



Critical Point Analysis and Improvement Strategies for Demersal Fish Handling in the Seribu Islands

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(Received September 2025/Accepted May 2026)

ABSTRACT

The handling of demersal fish in the Seribu Islands faces major challenges related to quality degradation due to limited cold chain facilities and a lack of knowledge of sanitation among fishermen. This study aimed to analyze the sanitation conditions, handling practices, and fish storage procedures, as well as fish quality, transfer processes, and critical points of quality deterioration. Developing improvement strategies for the cold chain process in handling demersal fish. The organoleptic assessment results showed values in the range of 6.78–7.02, which showed that some fish did not meet the SNI standard (≥ 7.0). The main factors contributing to the decline in quality include limited ice, inadequate fish storage containers, poor sanitation, and prolonged distribution time. The identification of critical points showed that the aspects with the lowest scores were the temperature of the fish when it was unloaded from the ship (1.00), cleanliness of the fish storage area (1.14), and feasibility of the fish transport container (1.29). The SWOT analysis used to formulate a cold chain process improvement strategy resulted in an IFAS score of +1,14 and an EFAS of +0.69, which placed the strategy in Quadrant I (SO-Aggressive Strategy). The development strategy is directed towards optimizing internal strengths to take advantage of external opportunities. Recommendations include improving the efficiency and quality of the cold chain through government support, improving storage facilities, and enhancing the competence of fishermen in quality management and product diversification.

Keywords: demersal fish handling, fish sanitation, critical point analysis, SWOT

INTRODUCTION

Fishery products are perishable foods, especially if not handled properly. This is because decaying bacteria multiply rapidly in the fish body (Rahmatang *et al.* 2019). This is because fish contain high water and protein content (Kaban *et al.* 2019). The storage of fish on board the ship greatly affects fish quality during the journey from sea to land. The hatch used to store fish on ships is often not applied according to the Indonesian National Standard (SNI) standards. In addition, there are other containers for storing fish, such as cool boxes or large drums, that are also not equipped with enough covers and ice, so that the fish are directly exposed to sunlight and experience rapid deterioration in quality.

Freshly caught and dead fish have the highest freshness rate. However, the quality of fish can only be maintained through good and correct handling and cannot be improved (Asni *et al.* 2022). Improper handling, long supply chains, and inadequate

processing infrastructure contribute to the decline in fish quality and high post-harvest damage (Kala'tiku *et al.* 2023). Post-harvest handling is also related to the tools used to bring, process, and store fish and the stakeholders involved.

According to Asni *et al.* (2022), the speed of quality decline occurs due to internal and external factors. Internal factors include the type of fish and their biological condition. Fish with thin skin, such as pelagic fish, are more susceptible to rotting bacteria, whereas fish with a high fat content experience oxidation processes faster (Vatria 2020). External factors that cause a decline in fish quality include timing, handling methods, death processes, and fish handling facilities. The manner of fish death during the fishing process greatly affects the rate of decline in fish quality and the selling value. Fish that die from injuries tend to decay faster (Suprayitno 2020). One of the processes that decrease fish quality is characterized by an increase in the pH of fish meat (Leiwakabessy *et al.* 2024). According to Rahmatang *et al.* (2019), this occurs because of the degradation of proteins and non-protein compounds that contain nitrogen, which causes an increase in pH in fish meat; thus, the higher the rate of fish decay, the higher the pH. Decaying fish usually have a pH of approximately 10–11. Meanwhile, the organoleptic value of fish continues to decline until it reaches the lowest value. Fish that have rotted and smell bad generally have an organoleptic value of < 2 .

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The stage of moving fish from the ship to the fish landing site is also a critical point that can affect quality. The loading and unloading processes that are performed manually can take a relatively long time, so fish can be exposed to high environmental temperatures for a long time. This condition eventually increases the rate of decay, especially if the fish transport container is not closed and ice is not provided or the fish transport equipment is not refrigerated. In addition, the lack of loading and unloading schedule arrangements and coordination between stakeholders results in fish accumulating under less-than-ideal storage conditions. This highlights the importance of improving the timing and logistics efficiency to maintain fish quality until it reaches consumers.

The fisheries logistics perspective shows that there are two categories of regions: producer and consumer regions. Producer regions are the areas of origin for catching and initial handling of fish, whereas consumer regions are the destinations for distribution and marketing. Panggang Island, which is administratively part of the Special Capital Region of Jakarta, serves as a fishing production region that supplies its catch to the consumer areas in Jakarta. Despite being within the same administrative region and the main market for catches from Panggang Island being sold to Jakarta, the quality of fish received by consumers in Jakarta is often suboptimal. This indicates problems with the fish handling system and the implementation of the cold chain from the early post-harvest stages in producer regions. Therefore, Panggang Island was selected as the research location to identify cold chain issues and formulate improvement strategies to support fish quality improvement in consumer regions.

Based on these problems, this study aimed to analyze the conditions of sanitation, handling, and storage of fish; analyze fish quality, the process of removal, and critical points of decline in fish quality; and develop strategies to improve the cold chain process of demersal fish handling.

METHODS

Research Design and Location

This research was conducted in the waters of the Seribu Islands, 7 miles from the coast of Panggang Island. The research was implemented over 6 days in February 2025. The research subjects were trap fishermen operating demersal fishing vessels, with a sample size of 7 trap vessels actively operating at the research location. Sample determination was carried out using purposive sampling, with the criteria being that fishermen actively operated traps for more than 15 years and targeted demersal fish. This method was chosen because it was considered capable of representing the characteristics and operational conditions that aligned with the research objectives.

Data Collection

The data collection technique used was purposive sampling. The data used included primary data. Primary data were obtained through field observations and interviews with fishermen. The primary data included:

- Data on sanitation conditions, and fish storage and handling were obtained through observations and interviews regarding fishing practices, tools, and materials used during the fishing process.
- Data for the organoleptic test were obtained from fish caught by fishermen using fish traps. Fish samples were collected from the bottom, middle, and top of the fish storage area.

The research stages were systematically structured using an appropriate approach to obtain accurate information that aligned with the research objectives. The first stage involved identifying the conditions of the fish storage area and the fish transfer process using observation and interview methods to obtain the factors that influence fish quality. The second stage, namely the organoleptic test of fish quality upon landing, is based on score sheet SNI 01-2346-2006 (Table 1 Organoleptic Assessment Parameter of Fish Organoleptic Quality), which assesses organoleptic parameters with output aspects that are suspected to be critical points for the decline in fish quality.

Data analysis

The first objective of the data analysis was to use descriptive analysis to evaluate the sanitary conditions of fish storage areas by examining the physical condition of the ship, tools, and materials used at sea.

The second objective data analysis used organoleptic analysis with a scoring system. Organoleptic assessment is a method that can be used to determine the quality of landed fish (Fadillah 2021). Data obtained from the organoleptic assessment sheet was then tabulated and quality intervals determined using the scoring method (SNI 01-2346-2006):

$$\left(\bar{x} - \left(1,96 \cdot \frac{s}{\sqrt{n}} \right) \right) \leq \mu \leq \left(\bar{x} + \left(1,96 \cdot \frac{s}{\sqrt{n}} \right) \right) = 95\%$$

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

$$s^2 = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}$$

$$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}}$$

Where	:	
n	=	Sample size
S ²	=	Diversity of Quality Values
1.96	=	Standard coefficient of deviation at 95%
\bar{x}	=	Average Quality Value

Table 1 Organoleptic Assessment Parameters

Parameters	Criteria and Specifications of Quality	Score
Eyes	Bright, protruding eyeballs, clear cornea	9
	Bright, flat eyeballs, clear cornea	8
	Slightly bright, flat eyeballs, grayish pupils, cornea slightly cloudy	7
	The eyeball is slightly concave, the pupil turns grayish, the cornea is somewhat cloudy	5
	Sunken eyeballs, pupils begin to turn milky white, corneas cloudy	3
	The eyeball is very concave, the cornea is slightly yellow	1
Gill	Brilliant color clean, without mucus	9
	Red color less brilliant, without mucus	8
	Red color is a bit dull, without mucus	7
	Red color is slightly dull, slightly mucus	6
	There is a change in color, reddish-brown, a little mucus	5
	Red-brown color, thick mucus	3
	Red-brown color there is a slight white, thick mucus	1
Mucus on the surface of the body	Clear, transparent, bright glossy mucus coating	9
	The mucus layer is clear, transparent, bright, no discoloration	8
	The mucus layer begins to be somewhat cloudy, the color is slightly white, less transparent	7
	The mucus layer begins to become cloudy, the white color is slightly dull, less transparent	6
	Thick mucus clumps, begins to turn white, cloudy	5
	Thick mucus clumps, yellowish-white in color	3
	Thick mucus clumps, brownish-yellow color	1
Flesh (Color and Appearance)	Very brilliant meat incisions, type-specific, no redundancy along the spine, intact abdominal wall	9
	Excellent flesh incision, type-specific, no redness along the spine, intact abdominal wall	8
	Flesh incision is less brilliant, type-specific, no redness along the spine, abdominal wall intact	7
	The flesh incision begins to fade, a lot of redness along the spine, the abdominal wall is slightly soft	5
	The flesh incision begins to fade, a lot of redness along the spine, the abdominal wall is slightly soft	3
	The flesh incision is very dull, the red color is very clear along the spine, the abdominal wall is very soft	1
Smells	Smells very fresh, type specific	9
	Fresh, type-specific	8
	Neutral	7
	The smell of ammonia began to smell, a slight sour smell	5
	The smell of ammonia is strong, there is an H ₂ S ₄ smell, clear and foul acid smell	3
	Clear foul smell	1
Texture	Dense, elastic, difficult to tear flesh from the spine	9
	Relatively dense, elastic when pressed with fingers	7
	Slightly soft, slightly elastic, slightly easy to tear the meat	5
	Soft, visible finger marks when pressed, easy to tear flesh	3

xi = Quality Value from Panelist to I
s = The Importance of Quality Values

determined based on the relative critical limit (relative critical limit/RCL) showed in Table 2 Criteria for Assessing Critical Points for Fish Handling Demersal.

Critical point analysis of fish handling was conducted at the landing or unloading stage. Data on the quality of the fish caught were obtained from seven vessels measuring 1.5–7 GT that landed on Panggang Island. Potential critical points in the study were identified by considering the risks that might occur if an activity is not performed properly. The implementation of the activity was assessed with a score of 1 (poor), 2 (less good), and 3 (good), and its critical status was

The third objective of data analysis was to develop a strategy for improving or optimizing fish handling during the cold chain using SWOT analysis. SWOT analysis is a method used to systematically identify various factors in formulating a company's strategy (Mashuri & Nurjannah 2020). The SWOT method is a strategic planning technique that assesses strengths (strengths), weaknesses (weaknesses), opportunities (opportunities), and threats (threats).

Table 2 Criteria for assessing critical points for fish handling demersal

Critical Points	Assessment Criteria	Score
Fish Handling on Fishing Vessels		
	Using ice with a stable temperature (≤ 4 °C)	3
Use of ice during onboard storage	Using ice with unstable temperatures	2
	No ice at all	1
Cleanliness of onboard storage	Clean (mucus-free, residual dirt)	3
	Pretty clean	2
	Dirty	1
Time between hauling and cooling	< 15 minutes	3
	15-30 minutes	2
	> 30 minutes	1
Arrangement and accumulation of fish	Laid out with ice evenly	3
	Arranged but the ice is unevenly distributed	2
	Stacked without ice breaks	1
Fish Unloading at the Port		
	< 15 minutes after docking	3
Speed of Fish Drop	15-30 minutes	2
	> 30 minute	1
Temperature of the fish when lowered	≤ 4 °C	3
	5-10°C	2
	> 10°C	1
Containers/Means of transport to land	Clean, with closed conditions	3
	Makeshift and closed	2
	Dirty with open conditions	1
Fish Handling while in the Collector		
	Freezer with a temperature of ≤ -18 °C	3
Transfer of fish to a new container	Coolbox	2
	Regular box	1
	Ice is evenly added	3
Supplemental Ice Feeding	Ice added but unevenly distributed	2
	No extra ice	1
Packing before shipment to port Muara Angke/Baru	Packed with plastic and put into insulated box	3
	Coolbox	2
	Regular box	1
Medium Storage Temperature	≤ -18 °C	3
	4-18°C	2
	> 4°C	1

Note: 1= Not good; 2 = Not good; and 3 = Good.

RESULTS AND DISCUSSION

The decomposition process in fish after capture cannot be stopped, but it can be slowed down by maintaining freshness. Therefore, post-harvest handling must be performed carefully to extend the product's shelf life (Mailoa *et al.* 2020; Suprayitno 2020). The quality of the catch is also influenced by the sanitary conditions at the fish landing site; unsanitary conditions can accelerate the deterioration of quality (Kau *et al.* 2024).

Sanitation, Handling, and Storage of Fish

Sanitation is an effort to minimize or avoid the presence of pathogenic microorganisms that can endanger human health and food safety (Mustaruddin *et al.* 2022). Poor sanitation handling and lack of sanitation facilities have the potential to cause losses, such as a decrease in the selling price of fish and

susceptibility to acute diseases due to spoiled nutritional content and contamination with harmful pathogens (Kau *et al.* 2024; Mustaruddin *et al.* 2022). Well-implemented sanitation makes employees feel comfortable at work and creates a healthy environment (Hanarisanty *et al.* 2023).

Trap Fishing Boat Design

According to the Regulation of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number 7/Permen-Kp/2019, Article 5, the Standards for Fish Handling and Storage Facilities on Fishing Vessels include the following:

- Fishing vessels are designed to prevent the entry of insects, rats, and other pests.
- Fishing vessels are designed to prevent fish contamination from dirty water, waste, fuel oil, lubricants, smoke, and other hazardous materials.
- The construction and layout of the fish hatch are designed to be easy to clean, and the fish hatch is

not used as a storage place for fuel, oil, or other potentially contaminated materials.

- The layout and design of the process flow in fishing vessels are arranged to prevent cross-contamination.
- Surfaces in direct contact with fish are made of waterproof materials that do not damage the physical condition of the fish, are non-corrosive, and are easy to clean.
- The Fish Hatch must be equipped with an automatic temperature recorder/recorder placed in an easy-to-read place, or in the absence of an automatic temperature recorder/recorder, temperature measurements and recording are carried out periodically every 2 (two) hours; and
- Fishing vessels that carry out fishing activities:
 - Not freezing fish must have facilities to cool fish to the ice melting point temperature; or
 - Freezing: Fish must have a facility capable of rapidly lowering the temperature so that it reaches the central temperature of the fish equal to or less than -18°C ;
- The utensils and containers used were made of non-corrosive materials; the coating material did not cause contamination, was waterproof, did not damage the physical condition of the fish, and was easy to clean.
- There are sufficient garbage/waste shelters.
- Personal hygiene facilities are available with means of rinsing, soap, and disinfectant; and
- Toilets on fishing vessels are not located near fish handling and storage areas.

The design of trap fishing boats on Panggang Island, Thousand Islands, can be said to be not in accordance with the Regulation of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number 7/Permen-Kp/2019 Article 5 concerning Standards for Fish Handling and Storage Facilities on Fishing Vessels, namely the ship should (a, b) be designed to prevent the entry of insects, rodents and contamination such as fuel, lubricants, smoke and other hazardous materials. However, the floor of the ship where the fish box is held is the same as the fuel storage area dan tipe kapal undeck boat sehingga serangga, tikus dan binatang pembawa patogen mudah keluar masuk. (c, d, f) The absence of a hatch makes fish storage, loading and unloading and fuel storage in the same place, namely the deck of the ship, so that fish are very easily contaminated. (e) 5 out of 7 ships, the deck where the fish were dismantled was not coated with direct resin of the wooden floor, which was not waterproof, making it very easy for bacteria deposited on the wooden surface to enter the fish's

Table 3 Results of organoleptic observations in 7 trap fleets

	Eye	Gills	Mucus	Smell	Texture	Average
Average	6.95	7.05	6.95	6.76	6.80	6.90
Deviation	0.89	0.66	0.81	0.93	0.97	0.70
Range	6.79–7.10	6.93–7.16	6.81–7.09	6.67–7.02	6.60–6.92	6.78–7.02

body, especially if the fish was injured. (g) Fishing vessels that carry out fishing activities, but do not freeze fish, should have facilities to cool fish to a temperature below the melting point of the ice, but the fish temperature at the time of measurement, which is only around 12.6°C . (h) Storage containers or fish boxes are indeed made of fibre materials, which are materials that are not easily corroded and easy to clean, but fishermen are not diligent in cleaning the containers, so that they are still dirty and cause contaminants, because the containers are not cleaned diligently from the rest of the dirt, both from fish mucus and fish blood. (i) There is no garbage/waste shelter, so that the waste produced is directly dumped into the sea or left on board. (j) the unavailability of personal hygiene facilities, besides that, because the ship only has a capacity of 1.5-7GT, there is no toilet on board.

Fish Quality, Fish Transfer Process and Critical Point of Fish Quality Decline

• Quality of Fish Caught Landed at the Western Port of Panggang Island

The results of the organoleptic observations of the trap catches are presented in Table 3 Results of organoleptic observations in 7 trap fleets. The data provide an overview of the quality condition of fish based on five main parameters: eyes, gills, mucus, smell, and texture.

The fish species used as samples for organoleptic observation from 7 trap fishermen, totaling 129 fish, were: *Caesionidae*, *Scolopsis margaritifera*, *Lutjanus carponotatus*, *Choerodon anchorago*, *Mullus sp.*, *Balistoides viridescens*, *Caesio caerulea*, *Scarus spinus*, *Choerodon schoenleinii*, *Diagramma pictum*, *Diagramma pictum*, *Parupeneus pleurostigma*, *Epinephelus malabaricus*, *Parastromateus niger*, *Epinephelus coioides*, *Lethrinus lentjan*, *Lethrinus erythracanthus*, *Scarus rubroviolaceus*, *Cantherhines pardalis*, *Cheilinus fasciatus*, *Lutjanus vitta*, *Siganus virgatus*, and *Scarus quoyi*.

Based on the results of organoleptic testing, the fish caught by fishermen from the 7 vessels showed an average value between 6.78 and 7.02. According to the Indonesian National Standard (SNI) 01-2346-2006 concerning fresh fish, the minimum organoleptic value to declare the quality of fish in good condition is 7.0. Therefore, it can be concluded that fish with a value below seven do not meet the quality standards of fresh fish and are categorized as poor quality.

Poor quality or fish that have experienced a decrease in quality are closely related to post-catch handling that is not optimal. Although some fishermen use ice cubes as a cooling medium, the amount is often

not proportional to the volume of fish caught during fishing. In fact, some fishermen did not use ice at all during storage on board. This is due to several factors such as the following. First, the limitations of ice cubes are discussed. Fishermen from Panggang Island usually freeze their own 1 kg plastic ice cubes because there are no ice cube factories on Panggang Island or on the islands around Panggang Island, such as Pramuka Island or Pari Island, which do not have local ice cube production facilities to meet the needs of fishermen. The nearest ice block factory to the Thousand Islands is in Jakarta, so if fishermen still want ice blocks from Jakarta, they have to travel 2-4 hours to Jakarta. The process of taking the ice takes time, fuel costs, and extra labor; therefore, many fishermen choose not to do it.

Second, the hatch on the ship was not used to store fish. Fishermen store fish in small cool boxes. In contrast, fish are stored in an open fish basket without a lid or ice. Cool boxes are used to store fish; if they are filled with enough ice, the volume of fish that can be loaded becomes less. As a result, fishermen tend to reduce their use of ice to maximize their catches.

Third, fishermen misunderstand fish handling. Fishing is carried out using the method one day fishing, with a travel time of approximately 30 minutes to 3 hours to reach the Fishing Area (DPI). Therefore, some fishermen assume that fish freshness can be maintained without maximum cooling. In the cold chain system, every stage of fishery product handling—from catching, storage, and transportation to distribution—must be carried out at a stable, low temperature to prevent quality degradation. Delaying the cooling process immediately after the fish are caught is a critical point (critical control point) that directly impacts the final quality. Metabolic processes and enzymatic reactions in fish continue even after death, and the high ambient temperature on board accelerates the growth of spoilage microorganisms. Without the initial low-temperature treatment, fish deteriorate rapidly before reaching the next stage of the distribution chain.

Fourth, the ship's condition does not meet the standards. Some ships do not have adequate roofs or have damaged roofs, so fish are easily exposed to sunlight and high temperatures. Uncontrolled environmental temperatures accelerate the degradation of fish quality. According to Ramadhani (2024) and Sipahutar *et al.* (2019), fish must be protected from exposure to ultraviolet light because it can damage the structure of microbial cells, triggering the formation of compounds that affect pH and can damage fish quality.

Fifth, handling fish that do not apply the principles of speed, precision, and care. Fish caught using a trap are usually still alive when lifted to the surface, so the quality condition is at its maximum. However, many fish suffer physical damage as a result of this process. Fish that are still trying to escape the trap can be injured in

the circumference of the head and fins, or have peeled scales or physical injuries due to exposure to the fins of other fish in the trap. When the fish are removed from the trap, they are not placed directly into the container or cool box, but rather directly onto the floor of the ship. The floor of the boat was not coated in any way, so bacterial contamination could occur. The fish is then transferred to a storage container, but the storage space is too dense (squeezed), so pressure can occur that causes abdominal rupture. Fish that move actively in confined spaces also suffer physical injuries to their bodies or the bodies of other fish. Such physical damage increases the risk of microbial contamination, accelerates spoilage, and lowers organoleptic values, even when refrigeration practices are performed. In addition, fishermen do not use personal protective equipment (PPE) when handling fish, which can cause microbial contamination from their hands or surrounding environment.

Critical Points for Handling Demersal Fish in the Cold Chain

Critical points were identified to determine the stages of handling with the most significant potential to decrease the quality of demersal fish. The assessment was carried out based on several parameters observed and assessed directly in the field, and the results were processed to determine the average score of each handling element. Table 4 Critical Points for Handling Demersal Fish in the Cold Chain

Based on the analysis of the critical points, several aspects had the lowest average scores. The first aspect is the temperature of the fish when it is unloaded from the ship, which has an average value of 1.00. This highlights the need for stricter monitoring of temperature stability, which should be at least 4°C in the early stages of post-capture. Second, the cleanliness aspect of the fish storage area on board the ship had a score of 1.14, indicating a high potential for product contamination, which will affect the quality of fish before landing. Third, the aspects container used to transport fish to land had a score of 1.29, which can cause an increase in temperature and physical damage to fish while moving from the ship to land.

The three aspects with the lowest average scores indicate that the post-catch handling stages, both on board and in the process of moving ashore, are still not optimal and need improvement. Aspects of temperature control, cleanliness, and the feasibility of facilities and infrastructure at the time of initial distribution must be prioritized to maintain quality and avoid product contamination.

Distribution system: distance and effect on fish quality

Fish trap fishermen with boats measuring 2-5 GT can catch of around 2-15 kg per day, depending on the capacity of the boat and the number of crew members (Crew of Boats). Larger vessels and more crews allow

Table 1 Critical Points

Critical Points	Total	Average	Status
Fish Handling on Fishing Vessels (RCL: 1,675)			
Use of ice during onboard storage	12	1.71	
Cleanliness of onboard storage	8	1.14	Critical
Time between hauling and cooling	15	2.14	
Arrangement and accumulation of fish	12	1.71	
Fish Unloading at the Port (RCL: 1,57)			
Speed of Fish Drop	17	2.43	
The temperature of the fish when lowered	7	1.00	Critical
Containers/Mean of transport to land	9	1.29	Critical
Fish Handling while in the Collector (RCL: 1,92)			
Transfer of fish to a new container	14	2.00	
Supplemental ice administration	15	2.14	
Packaging before being sent to Muara Angke/Baru port	14	2.00	
Temporary storage temperature	11	1.57	Critical

them to reach the DPI further and carry more fishing gear (traps) and diving equipment, thus increasing the volume of catches. Fish caught are rarely or not directly brought to Muara Angke or Muara Baru because of the considerable distance (about 26–27 nautical miles, or ~38–40 km), and if the speed of the fishermen's wooden boat is on average 5–7 knots, it makes the trip 4–5 hours each way.

The selling price of fish will be higher if they are sold directly to large ports such as Muara Baru or Muara Angke than if they are sold to local collectors. However, fishermen consider aspects of operational costs, such as fuel, supply consumption, labor, and mooring costs. Therefore, most fishermen prefer selling their catch to local collectors on Panggang Island. The selling price to collectors is lower, but it is considered more practical and efficient because it can avoid logistics costs and risks in Jakarta. However, the consequence that must be accepted is that local collectors wait for a sufficient amount of fish to be sold to Muara Baru or Muara Angke to make distribution costs more efficient. In non-fishing seasons or bad weather, this process can take up to 2–3 days.

During the waiting period of 2–3 days, the fish are stored using ice (chilling) instead of freezing. The cooling process only inhibits the growth of microorganisms rather than stops their development, so that cold temperature storage still has an expiration date (Asiah, *et al.* 2020; Nurhayati, *et al.* 2022). As a result, the freshness of the fish continues to decrease significantly, even though it looks good. This condition affects the selling value of fish, the level of consumer acceptance, and ultimately affects fishermen's income.

Demersal Fish Handling Cold Chain Process Improvement Strategy

Internal and external factors were identified based on field observations, interviews with fishermen, and a literature review. Internal factors include strengths and weaknesses, as seen from the conditions of resources, skills, technology, and the way local fishermen work. The selected strengths represent aspects that directly

support the effectiveness of fish handling, such as the distance between the landing site and the center of fishery activity, efficient work patterns, use of environmentally friendly fishing gear, and fishermen's knowledge of the fishing area. The weaknesses identified include limited storage facilities on board, implementation of sanitation that does not meet HACCP standards, lack of training on cold chains, long waiting times without cold storage, and no periodic temperature recording. Internal factors are identified in Table 5 Internal Factor Analysis Summary (IFAS) Matrix of Demersal Fish Cold Chain Handling.

External factors include opportunities and threats based on trends, environments, and infrastructure. The selected opportunities consider market demand trends for quality fish, facility support from the government, and prospects for product diversification. However, threats include extreme weather, price fluctuations, uncertainty of distribution schedules, and limitations of cold chain infrastructure in the Panggang Island region. The identification of external factors is compiled in Table 6 External Factor Analysis Summary (EFAS) Matrix of Demersal Fish Cold Chain Handling.

From the table above, it can be seen that the total IFAS Strength is 1,8 while the Weaknesses are 0,66, resulting in a total IFAS score of +1.14. The EFAS Opportunities score was 1,52, while the Threats score was 0,83, resulting in a total IFAS score of +0.69. Since both the IFAS and FAS scores are positive, the position falls within Quadrant I, namely the Aggressive/SO Strategy. This position indicates that development priorities are directed towards optimally utilizing internal strengths to capture available external opportunities, while WO, ST, and WT strategies serve as supporting alternatives.

The SO Strategy's main focus is to increase value-added, maintain product quality, and strengthen the cold chain system, which directly contributes to improving fishermen's income and enhancing the market competitiveness of fishery products. This is particularly relevant considering external opportunities

Table 2 IFAS (Internal Strategic Factor Analysis Summary)

Internal factors	Weight	Rating	Score
Strengths			
The distance from DPI to Panggang Island is close	0,10	4,00	0,40
Efficient fisherman's work pattern / one day fishing	0,12	4,00	0,48
Fishermen's expertise and knowledge of the fishing grounds	0,13	4,00	0,52
Types of eco-friendly fishing gear (traps)	0,10	4,00	0,24
Subtotal	0,44		1,8
Weaknesses			
Fish storage capacity on the ship is limited, and the cooling system is not yet in use	0,13	1,00	0,13
Sanitation of fish handling on board is not in accordance with HACCP standards	0,10	2,00	0,20
Lack of training or education on the cold chain and sanitation	0,10	1,00	0,10
Prolonged waiting time, as fish are placed with collectors without being stored in cold storage facilities	0,10	1,00	0,10
No automatic temperature recorder	0,13	1,00	0,13
Subtotal	0,56		0,66
Total	1		2,46

Table 3 EFAS (External Strategic Factor Analysis Summary)

External factors	Weight	Rating	Score
Opportunities			
Market Trends/Demand for Quality Fish	0,16	4,00	0,64
Government support for fishermen (coolbox and cold storage assistance/ice factory on Panggang Island)	0,13	4,00	0,52
Development of derivative products (fish fillets, seasoned processed fish)	0,12	3,00	0,36
Subtotal	0,42		1,52
Threat			
Extreme weather conditions and erratic climate change disrupt fishing activities and the quality of catches	0,18	1,00	0,18
Price fluctuations (prices fall due to imported fish from other regions, farmed fish, or fish in season)	0,12	2,00	0,24
Unrelated schedule of fish shipments to Muara Baru/Angke port	0,14	2,00	0,28
Lack of infrastructure in the cold chain of Panggang Island (although above sea level)	0,13	1,00	0,13
Subtotal	0,58		0,83
Total	1		2,35

such as government support through the provision of cool boxes and cold storage facilities (O2), and the growing market demand for high-quality fish (O1). The implementation of this strategy includes optimizing fish quality by taking advantage of the proximity between the Fishing Grounds and Panggang Island (S1-O1) to maintain product freshness. The efficiency of the cold chain is further reinforced through government support in providing cold storage facilities (S1, S2-O2), along with sustainable fish branding (S3, S4-O3) to expand market segments and improve competitiveness, as presented in Table 7 SWOT Strategy Matrix for Improving the Cold Chain System of Demersal Fish Handling.

CONCLUSION

The sanitation, handling, and storage conditions of fish on fishing boats using traps on Panggang Island do not meet the standards set by Minister of Maritime Affairs and Fisheries Regulation No. 7/2019. The main

critical aspects identified were fish storage temperature, cleanliness of storage areas, and fish transport containers, which affected the quality of the catch. Organoleptic test results showed average scores ranging from 6.78 to 7.02, indicating that some fish quality parameters were still below the acceptable standard. The recommended strategy for improving the cold chain process is categorized in Quadrant I (Aggressive/SO Strategy), focusing on optimizing fish quality through the utilization of fishing areas close to land, government support for cold storage and cool boxes, as well as diversification of fish processing to maintain the sustainability of the fisheries business.

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Table 7 SWOT strategy matrix for improving the cold chain of demersal fish

Strength (S) and Weaknesses (W)	<p>Strength (S)</p> <ol style="list-style-type: none"> 1. The distance from DPI to Panggang Island is close 2. Efficient fisherman's work pattern / one day fishing 3. Fishermen's expertise and knowledge of the fishing grounds 4. Types of eco-friendly fishing gear (traps) 	<p>Weaknesses (W)</p> <ol style="list-style-type: none"> 1. Fish storage capacity on the ship is limited, and the cooling system is not yet in use. 2. Sanitation of fish handling on board is not in accordance with HACCP standards 3. Lack of training or education on the cold chain and sanitation 4. Prolonged waiting time, as fish are placed with collectors without being stored in cold storage facilities 5. No automatic temperature recorder
<p>Opportunity (O) and Threat (T)</p> <p>Opportunity (O)</p> <ol style="list-style-type: none"> 1. Market Trends/Demand for Quality Fish 2. Government support for fishermen (cool box and cold storage assistance/ice factory on Panggang Island) 3. Development of derivative products (fish fillets, seasoned processed fish) 	<p>Strategy SO</p> <ol style="list-style-type: none"> 1. Optimization of fish quality by utilizing the proximity of Fishing Grounds to the mainland (S1) (O1) 2. Strengthening the efficiency of the cold chain through government support (provision of cold storage or cool boxes) (S1) (S2, O2) 3. Collaboration with the government or UMKM to develop processed fish products such as fillets, frozen, or seasoned products with sustainable fish branding (S3) (S4, O3). 	<p>Strategy WO</p> <ol style="list-style-type: none"> 1. Utilizing government-provided cool boxes as a solution to the limited cold storage capacity on the vessel (W1, O2) 2. Providing fishermen with training in quality management, HACCP and supply chain practices through a government program (W3, O2) 3. Diversification of value-added products to address prolonged distribution waiting times (W4, O3)
<p>Threat (T)</p> <ol style="list-style-type: none"> 1. Extreme weather conditions and erratic climate change disrupt fishing activities and the quality of catches. 2. Price fluctuations (prices fall due to imported fish from other regions, farmed fish, or fish in season) 3. Unrelated schedule of fish shipments to Muara Baru/Angke port 4. Inadequate cold chain infrastructure on Panggang Island 	<p>Strategy ST</p> <ol style="list-style-type: none"> 1. Developing adaptive fishing and distribution schedules to mitigate extreme weather conditions and irregular fish shipment schedules (S1, T1) (T3) 2. Promoting sustainable fish branding for premium markets in response to increasingly selective consumer demand and fluctuating prices (S4) (T2) 3. Establishing long-term trading partnerships with collectors/UMKM to reduce risks associated with price fluctuations (S3) (T2) 	<p>Strategy WT</p> <ol style="list-style-type: none"> 1. Establishing minimum sanitation standards in fish handling and the use of storage boxes (e.g., determining the capacity of fish that can be accommodated in cooling boxes on 2 GT vessels) to maintain quality (W1) (W2, T1) 2. Developing mini cold storage facilities on Panggang Island for temporary storage during distribution waiting periods (W4, T4)

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