processing technology. Fish jerky and mussel-based spreads also ranked highly due to their potential for product differentiation and value addition. Seaweed-based products were identified as promising but underdeveloped, primarily due to limited awareness and technical expertise among local producers.

Table 4. Evaluation of potential commercialization of marine-based food products

Marine Product	Raw Material Availability	Market Demand	Feasibility	Composite Score	Rank
Bottled Sardines	4.80	4.75	4.60	4.72	1
Fish Jerky	4.65	4.60	4.55	4.60	2
Mussel-Based Spread	4.50	4.40	4.45	4.45	3
Crab Paste	4.30	4.35	4.25	4.30	4
Seaweed-Based Products	4.10	4.20	4.00	4.10	5

Scale: 1.00–1.80 (Very Low), 1.81–2.60 (Low), 2.61–3.40 (Moderate), 3.41–4.20 (High), 4.21–5.00 (Very High)

Challenges in Marine-Based Food Processing and Development

In **Table 5**, there were major challenges that affected food processing and development of marine-based products in Samar, Philippines. These include limited access to processing equipment, inadequate storage facilities, lack of technical knowledge, and weak market linkages. Some also mentioned financial constraints and limited institutional support as major barriers to innovation and expansion.

Post-harvest losses were reported as a significant issue, particularly during periods of high production. The absence of cold storage and efficient preservation methods leads to spoilage and reduced product quality. Also, the lack of standardized processing practices affects product consistency and safety, limiting opportunities for commercialization.

Table 5. Challenges in marine-based food processing

Key Challenges	*n*	%	Rank
Lack of processing equipment	45	90%	1
Inadequate storage facilities	42	84%	2
Limited technical knowledge	40	80%	3
Weak market linkages	38	76%	4
Financial constraints	35	70%	5

Note: n – the number of participants who mentioned the marine resources during interviews

Implications for Marine-Based Food Industry Development in Samar

In **Table 6**, major themes such as resource availability, processing practices, product development, market potential and constraints were identified. The findings indicate that Samar possesses substantial potential for the expansion of value-added marine food processing. The abundant supply of fish and mollusks provides a stable

resource base that can support continuous production and long-term industry development. Despite this advantage, processing activities remain largely dependent on traditional methods, resulting in limited product diversification and lower value creation. Nevertheless, the increasing demand for processed seafood products presents significant opportunities for product innovation, market expansion, and commercialization.

Table 6. Development potential of marine-based products

Theme	Key Findings	Implication
Resource Availability	High abundance of fish and mollusks	Supports continuous production
Processing Practices	Mostly traditional	Needs technological upgrading
Product Development	Limited value-added products	Opportunity for diversification
Market Potential	High demand for processed seafood	Strong commercialization potential
Constraints	Equipment, skills, infrastructure gaps	Requires institutional intervention

DISCUSSION

Samar is known for its extensive marine biodiversity and abundant fisheries resources, owing to its archipelagic geography and vast coastal waters. This study found out that the province possesses marine resources, particularly fish, mollusks, crustaceans, and seaweeds, which provide a strong foundation for the development of marine-based industries. The abundance of fish species, including sardines (hawol-hawol), galunggong, and tuna, together with the availability of mussels, oysters, crabs, and shrimps, highlights the capacity of the province to support a sustainable supply of raw materials for food processing and value-added production.

Technology Utilization. Several studies have pointed out the value of technology in advancing marine economy and production. The integration of digital technologies, including automation, robotics, blockchain, and big data analytics, has significantly improved production efficiency, product traceability, sustainability, and quality management within the seafood processing industry (Mishra, 2023; Subash et al., 2024). However, the findings of the present study revealed that the marine-based industry in Samar, Philippines, remains largely dependent on traditional processing methods. Participants reported the continued use of conventional preservation and processing techniques, with limited adoption of modern equipment and value-adding technologies. This technological gap constrains production efficiency, limits product diversification, and reduces opportunities for expanding into higher-value markets. Inadequate access to processing equipment, technical expertise, and supporting infrastructure emerged as major barriers to technology adoption among local processors.

Processing Practices. Proper processing methods are essential for preventing spoilage, extending the shelf life of aquatic products, and preserving their nutritional value, texture, and flavor. Common processing techniques include thermal processing, curing, high-pressure processing, and ultrasonic treatment (Siewe et al., 2024). Traditional heating remains the most widely used method but is associated with uneven heating, nutrient loss, and deterioration of sensory qualities (Ismail et al., 2021), whereas curing effectively inhibits microbial growth and prolongs product preservation (Wang et al., 2023). Similarly, the findings revealed that marine-based food processing in Samar remains dominated by traditional preservation methods, particularly sun drying, smoking, and fermentation, because these techniques are affordable and require minimal equipment. In contrast, semi-processed and value-added products were less commonly produced, indicating limited adoption of advanced processing technologies. There is the need for technological upgrading, capacity building, and institutional support to promote product diversification, enhance value addition, and strengthen the competitiveness of marine-based food industry in Samar.

Commercialization. There is a growing need for sustainable utilization and commercialization of marine resources by converting aquatic biomass into high-value products, including food, nutraceuticals, pharmaceuticals, cosmetics, biofuels, and other industrial materials through advances in marine biotechnology and innovation (Schneider et al., 2023). Fisheries play an important role in this sector by supporting food security, livelihoods, and economic development (Das & Mondal, 2024), while the commercialization of marine-derived products and processing by-products creates opportunities for value addition, waste reduction, and job creation (Lal et al., 2023). Similarly, the findings indicated that marine-based food products in Samar have strong commercialization potential due to the availability of marine resources, favorable market demand, and opportunities for value-added processing. However, this potential is constrained by limited processing technologies, inadequate infrastructure, insufficient technical expertise, and restricted market access. The results highlight the need for technology adoption, product innovation, entrepreneurship development, and stronger institutional support to enhance product competitiveness, expand market opportunities, and promote the sustainable growth of marine-based economy in the region.

Samar has the potential to become a regional hub for marine-based food processing, value-added product development, and seafood commercialization. The findings of this study have important implications for the development of marine-based food industry in Samar.

Maximizing the abundant marine resources requires a comprehensive strategy that integrates technological innovation, value-added processing, and market development. Government agencies, higher education institutions, and private industry should strengthen technology transfer programs, provide modern processing equipment, and deliver continuous technical training to improve product quality, safety, and production efficiency.

Investments in cold chain facilities, processing centers, packaging technologies, and quality assurance systems can further reduce post-harvest losses and increase the marketability of marine-based products. Improving commercialization also requires strengthening market linkages through product branding, certification, and compliance with national and international food safety standards.

The development of cooperative marketing systems, digital marketing platforms, e-commerce channels, and participation in regional and international trade fairs can expand the market reach of locally processed seafood products.

Encouraging product innovation through research and development can diversify marine-based products, increase their value, and respond to changing consumer preferences. These interventions can enhance the competitiveness of marine-based food industry in Samar, generate higher incomes for coastal communities, create employment opportunities, and contribute to the sustainable growth of the blue economy while ensuring the responsible utilization of its marine resources.

CONCLUSION

Samar possesses abundant marine resources, particularly fish, mollusks, crustaceans, and seaweeds, providing a strong resource base for the development of marine-based industries. Despite this potential, the local marine-based food industry remains largely dependent on traditional processing methods, with limited adoption of modern technologies, resulting in low product diversification and constrained value addition. Participants identified inadequate processing equipment, technical expertise, infrastructure, and market access as major barriers to improving production and expanding commercialization.

The marine-based food products in Samar have strong commercialization potential because of the availability of raw materials and favorable market demand. However, realizing this potential requires technological upgrading, improved processing facilities, product innovation, entrepreneurship development, and stronger institutional support. Investments in modern processing technologies, cold chain systems, quality assurance, branding, certification, digital marketing, and market linkages can enhance product competitiveness, increase market access, promote value-added production, generate employment and higher incomes for coastal communities, and position Samar as a regional hub for marine-based food processing and seafood commercialization.

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