International Journal of Sustainable and Integrated Studies
Volume 1, Issue 4 | ISSN: 3155-6361
DOI: https://doi.org/10.65339/ijsis.V1.I4.303

Sanitation, Hygiene, and Supply Management Practices Among Fish Vendors in Bongao Public Market, Tawi-Tawi, Philippines

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Publication history:

Received: October 18, 2026 Accepted: November 18, 2026
Revised: November 16, 2026 Published: November 19, 2026

International Journal of Sustainable and Integrated Studies, Vol. 1, No. 4, pp. 473–480, November 2026.

Abstract

This study assessed sanitation and hygiene practices, supply management, and operational challenges among fish vendors at Bongao Public Market, Tawi-Tawi, Philippines. Using a descriptive cross-sectional case study design, 50 vendors were selected through quota sampling. Data were gathered through structured questionnaires, supplemented by interviews and direct observations, and analyzed using frequencies, percentages, and weighted means. All respondents were male and Tausug, while the largest age group was 31–40 years (36%). Heavy rainfall was the leading operational challenge (74%), followed by hot weather (24%). Vendors reported frequent avoidance of spoiled fish (weighted mean = 4.78), washing fish before display (4.70), and cleaning stalls and tools (4.62). However, proper waste disposal (2.44), covering displayed fish (2.18), and wearing protective gear (2.07) received low ratings. Respondents generally reported sufficient fish supplies for daily sales (4.66). Overall, established hygiene routines and perceived supply adequacy coexisted with weaknesses in contamination prevention and weather-related operational challenges. The study recommends regular food safety training, improved waste collection and drainage, accessible protective equipment, fish covers, and appropriate ice or refrigeration facilities. Findings are limited by nonprobability sampling at one market, reliance primarily on vendor reports, and the absence of microbiological testing. By identifying specific priorities for vendors and market administrators, this study provides practical evidence for locally responsive sanitation improvements. Coordinated action among local government units, public health authorities, and vendors is particularly important. Its implications support Sustainable Development Goal 3, Good Health and Well-Being, while encouraging safer seafood handling and more sustainable fish vending livelihoods in Bongao.

Keywords: Fish Vendors; Food Safety; Hygiene Practices; Public Market Sanitation; Supply Management

1. Introduction

Sanitation and food safety are fundamental to public health, particularly in open-air markets where food handling, storage, and distribution are influenced by environmental conditions (Jaffee & Henson, 2024). The World Health Organization (WHO, 2026) emphasizes that safe food handling and effective food safety systems are essential to preventing foodborne disease. Proper hygiene, sanitation, and handling practices help prevent contamination, preserve food quality, and reduce foodborne disease risks. Fish is particularly vulnerable to deterioration because of its perishable nature. Improper handling, contaminated water, unsanitary surfaces, and inadequate storage conditions can encourage microbial growth and compromise seafood safety (Bedane et al., 2022). Consequently,

fish vendors must maintain hygienic selling environments through proper cleaning, safe handling, appropriate storage, and effective waste disposal. Market sanitation also depends on access to clean water, adequate drainage, suitable storage facilities, and effective waste management. These conditions are important to food safety and environmental health in traditional markets (WHO, 2023a). Examining these practices among fish vendors is essential to identifying sanitation weaknesses and opportunities for improving consumer protection.

Existing literature identifies sanitation infrastructure, environmental exposure, and food-handling practices as interconnected factors affecting food safety in traditional and informal markets. Recent WHO guidance emphasizes practical hygiene, contamination prevention, and food protection measures in traditional markets (WHO, 2023a, 2024a). These measures are relevant to seafood vendors working in open-air market conditions. Food safety concerns are especially significant in seafood trading because fish quality depends on careful handling, temperature control, cleanliness, and suitable storage (Huss et al., 2003). Exposure to contaminated environments and inappropriate handling conditions increases the potential for microbial contamination (Bedane et al., 2022; WHO, 2023b). Effective sanitation therefore requires both responsible vendor practices and adequate market facilities. Supply management is another important consideration in fish vending because seafood availability, product freshness, and daily sales depend on efficient handling and distribution. In coastal communities, fish vendors connect producers and suppliers with consumers, making their daily operations important to local food availability and economic activity. Understanding the relationship between sanitation practices, supply management, and environmental challenges can support safer and more reliable seafood trading.

Globally, foodborne diseases remain a major public health concern. WHO (2026) reports that unsafe food can cause more than 200 diseases and disproportionately affects vulnerable populations, particularly young children. These concerns highlight the importance of strengthening food safety practices in traditional markets. At the national level, the Philippines is a major fish-producing country, with approximately 4.34 million metric tons of fisheries production in 2022, including aquaculture and capture fisheries (Bureau of Fisheries and Aquatic Resources [BFAR], 2022). Seafood also provides an important source of dietary protein for Filipino households (Tahiluddin & Kadak, 2022). Fisheries and aquaculture contribute to Philippine food production and livelihoods (Tahiluddin & Terzi, 2021). Maintaining safe fish-handling and distribution practices is therefore important to national food security and consumer health. Locally, Tawi-Tawi consists of more than 300 islands and extensive reef systems within the Coral Triangle, a globally recognized marine biodiversity region (Muallil et al., 2020). As an island province, Tawi-Tawi relies on maritime connections for movement between communities. Fishing and seaweed farming remain important livelihood activities that support the province's economy and food supply. Bongao became the official provincial capital of Tawi-Tawi in 1979 under Batas Pambansa Blg. 24. Its designation as the provincial capital contributed to its development as an administrative and commercial center (Batas Pambansa Blg. 24, 1979; Provincial Government of Tawi-Tawi, n.d.). Bongao Public Market serves as an important local seafood trading center where commercially important fish from Tawi-Tawi waters are sold to local buyers, while nearby fish warehouses facilitate trade with other areas (Muallil et al., 2020). Traditional food markets serve as important spaces for economic exchange and social interaction, where relationships between vendors and consumers are influenced by interpersonal connections and cultural norms (Nordhagen et al., 2023). Within this setting, maintaining hygienic fish handling, adequate supplies, and sanitary market conditions is essential to protecting consumers and sustaining local livelihoods.

The study is conceptually grounded in the relationship among food safety, sanitation infrastructure, seafood handling, and market operations. WHO (2026) emphasizes food safety as a shared responsibility, including the role of food handlers in preventing contamination across the food supply chain. This perspective establishes vendor hygiene and responsible handling as essential components of consumer protection. Market sanitation is further influenced by environmental conditions and the availability of basic facilities. Access to clean water, effective waste disposal, proper drainage, and suitable storage supports safer food handling and reduces environmental health risks (WHO, 2023a). Likewise, appropriate fish handling and storage are necessary to minimize microbial contamination and preserve seafood quality (Bedane et al., 2022). Within this conceptual perspective, fish vendors' demographic characteristics, sanitation and hygiene practices, supply management activities, and operational challenges are examined as interconnected aspects of market operations. Their assessment provides a basis for identifying practical interventions that can strengthen food safety, improve market conditions, and support sustainable fish vending.

Although existing literature discusses food safety, sanitation infrastructure, and the challenges of informal markets, the specific sanitation, hygiene, and supply management practices of fish vendors at Bongao Public Market require localized assessment. Recent guidance for traditional food markets provides relevant general principles (WHO, 2023a, 2024a), but it does not directly establish the conditions experienced by fish vendors in Bongao, Tawi-Tawi. This study addresses that contextual gap by assessing the sanitation and hygiene practices, supply management activities, and operational challenges of fish vendors in Bongao Public Market. Specifically, it aims to determine respondents' demographic characteristics in terms of age, sex, and ethnicity; identify challenges affecting sanitation, hygiene, and daily operations; describe existing food-handling and supply

management practices; and formulate recommendations for improving seafood safety and market conditions. The study focuses exclusively on fish vendors operating within Bongao Public Market and excludes vendors of other commodities, restaurants, household fish processing, and large-scale seafood distribution. Its assessment relies on vendor self-reports, direct observations, and available local government health reports, without laboratory or microbiological testing. These boundaries provide a focused basis for developing practical, locally appropriate sanitation and market management recommendations.

The study aligns with several Sustainable Development Goals through its focus on seafood safety, public health, local livelihoods, and market sanitation. SDG 3 – Good Health and Well-Being is directly supported through the assessment of sanitation, personal hygiene, and safe seafood handling. Identifying practices that may increase contamination risks can guide food safety education and market sanitation improvements intended to protect consumers and vendors. SDG 8 – Decent Work and Economic Growth is relevant because fish vending provides livelihood opportunities and supports local commercial activities. Improving sanitation conditions, fish preservation, and supply management can contribute to safer working environments, reduced product losses, and more reliable business operations. SDG 12 – Responsible Consumption and Production is reflected in the study's emphasis on responsible fish handling, proper waste disposal, product preservation, and efficient supply management. These practices can help reduce seafood spoilage, minimize market waste, and promote responsible distribution and consumption. SDG 11 – Sustainable Cities and Communities is also relevant because improved drainage, waste management, access to clean water, and sanitary public market facilities can support healthier and more resilient community trading environments. Collectively, these connections demonstrate how improvements in fish vending practices may contribute to public health protection, responsible resource management, livelihood stability, and sustainable local market operations.

The study contributes to multidisciplinary sustainability by connecting public health, environmental management, socio-economic development, and institutional responsibility within the context of traditional seafood markets. From a public health sustainability perspective, the study provides information that can support continuing food safety education, hygienic seafood handling, and contamination prevention. Strengthening these practices can contribute to safer seafood consumption and healthier market environments. In terms of environmental sustainability, improved waste disposal, drainage, and sanitation practices can help reduce pollution and maintain cleaner public market surroundings. Appropriate fish storage and supply management can also minimize spoilage and unnecessary product waste. Regarding socio-economic sustainability, the study recognizes fish vending as an important source of livelihood and seafood distribution in Tawi-Tawi. Improving fish handling, product preservation, and supply reliability can help vendors maintain product quality, protect their income opportunities, and respond to environmental disruptions. The study also supports community and institutional sustainability by providing evidence that local government units, public health authorities, fisheries personnel, and market administrators can use to develop sanitation programs, improve market facilities, and strengthen food safety monitoring. Coordinated efforts among these stakeholders can encourage responsible vendor practices and improve market management. Furthermore, the study contributes to educational sustainability by identifying areas where continuous training and practical sanitation guidance may benefit fish vendors. Its findings can serve as a reference for future investigations involving food safety, seafood supply management, and sanitation in traditional coastal markets. Overall, the study emphasizes that sustainable fish vending requires the integration of hygienic food handling, effective supply management, environmental protection, and institutional support. Addressing these interconnected concerns can contribute to safer seafood markets, stronger local livelihoods, improved consumer confidence, and the long-term sustainability of Bongao Public Market.

2. Material and methods

2.1 Research Design

The study utilized a descriptive cross-sectional case study design to examine existing sanitation and hygiene practices, food safety challenges, and supply management activities among fish vendors at Bongao Public Market. This design enabled the researchers to describe prevailing conditions and assess vendors' reported practices within their actual market environment. Quantitative data from structured questionnaires were supplemented by interviews and direct observations to provide contextual information about fish handling, market sanitation, and daily operations.

2.2 Locale of the Study

The study was conducted at Bongao Public Market, locally known as Tabuh, in Bongao, Tawi-Tawi, Philippines, located at approximately 5°04′11.2″N latitude and 119°53′02.0″E longitude. The market serves as a central seafood trading hub for Bongao and nearby islands and operates daily from 6:00 a.m. to 6:00 p.m. Fish vendors display their products on selling tables and in ice-covered containers, sometimes alongside vendors of other commodities. The market was selected because of its accessibility to the researchers and its significance to local seafood commerce, providing an appropriate setting for examining sanitation routines, food-handling practices, and supply management activities.

2.3 Respondents of the Study
The respondents consisted of fish vendors actively engaged in selling fresh or processed seafood products at Bongao Public Market during the data collection period. Eligible participants were required to have at least one year of experience in fish or seafood vending and to provide voluntary informed consent. Their direct involvement in handling, storing, displaying, and selling seafood made them suitable respondents for assessing sanitation practices, food safety concerns, and supply management activities.

2.4 Sample and Sampling Procedure
The study involved 50 fish vendors selected through quota sampling, a non-probability sampling technique involving a predetermined number of respondents who meet specified eligibility requirements. Participants were selected based on their fish vending experience, availability during data collection, and willingness to participate. This procedure enabled the researchers to gather information from eligible vendors with direct experience in seafood handling, sanitation, and supply management at Bongao Public Market.

2.5 Research Instrument
Data were gathered using a structured questionnaire developed according to the study objectives. The supply management component addressed product availability, demand, and supply, drawing on topics discussed by Bermas et al. (2023). The questionnaire items were contextualized to reflect the operational conditions of fish vendors at Bongao Public Market. The questionnaire contained two main sections. The first gathered demographic information, including age, sex, and ethnicity, while the second assessed sanitation and hygiene practices, supply management activities, and challenges affecting food safety. Practice-related responses were measured using a five-point frequency scale. Mean scores ranging from 1.00 to 1.80 were interpreted as Never, 1.81 to 2.61 as Rarely, 2.62 to 3.42 as Sometimes, 3.43 to 4.23 as Often, and 4.24 to 5.00 as Always. These classifications provided a consistent basis for describing the frequency of respondents' reported practices.

2.6 Data Gathering Procedure
Data collection began with a review of literature concerning sanitation, food safety, seafood handling, and supply management in public and informal markets. The researchers subsequently prepared the questionnaire to address the study objectives and local market conditions. After preparing the research materials, the necessary institutional permissions and ethical clearances were secured. Eligible fish vendors were informed about the study's objectives, procedures, and voluntary nature before providing informed consent. The researchers administered the questionnaires to selected respondents at Bongao Public Market, supplemented by interviews and direct observations to obtain contextual information about vendors' experiences and market conditions. Completed questionnaires and observational records were reviewed, organized, and prepared for statistical analysis.

2.7 Data Analysis Techniques
The collected data were analyzed using descriptive statistical techniques, including frequencies, percentages, and mean scores. Frequencies and percentages summarized respondents' demographic characteristics, particularly age, sex, and ethnicity, as well as reported operational challenges. Mean scores were calculated to assess the frequency of sanitation and hygiene practices and supply management activities based on the established five-point interpretation scale. Interview responses and direct observations, where available, were examined descriptively to supplement the quantitative findings and provide contextual insights into market conditions. Microsoft Excel was used for data organization, statistical calculations, and preparation of results. The findings were interpreted according to the study objectives to identify sanitation deficiencies, food safety concerns, and opportunities for improving fish handling and supply management practices.

2.8 Ethical Considerations
Ethical principles were observed throughout participant recruitment, data collection, analysis, and reporting. The researchers secured the necessary institutional permissions and ethical clearances before conducting the study. Respondents were informed about the research objectives, procedures, and intended use of the collected information, and voluntary informed consent was obtained before participation. Participants were assured of their right to withdraw at any stage without adverse consequences. Confidentiality and anonymity were maintained through appropriate data-handling procedures, including the exclusion of personally identifying information from the reported findings. All collected information was used exclusively for research purposes and handled in accordance with applicable institutional policies and ethical requirements. These safeguards ensured respect for respondents' privacy, dignity, and rights throughout the investigation.

3. Results and Discussion

3.1 Demographic Characteristics of Fish Vendors
3.1.1 Sex and Ethnic Profile of Respondents

The demographic findings revealed that all 50 respondents were male, representing 100% of the sample. Similarly, all respondents identified as Tausug, accounting for 100% of the surveyed fish vendors. These findings describe the demographic composition of the participating vendors and provide context for understanding seafood trading activities in Bongao Public Market. The respondents' shared ethnic background highlights the importance of considering local language, cultural practices, and occupational experiences when developing sanitation education and food safety initiatives.

3.1.2 Age Distribution of Fish Vendors

The largest age group consisted of vendors aged 31–40 years, comprising 18 respondents (36%). This was followed by those aged 20–30 years, with 14 respondents (28%); 41–50 years, with 10 respondents (20%); and 51–60 years, with eight respondents (16%). The findings indicate that fish vending involves several adult age groups, with the highest representation among individuals aged 31–40 years. This distribution provides a demographic basis for understanding the surveyed vendors and developing sanitation training appropriate to their occupational experiences.

3.2 Operational and Environmental Challenges Among Fish Vendors

3.2.1 Heavy Rainfall and Disruptions to Fish Vending Operations

Heavy rainfall emerged as the most frequently reported operational challenge, identified by 74% of respondents. This represented the largest proportion of reported difficulties affecting fish vending activities at Bongao Public Market. Heavy rainfall can disrupt transportation routes, seafood deliveries, customer movement, and access to fishing communities and suppliers. Flooding may also affect market sanitation and surrounding water conditions, increasing the importance of hygienic handling and reliable supply arrangements. These challenges highlight the need for improved drainage, climate-responsive market infrastructure, and measures to maintain seafood quality and business continuity during adverse weather. Related studies describe climate-related vulnerabilities in Philippine small-scale fisheries (Macusi et al., 2021) and operational constraints among informal fish vendors (Mushi, 2023).

3.2.2 Hot Weather and Seafood Preservation Challenges

Hot weather was identified as the second most frequently reported challenge, affecting 24% of respondents. This indicates that elevated temperatures constitute another environmental concern for fish vendors operating in the public market. High temperatures accelerate fish deterioration and increase the need for appropriate preservation and storage practices. Adequate ice supplies, insulated containers, refrigeration, and efficient inventory turnover can help maintain seafood freshness and reduce spoilage. Strengthening these measures is important for protecting product quality and supporting vendors' daily operations. Climate-resilient seafood operations also depend on suitable preservation and infrastructure (Hoevenaars & Beijnen, 2024).

3.2.3 Market Crowding During Ramadan

Market crowding during Ramadan was reported by 2% of respondents, making it the least frequently identified operational challenge. Although reported by a small proportion of vendors, it represents a seasonal concern associated with market activity during the religious observance. Increased customer movement during particular hours may affect stall accessibility, vendor mobility, and the organization of selling areas. Appropriate market space management and organized customer movement can help maintain efficient seafood trading and hygienic market conditions during periods of increased activity.

3.3 Sanitation and Hygiene Practices Among Fish Vendors

3.3.1 Food Quality Control and Routine Hygiene Practices

The highest weighted mean was recorded for avoiding the sale of spoiled fish (4.78), followed by washing fish before display (4.70) and maintaining clean stalls and tools (4.62). Other highly rated practices included using clean containers (4.50), ensuring access to clean water (4.48), and proper handwashing (4.46). All six practices fell within the Always category, indicating that respondents reported consistently observing these sanitation measures. These findings reflect vendors' attention to seafood quality, cleanliness, and basic food safety practices. Avoiding spoiled fish helps protect consumers, while washing seafood and maintaining clean equipment and selling areas support hygienic handling. Access to clean water, appropriate containers, and regular handwashing further strengthens sanitation routines. Maintaining these practices through continuing education and regular market sanitation activities can support consumer confidence and seafood safety.

3.3.2 Waste Disposal, Fish Protection, and Personal Protective Practices

The lowest weighted mean scores were recorded for wearing protective gear (2.07), covering displayed fish against flies and dust (2.18), and proper waste disposal (2.44). All three practices were classified as Rarely, indicating deficiencies in important aspects of market sanitation and personal protection. A recent study of fish market vendors in Baguio City similarly highlighted the need for targeted sanitation training and infrastructure improvements (Bunzo & Simon, 2026). These findings identify priority areas for improving food safety at Bongao Public Market. Research involving seafood from traditional markets in Bali identified bacterial contamination

risks and emphasized appropriate handling and storage (Sudaryatma et al., 2025). Fish contains moisture and nutrients that can support microbial growth under favorable conditions, while exposure to insects, contaminated surfaces, and unhygienic environments can increase contamination risks. Strengthening waste segregation and disposal, protecting displayed seafood, and encouraging appropriate protective equipment are therefore necessary. Food safety education, accessible waste containers, reliable water supplies, and improved drainage can support more consistent sanitation practices.

3.4 Supply Management Practices Among Fish Vendors

3.4.1 Adequacy of Fish Supply and Customer Demand

The statement concerning sufficient fish supply for daily sales obtained the highest weighted mean of 4.66, interpreted as Always. Meanwhile, the statement indicating that product supply meets customer demand received a weighted mean of 4.22, interpreted as Often. These findings indicate that respondents generally perceived their fish supplies as adequate for daily business requirements. Coordinating fish procurement with seasonal availability and customer demand can help preserve seafood freshness, minimize post-harvest losses, and improve inventory management. For Bongao fish vendors, maintaining reliable supplier relationships and monitoring daily sales requirements can support consistent seafood availability.

3.4.2 Product Availability and Revenue Opportunities

The statement indicating that increasing product supply can generate additional revenue obtained a weighted mean of 4.40, corresponding to the Always category. This suggests that respondents frequently associated greater product availability with increased income opportunities. The relationship between product availability and vendors' business outcomes is also relevant to the supply and demand issues discussed by Bermas et al. (2023). Maintaining sufficient inventory can help vendors respond to customer demand and maximize sales opportunities. However, procurement decisions must consider seafood perishability, storage capacity, and market prices to prevent unnecessary losses and maintain business efficiency.

3.4.3 Local Fish Supply Availability

The statement indicating that local fish supply is limited obtained a weighted mean of 1.74, interpreted as Never. This finding suggests that respondents generally did not perceive fish availability in the locality as a significant supply constraint. The reported availability of seafood reflects the importance of Tawi-Tawi's marine resources in supporting local fishing and trading activities. Muallil et al. (2020) documented commercially important coral reef fish diversity in Tawi-Tawi. Nevertheless, weather conditions, transportation access, seasonal variations, and fishing regulations may affect long-term supply reliability.

3.4.4 Product Pricing and Surplus Management

The statement indicating that higher product prices are associated with greater surplus obtained a weighted mean of 4.18, interpreted as Often. This suggests that respondents frequently recognized a relationship between fish prices, consumer purchasing behavior, and unsold inventory. The findings reflect the importance of adjusting procurement and pricing strategies to market conditions. Bermas et al. (2023) examined challenges faced by fish vendors, including issues relating to prices and market demand. For fish vendors in Bongao, monitoring consumer demand, managing inventory quantities, and applying appropriate pricing strategies can improve product turnover, reduce surplus, and minimize losses associated with perishable seafood.

3.5 Integrated Findings on Sanitation, Supply Management, and Market Sustainability

3.5.1 Strengths and Deficiencies in Fish Vending Practices

The findings revealed strong reported performance in several sanitation practices, particularly avoiding spoiled fish (4.78), washing fish before display (4.70), and maintaining clean stalls and tools (4.62). However, wearing protective gear (2.07), covering displayed fish (2.18), and proper waste disposal (2.44) received substantially lower ratings. Supply management findings indicated adequate daily fish availability (4.66), while heavy rainfall remained the leading operational challenge (74%). These results demonstrate that favorable routine hygiene and supply management practices coexist with deficiencies in waste management, seafood protection, and personal protective measures. Environmental conditions further complicate daily operations by affecting transportation, storage, and product preservation. Addressing these concerns requires an integrated approach combining sanitation education, appropriate market facilities, reliable seafood storage, and climate-responsive operational planning.

3.5.2 Implications for Food Safety and Sustainable Market Operations

The study identified several priorities for improving market conditions, including waste disposal, drainage, protective equipment, covered fish displays, and adequate cold storage. Although vendors generally reported sufficient fish supplies and consistent basic hygiene practices, environmental challenges and less frequently observed sanitation measures remained important concerns. These priorities are consistent with risk-based market inspection guidance (WHO, 2024b). These findings support coordinated improvements involving fish vendors, market administrators, local government units, and public health authorities. Continuing food safety education,

improved sanitation facilities, reliable water access, and appropriate fish preservation systems can help strengthen seafood quality and consumer protection. Climate-responsive infrastructure and coordinated supply arrangements may also improve operational resilience, reduce product losses, and support sustainable fish vending livelihoods in Bongao, Tawi-Tawi.

4. Conclusion & Recommendations

This study examined the sanitation, hygiene, supply management practices, and operational challenges of 50 fish vendors at Bongao Public Market, Tawi-Tawi, Philippines. The respondents were exclusively male and Tausug, with the largest proportion aged 31–40 years. Findings revealed that vendors generally maintained favorable hygiene practices, particularly avoiding spoiled fish, washing seafood before display, maintaining clean stalls and equipment, and practicing proper handwashing. However, deficiencies in waste disposal, covering displayed fish, and wearing protective equipment indicated important sanitation concerns. Supply management practices were generally adequate, with vendors reporting sufficient fish availability to meet daily sales requirements and customer demand. Heavy rainfall emerged as the primary operational challenge, followed by hot weather and seasonal market crowding. Overall, the findings demonstrate that established hygiene routines and adequate seafood supplies coexist with sanitation deficiencies and environmental challenges, highlighting the need for coordinated improvements in food safety, market facilities, and operational resilience.

Based on the findings, local government units, public health authorities, and market administrators should prioritize regular sanitation and food safety training for fish vendors, emphasizing proper waste disposal, protective equipment, hygienic seafood display, and contamination prevention. Market administrators should strengthen waste collection systems, improve drainage facilities, maintain reliable access to clean water, and provide appropriate waste containers and protective equipment. Vendors should consistently cover displayed fish, maintain clean selling areas, and reinforce established handwashing and seafood handling practices. To address weather-related challenges, local authorities and fisheries agencies should improve access to ice, refrigeration, and appropriate storage facilities while supporting reliable transportation and supplier coordination during heavy rainfall. Market administrators should establish clear sanitation guidelines, conduct regular inspections, and monitor compliance. Continued collaboration among vendors, government agencies, and public health personnel is recommended to strengthen food safety, minimize product losses, maintain seafood quality, and support sustainable market operations and livelihoods.

This study was limited to 50 fish vendors selected through non-probability quota sampling at Bongao Public Market, Tawi-Tawi. Its descriptive cross-sectional design captured reported practices and challenges during the data collection period without examining changes over time or establishing causal relationships. The findings relied primarily on structured questionnaires, supplemented by interviews and direct observations, and may reflect limitations associated with self-reported information. Laboratory testing and microbiological analysis were not conducted, preventing direct verification of seafood contamination. The study excluded other vendors and seafood distribution settings, limiting the generalizability of its findings. Future research may include broader samples, additional markets, longitudinal assessments, and microbiological testing.

5. Compliance with ethical standards

This study adhered to applicable institutional ethical guidelines and was conducted after securing the necessary permissions and ethical clearances. All 50 fish vendors voluntarily participated after providing informed consent and being informed of the study's objectives, procedures, and their right to withdraw without adverse consequences. Confidentiality, anonymity, and data privacy were maintained throughout the research process, and all collected information was used exclusively for academic purposes. Data were analyzed and reported objectively to ensure research integrity.

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