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Analisis Risiko dan Struktur Biaya Rantai Pasok Ikan Lemuru Segar di Pelabuhan Banyuwangi

Risk Analysis of Fresh Lemuru Fish Supply Chain at Banyuwangi Port

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Abstrak

Melimpahnya hasil perikanan lemuru disekitar PPP (Pelabuhan Perikanan Pantai) Muncar menyebabkan tumbuhnya klaster industri pengolahan berbahan baku ikan lemuru yang menghasilkan ikan kaleng (sardine, tuna), tepung dan minyak ikan serta ikan beku (*frozen fish*) di sekitar pelabuhan Muncar. Pabrik atau industri yang bahan bakunya membutuhkan biaya besar untuk pemindahan material tersebut mudah rusak akan cenderung memilih lokasi industrinya di sekitar sumber bahan baku. Jumlah produksi dan konsumsi ikan ini juga dipengaruhi oleh musim dan cuaca sehingga pasokan ikan tangkap tidak pasti namun permintaan ikan selalu meningkat. Selain itu risiko lainnya adalah pengetahuan penanganan ikan yang kurang tepat, distribusi ikan tangkap yang terlalu lama mempengaruhi penurunan kualitas ikan tangkap segar dan harga jual ikan tangkap. Ikan lemuru di Pelabuhan Perikanan Muncar sangat tergantung pada musim ikan, sehingga ketersediaan pasokan fluktuatif. Tujuan penelitian ini adalah mengidentifikasi struktur rantai pasok dan risiko rantai pasok ikan lemuru di Pelabuhan Perikanan Muncar, menganalisis faktor risiko tertinggi dalam rantai pasok ikan lemuru di Pelabuhan Perikanan Muncar pada setiap tier nelayan, pengepul dan merekomendasikan mitigasi risiko rantai pasok ikan lemuru kepada setiap tier di Pelabuhan Perikanan Muncar berdasarkan identifikasi risiko.

Kata kunci: manajemen risiko rantai pasok, ikan lemuru

Abstract

The abundance of lemuru fishery products around Coastal Fisheries Port in Muncar has led to the growth of a processing industry cluster made from lemuru fish which produces canned fish (sardines, tuna), fish flour and oil as well as frozen fish around Muncar port. Factories or industries whose raw materials require a large amount of money to move materials that are easily damaged will tend to choose their industrial locations around sources of raw materials. This shows that Indonesian people are aware of the nutritional contribution of consuming fish. The amount of production and consumption of this fish is also influenced by the season and weather so that the supply of caught fish is uncertain but the demand for fish is always increasing. Apart from that, other risks are inaccurate knowledge of fish handling, the distribution of caught fish that takes too long affects the decrease in the quality of fresh caught fish and the selling price of caught fish. Flying fish at Muncar Fishery Port is very dependent on the fishing season, so the availability of supplies fluctuates. The purpose of this study was to identify the supply chain structure and supply chain risks for lemuru at Muncar Fishery Port, analyze the highest risk factors in the lemuru supply chain at Muncar Fishery Port at each tier of fishermen, collectors and traders and recommends supply chain risk mitigation for lemuru fish for each tier at the Muncar Fishery Port based on risk identification.

Keywords: supply chain, risk management, lemuru fish

Introduction

The abundance of lemuru fishery products around Coastal Fisheries Port in Muncar has led to the growth of processing industry clusters made from lemuru fish which produce canned fish (sardines, tuna), fish flour and oil as well as frozen fish (frozen fish) around Muncar port. Factories or industries whose raw materials require large costs for moving materials or materials that are easily damaged will tend to choose industrial locations around sources of raw materials (Wignjosubroto, 1992) in (Purwaningsih, 2015). Thus, fish processing industries are often found around fishing ports because fish is a commodity that is easily damaged without proper handling with a cold chain system.

Muncar fish processing industry based on the size of production capacity and production equipment can be classified into two groups, namely modern industry and traditional industry. The modern industrial groups are the fish canning industry, cold storage and the fish flour and oil industry. This modern industry makes lemuru fish the main industrial raw material and uses various modern machines and production facilities. Traditional industrial groups are industrial houses and small industries that produce es-esan fish, paste, shrimp paste, pemindangan and salting. Although the economic value of lemuru fish is low, its role in the ecological balance for the Bali Strait fishery is quite important as a demersal fish with the largest stock. Around 70% - 80% of the Bali Strait fishery production is lemuru fish (BPPI Muncar, 2009) in (Purwaningsih, 2015), the influence of the lemuru fishery on the economy of fishermen and the fish processing industry in Muncar is important.

According to Waters (2007) some of the core activities related to logistics include supply chain design, namely procurement or purchasing, transportation, receiving, warehousing, material handling, distribution, recycling, returns, waste disposal, and communication. If all these activities are integrated, an efficient material flow is obtained. Integration of an organizational network in the lemuru supply chain starting from fishermen, collectors, traders, and processors is important. A robust supply chain according to Sodhi and Tang (2018) is a supply chain that is able to survive when exposed to various kinds of unexpected risk disturbances. If a company has prepared a mitigation strategy to deal with risk disturbances, then the company's success in achieving its goals will be maintained. The absence of a robust capture fish supply chain at Muncar Port is due to the absence of an appropriate mitigation strategy for the potential risks that exist. Risk events were found, among others, at the fluctuating growth rate of fish production due to high rainfall, the frequent occurrence of high sea waves, and strong winds which caused fishermen to be

unable to sail to catch fish so that there were no fish, there were still many ship engines that were damaged when catching fish. causing fishermen to be unable to carry out fishing activities, as well as a shortage of supplies for fishermen when catching fish so that when fishermen have caught fish or not getting fish, fishermen have to return to the wharf. In addition, risk events were found, namely the presence of poor quality fish when loading and unloading ships, decreased fish prices due to damaged fish at the fish collectors level, and decreased fish quality because fish were not handled properly at the trader level. This risk event is in accordance with the annual report of the Department of Maritime Affairs and Fisheries of Banyuwangi Regency regarding the problems faced, namely capture fisheries facilities and infrastructure are still very limited, the quality of fishermen's human resources is still low, lack of capital and unprofessional business management, and frequent tidal waves and strong winds.

In the distribution of captured fish products, an integrated operational system is needed that takes a long path to the final consumer. Long distances from upstream to downstream include fishermen, fish auction collectors, traders and consumers. If the distance factor is expressed as a function of time, then taking a long trip will affect the quality (freshness) of the caught fish. According to Winarni, *et al.* (2003) generally fish and other fishery products are perishable foodstuffs because they contain high levels of protein and water. Therefore, the correct treatment of fish after the fish is caught is very important. This treatment can be done by reducing the temperature such as cooling and freezing to prevent deterioration of fish quality.

In this study, lemuru fish (*Sardinella lemuru*) was selected as the research object, which is the largest production of caught fish at Muncar Port with a production of 8733 tons in 2021, an increase from 2020 of 6473 tons (Anonymous, 2022). In addition, captured fish commodities are usually sold fresh to consumers. Fishermen are encouraged to produce fresh and high-quality products that can be obtained with good handling. In an effort to realize a robust supply chain, risk management is considered important in the capture fish supply chain to formulate a risk mitigation strategy. The aims of this study were (1) to identify the supply chain structure and supply chain risks for lemuru at Muncar Fishery Port (2) recommending lemuru supply chain risk mitigation for each tier at Muncar Fishery Port based on risk identification.

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Materials and Methods

The research object was carried out in the lemuru supply chain from the Muncar Banyuwangi Fishery Port. The choice of this location is because Muncar Harbor is one of the largest landing sites in Banyuwangi and one of the largest production areas in Banyuwangi. This research was carried out in January-February 2023 by observing and analyzing supply chain risks and their impacts. The place of research is the Muncar Fishing Port, Banyuwangi Regency. This research requires primary data and secondary data.

Primary data is obtained from the first source and obtained directly based on observations made in the field. This primary data is obtained from each tier in the supply chain in the form of general information on the capture fish supply chain, information on risks in the capture fish supply chain, information related to risk in the form of an assessment of the probability of occurrence (probability), the impact caused (severity)) of each risk, and the ability of each tier to manage risk (capacity to manage) throughout supply chain activities and recommendations from risk owners and the government regarding the ability to handle risks. Risks are identified at each level in the fish supply chain so that identification can be carried out in more detail and later have an impact on risk mitigation. In determining recommendations, the costs and benefits of each control stage are calculated so as to clarify recommendations that can be used in mitigation.

Secondary data is data obtained from literature studies conducted from various literature, institutional documents, documents belonging to fishery supply chain actors, books, journals, and information related to the problem under study.

Interviews with respondents using the guide (interview guidance) by way of in-depth interviews so that detailed and in-depth information will be obtained regarding the events and risks that exist according to real conditions. The determination of this respondent is based on accidental sampling or the availability of respondents in the field at the right place and time and is continued using the snowball sampling technique, namely the number of samples that gets bigger as time goes by. From the identification with the risk owners at the fishermen, TPI, collectors, and traders (intermediary traders, fish market traders, and retailers) it can be summarized into several points which will be used as risk parameters hereinafter referred to as risk events. The potential risks are weather risks, natural disaster risks, biological and environmental risks, market-related risks, logistics and infrastructure risks, management and operational risks, public policy and institutional risks, political risks.

Field observations were carried out by direct observation of the object to be studied, namely lemuru fish at each tier from the Muncar Fishing Port, Banyuwangi Regency. Field observations are carried out in two ways, namely (1) Observation. Observations were made directly by observing the activities that occur in the supply chain system to obtain qualitative data and risks at each tier of captured fish. (2) Interview. This interview guide does not contain detailed questions but is limited to an outline statement of what data or information you wish to obtain from the respondent. (3) Desk Studies. Desk study is carried out by collecting information from various literature such as books, journals, relevant documents, and other data that supports the research being conducted. The data obtained is in the form of references to the application of ISO 31000:2009, references to the application of RapAgRisk, references to the application of cost structure analysis and statistical data on captured fish.

Results and Discussion

The potential for marine and fishery resources in Banyuwangi Regency is very large, this can be seen from the data from the Banyuwangi Central Bureau of Statistics, namely the amount of capture fisheries production in Banyuwangi Regency in 2021 on BPS-Statistics Indonesia (2022) which is 43,575.10 tonnes with the highest number being marine fisheries of 41,647.10 tons. The district with the highest production of capture fisheries is Muncar District with 19,696.50 tons in 2021, while in 2020 lemuru fish production is 23,641.40 tons. The names of sub-districts for marine fisheries production are presented in Table 1. Fish that have important economic value such as lemuru fish are found along the coast of Muncar. These resources have the potential to be developed, especially in Muncar District.

This potential cannot be utilized optimally, where the current level of utilization is still far from sustainable potential because fisheries marketing in Banyuwangi Regency is still very low according to fishermen and traders. Some of the problems faced by the Government of Banyuwangi Regency are the facilities and infrastructure for fish auctions which are still very limited, the quality of human resources for fishermen is still low, lack of capital and unprofessional business management and infectious diseases and viruses often occur. If fisheries potential can be utilized optimally, it will have a positive impact on economic growth, increase fishermen's income, create jobs, and improve fishermen's welfare, as well as increase local income.

Table 1. Fish production center in Banyuwangi Regency 2020 and 2021

No	The name of the marine fishery production district	Production in 2020 (ton)	Percentage (%)	Production in 2021 (ton)	Percentage (%)
1	Muncar	23,641.40	61.68	19.625.40	47.33
2	Blimbingsari	4179.60	10.90	3625.40	8.74
3	Purwoharjo	3269.80	8.53	2534.30	6.11
4	Tegaldlimo	2499.10	6.52	2857.40	6.89
5	Kalipuro	1128.60	2.94	1796.30	4.33
6	Pesanggaran	924.80	2.41	7341.40	17.70
7	Banyuwangi	813.90	2.12	703.90	1.70
8	Kabat	269.80	0.70	256.00	0.62
9	Wongsorejo	1601.50	4.18	2727.00	6.58
Total Production (data)		38,328.50	100	41,467.10	100

Source: Banyuwangi Fisheries Data, 2022

Model of the Captured Fish Supply Chain in Muncar

The capture fish supply chain in Banyuwangi consists of five tiers. The five tiers are fishermen tier, fish auction tier, collectors tier, traders and market tier, and consumer tier. The 1st pattern is that fish caught from fishermen are recorded at the fish auction place, then the fish are collected by captured fish collectors. Fishermen and fish collectors are subject to a levy of 2.5% of the fish's rupiah value. Fish from collectors are purchased by intermediary traders. Intermediary traders sell fish to captured fish consumers (household consumers and processing consumers). The second pattern is that fish caught from fishermen are recorded at the fish auction site, then the fish are collected by captured fish collectors. Fishermen and fish collectors are subject to a levy of 2.5% of the fish's rupiah value. Fish from collectors are bought by fish market traders. Fish market traders sell fish directly to consumers.

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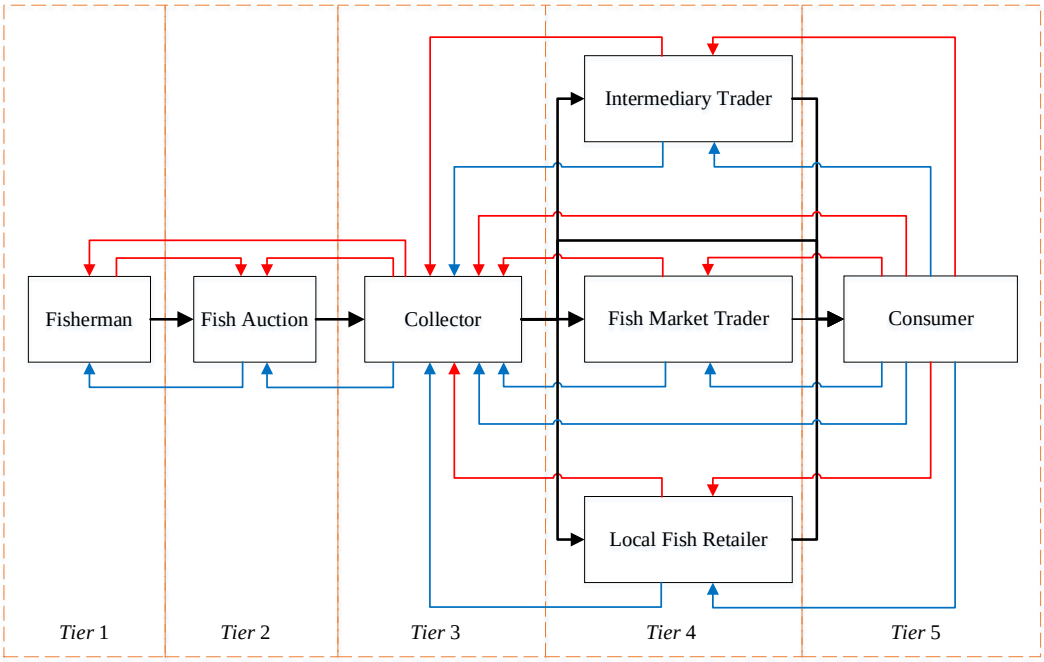

Figure 1. The supply chain for capture fish in Muncar

The third pattern is that fish caught from fishermen are recorded at the fish auction site. After the recording is done, the fish are collected by catch fish collectors. Fishermen and fish collectors are subject to a levy of 2.5% of the fish's rupiah value. Fish from collectors are purchased by retail traders. Retailers sell fish directly to consumers by going around the villages. The 4th pattern is that fish caught from fishermen are recorded at TPI, then the fish are collected by captured fish collectors. Fishermen and fish collectors are subject to a levy of 2.5% of the fish's rupiah value. Fish from collectors are then sent or purchased by consumers (household consumers and processing consumers).

The indicators used as the basis for determining risk assessment indicators refer to the RapAgRisk literature (Guritno and Khuriyati, 2018; Rizkina and Widodo, 2020). The focus of this research is supply chain risk assessment of perishable capture fisheries products. Therefore, the determination of the field of literature is based on the initial identification of the object under study (Rizkina, 2020), namely the capture fish supply chain with the object of research at Muncar. The field of literature used is Supply Chain Risk Assessment as a basis for consideration of risk indicators in general and Rapid Agricultural Supply Chain Risk Assessment (RapAgRisk) as a basis for consideration of supply chain risk indicators, especially fishery commodities. The general description regarding the risk identification literature is (Jaffee et al., 2008) weather risk, natural disaster risk, biological and environmental risk, market-related risk, logistics and infrastructure risk, management and operational risk, public and institutional policy risk, political risk.

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The meaning of the code for the first letter is **N** for Fishermen, **T** for Fish Auction Place, **P** for collectors, **C** for Intermediary Traders, **D** for Fish Market Traders, and **E** for Retail Traders. The meaning of the code for the second letter is the risk parameter in RapAgRisk, namely **C** for weather risk, **A** for natural disaster risk, **B** for biological and environmental risks, **P** for market-related risks, **L** for logistics and infrastructure risks, **M** for management risks and operational, **K** for public policy and institutional risk, and **O** for political risk. The meaning of the code for the third letter is the number of risks for each risk parameter.

Risks that have been identified and known for their probability and severity of impact can then be mapped so that the risk category can be identified (Rizkina and Nalawati, 2022). The combination of the two produces a risk-expected loss priority matrix or Expected Loss Ranking Matrix. After that, a Risk Vulnerability Assessment is carried out which has been carried out at each tier with the capacity to manage which has been carried out by the risk owner. From these two things, it can then be seen which risks have been handled properly by the risk owner and which risks require more handling. All respondents were asked to give their opinion regarding the Probability (P), Severity (S), and Capacity to Manage (C) values. The values of P, S, and C which are mapped onto the graph are obtained from the mode of several respondents for each tier.

Table 2. Descriptive risk parameters for the capture fish supply chain

Tier	No	Risk Code	Parameters	Description
Fisherman	1	N.C.1	Maritime weather	Maritime weather includes precipitation high, high sea waves, and strong winds cause fishermen unable to sail to catch fish so no fish or producefish down
	2	N.B.1	Increasing activity microbial	The long trip time causes the supply of ice on board is reduced to refrigerate fish so quality fish will decrease due to increase microbial activity
	3	N.M.1	Catch fish handling techniques	Incorrect handling of fish can physically damage fish when carrying out fishing activities with nets or fishing rods, storing fish in ship holds, loading and unloading ships, and weighing at the fish auction
	4	N.M.2	Delay in catching fish put into the hold of the ship	The caught fish are handled/inserted late in the hold of the ship causing the fish to be in an open environment for too long so that the quality of the fish will decrease
	5	N.M.3	Determination of fishing points by captains	The skipper's inaccuracy and speed in determining the point of fishing causes a long fishing time so that the catch is not optimal
	6	N.L.1	Conditions of storage of caught fish	In the fishing season/peak season the amount of fish caught will be excessive so that the storage area for the ship will be overcrowded exceeding capacity/over capacity causing the fish to jostle each other, especially the fish that are below the fish will be pressed on it so that the fish are damaged
	7	N.L.2	Fishermen run out of supplies	The length of time for the boat trip is based on the amount of supplies carried, if the supplies run out, fishermen must immediately return to the dock even though they have caught fish or not at all
	8	N.L.3	Ship engine damage	Damage to the ship's engine causes the fishing process to stop so that the ship must immediately pull over to the sea wharf for machine repair
	9	N.P.1	Decline in the price of caught fish	Damage to fish includes decreased quality of fish, physically damaged fish, or stomach rupture resulting in fish prices down even not sold
Fish auction	10	T.B.1	Microbial activity	Laying fish just like that during the weighing process without a basket/blank and just laying fish on the floor in an open environment causes fish to be contaminated with microbes so that fish are easily damaged

	11	T.M.1	Fish handling techniques	The physical contact of the fish is too hard when loading and unloading, weighing, or transporting it to the fish auction place so it happens damage to fish
Collector	12	P.B.1	Microbial activity	Damaged fish are soaked together with good quality fish when stressed it can contaminate good quality fish massively.
	13	P.B.2	Lack of ice stock	Lack of ice stock when storing fish causes microbial activity to increase which results in fish being easily damaged
	14	P.L.1	Fish damage during the delivery process	Damage to fish during delivery, fish sent in damaged condition, or lack of ice during delivery will result in fish being returned to collectors
	15	P.M.1	Fish handling techniques	The handling of fish by workers is not optimal, including sorting errors and just laying fish on the floor resulting in decreased fish quality
	16	P.P.1	Procurement of fish	The fish that are obtained from fishermen have many physical defects resulting in the price of fish going down and not even being sold for sale
	17	P.P.2	Fish prices down	The large number of damaged fish causes the selling price of fish to decrease and even not to be sold
Intermediary trader	18	C.B.1	Lack of ice stock	Lack of ice stock when storing fish causes microbial activity to increase so that fish will be easily damaged
	19	C.B.2	Increased microbial activity	Fish obtained with physical defects are then stored together with good quality fish in one cool box/ styrofoam resulting in good quality fish being polluted so that the quality of fish decreases in one cool box/ styrofoam
	20	C.P.1	Didn't get any fish	Not getting fish because there are no, few, or few fish catches from fishermen, or no/little supply of fish from collectors
	21	C.L.1	Fresh fish delivery process	The length of time for delivery, the lack of fish handling facilities in the fleet, and technical errors in transporting fish fresh by workers causing damaged fish

Table 2. Descriptive risk parameters for the capture fish supply chain (continuation)

Tier	No	Risk Code	Parameters	Description
Intermediary trader	22	C.M.1	No sorting	The presence of damaged fish affects the quality of other fish that are still fresh, resulting in a massive decrease in the quality of fish
Fish market traders	23	D.B.1	Microbial activity	Fish are placed in an open environment will increase microbial activity so that the quality of fish will decrease
	24	D.B.2	Lack of ice stock	Lack of ice stock when storing fish causes microbial activity to increase so that fish will be easily damaged
	25	D.B.3	Increased microbial activity	Fish that can have physical defects are then stored together with good quality fish in one styrofoam and/or cool box causing good quality fish to be polluted so that the quality of fish decreases in one styrofoam and cool box
	26	D.B.4	Fish storage time	Decline in fish quality and damage to fish due to the limited shelf life of fish can trigger the development of destructive microbes
	27	D.P.1	Procurement of fish many physical defects	The fish that are obtained from the collectors have many physical defects so that the price of the fish will drop and they cannot even be sold
	28	D.P.2	Didn't get any fish	Do not get fish because the catch of fish from fishermen is not there/a little or the supply of fish from collectors is not available/a little
	29	D.P.3	Fish are not sold	Market conditions cause fish not to be sold
	30	D.M.1	No sorting	The existence of rotten fish affects the quality of other fish that are still fresh, thereby reducing the quality of fish massively
Retailer	31	E.B.1	Lack of ice stock	Lack of ice stock when storing fish results in increased microbial activity so that fish will be easily damaged

Table 2. Descriptive risk parameters for the capture fish supply chain (continuation)

Tier	No	Risk Code	Parameters	Description
Retailer	32	E.B.2	Increased microbial activity	Fish that can have physical defects are then stored together with good quality fish in one cool box/ styrofoam causing good quality fish to be polluted so that the quality of fish decreases in one cool box/ styrofoam
	33	E.P.1	Didn't get any fish	Not getting fish because there are not enough fish caught by fishermen or there is no fish supply from collectors there is/a little
	34	E.L.1	Fresh fish delivery process	The length of time for delivery, the lack of fish handling facilities in the fleet, and technical errors in the transportation of fresh fish by workers cause the fish to spoil
	35	E.M.1	No sorting	The existence of rotten fish affects the quality of other fish that are still fresh, thereby reducing the quality of fish massively

Source: Processed data, 2023

Tier Fisherman

The results of the probability and severity assessment of each fisherman respondent for each of the risks faced by fishers are then mapped as follows:

Table 3. Risk mapping at the tier

		Potential Severity of Impact				
		Negligible	Moderate	Considerable	Critical	Catashtopic
Probability of Event	Highly probable					
	Probable				N.L.2	
	Occasional		N.P.1			
	Remote			N.C.1; N.B.1; N.M.2; N.L.1		
	Improbable			N.M.3		N.M.1; N.L.3

Explanation:

High Expected Loss
Medium Expected Loss
Low Expected Loss

Priority 1 = high loss, high probability and severity.
Priority 2 = medium loss, moderate probability and severity.
Priority 3 = low loss, low probability and severity.

Explanation:

N.C.1 : Maritime weather
N.B.1 : Increased microbial activity
N.M.1 : Errors in the technique of handling caught fish
N.M.2 : Delay in catching caught fish in the hold boat
N.M.3 : The skipper did not quickly and precisely determine the point of fishing
N.L.1 : The condition of the storage area for caught fish exceeds capacity
N.L.2 : Fishermen run out of supplies
N.L.3 : Ship engine damage
N.P.1 : Decline in the price of caught fish

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In table 3 it can be seen that above the fishermen level there are 2 priority 3 risks (low expected loss), namely the risk of not quickly and precisely determining the fishing point by the skipper (N.M.3) and a decrease in the price of caught fish (N.P.1). There are 6 priority 2 risks (medium expected loss), namely maritime weather risk (N.C.1), increased microbial activity (N.B.1), delays in putting caught fish into ship holds (N.M.2), errors in capture fish handling techniques (N.M.1), the condition of the storage area for caught fish exceeding capacity (N.L.1), and damage to the ship's engine (N.L.3). There is 1 priority 1 risk (high expected loss), namely the risk of fishermen running out of supplies (N.L.2). Then a Risk Management and Vulnerability Assessment is carried out, namely combining the results of the expected loss assessment in table 4.5 with the capacity to manage that has been carried out by the risk owner which has a scale of 1 to 5 to assess its effectiveness.

Table 4. Mapping of risk vulnerabilities at the tier

	Capacity to Handle Risk				
Expected loss	**1**	**2**	**3**	**4**	**5**
High					N.L.2
Moderate	N.L.3		N.L.1	N.C.1	N.B.1; N.M.1; N.M.2
Low					N.M.3; N.P.1

Explanation:

Vulnerability Scale	**Code**	**Key Characteristics**
Extremely vulnerable		Estimated losses are high, capacity is low
Highly vulnerable		Losses are estimated as medium-high, capacity low-medium
Moderate vulnerable		Losses are estimated to be medium, medium capacity
Low vulnerable		Losses are estimated to be low-moderate, medium-high capacity
Limited vulnerability		Estimated losses are low, capacity is high

The risk vulnerability map is made after obtaining the risk classification and the value of the risk owner's capacity for that risk (Rizkina and Widodo, 2020). Then from these two parameters, the map is obtained in table 4.6. Table 4.6 is the result of the Risk Management and Vulnerability Assessment mapping of fishermen, so it is known that the risk of increased microbial activity (N.B.1), errors in capture fish handling techniques (N.M.1), delays in putting the caught fish into the hold of the ship (N.M.2), the skipper (N.M.3) did not quickly and precisely determine the point of fishing, and the decrease in the price of captured fish (N.P.1) has a limited vulnerability category. The risk of maritime weather (N.C.1) and fishermen running out of supplies (N.L.2) has a low vulnerable category. At the risk of conditions where fish catches are stored beyond capacity (N.L.1)

has a moderate vulnerable category (moderate vulnerability). At the risk of damage to the ship's engine (N.L.3) has an extremely vulnerable category (extremely very vulnerable).

Tier Fish auction

The results of the probability and severity assessment of each respondent for each of the risks faced, are then mapped as follows :

Table 5. Risk mapping at the tier

		Potential Severity of Impact				
Probability of Event		Negligible	Moderate	Considerable	Critical	Catashtopic
	Highly probable					
	Probable					
	Occasional					
	Remote		T.M.1			
	Improbable	T.B.1				

Explanation:

	High Expected Loss
	Medium Expected Loss
	Low Expected Loss

Priority 1 = high loss, high probability and severity.
Priority 2 = medium loss, moderate probability and severity.
Priority 3 = low loss, low probability and severity.

Explanation:
T.B.1 : Microbial activity
T.M.1 : Fish handling techniques

In table 5 it can be seen that above the level of the fish auction place there are 2 priority 3 risks (low expected loss), namely the risk of microbial activity (T.B.1) and fish handling techniques (T.M.1). Then it is carried out, namely combining the results of the expected loss assessment in table 5 with the capacity to manage that has been carried out by the risk owner which has a scale of 1 to 5 to assess its effectiveness.

Table 6. Mapping of risk vulnerabilities at the tier

	Capacity to Handle Risk				
Expected loss	**1**	**2**	**3**	**4**	**5**
High					
Moderate					
Low					T.B.1; T.M.1

Explanation:

Vulnerability Scale	Code	Key Characteristics
Extremely vulnerable		Estimated losses are high, capacity is low
Highly vulnerable		Losses are estimated as medium-high, capacity low-medium
Moderate vulnerable		Losses are estimated to be medium, medium capacity
Low vulnerable		Losses are estimated to be low-moderate, medium-high capacity
Limited vulnerability		Estimated losses are low, capacity is high

The risk vulnerability map is made after obtaining the risk classification and the value of the risk owner's capacity for that risk. Then from these two parameters, a map is obtained in table 4.10. Table 4.10 is the result of Risk Management and Vulnerability

Assessment mapping at TPI, so it is known that the risk of microbial activity (T.B.1) and fish handling technique errors (T.M.1) have a limited vulnerability category.

Tier Collector

The results of the probability and severity assessment of each respondent for each risk faced are then mapped as follows:

Table 7. Risk mapping at the tier

		Potential Severity of Impact				
		Negligible	Moderate	Considerable	Critical	Catashtopic
Probability of Event	Highly probable					
	Probable			P.P.2		
	Occasional	P.M.1		P.B.2		
	Remote					
	Improbable	P.P.1	P.L.1	P.B.1		

Explanation:

	High Expected Loss
	Medium Expected Loss
	Low Expected Loss

Priority 1 = high loss, high probability and severity.
Priority 2 = medium loss, moderate probability and severity.
Priority 3 = low loss, low probability and severity.

Explanation:
P.B.1 : Microbial activity
P.B.2 : Lack of ice stock
P.L.1 : Fish damage during the delivery process
P.M.1 : Fish handling techniques
P.P.1 : Procurement of fish
P.P.2 : Fish prices down

In table 7 it can be seen that above the level of collectors there are 4 priority 3 risks (low expected loss), namely the risk of microbial activity (P.B.1), fish damage during the shipping process (P.L.1), fish handling techniques (P.M.1), and fish procurement (P.P. 1). There is 1 risk priority 2 (medium expected loss), namely a lack of ice stock (P.B.2). There is 1 risk priority 1 (high expected loss), namely the price of fish decreases (P.P.2). Then it is carried out, namely combining the results of the expected loss assessment with the capacity to manage that has been carried out by the risk owner which has a scale of 1 to 5 to assess its effectiveness.

Table 8. Mapping of risk vulnerabilities at the tier

	Capacity to Handle Risk				
Expected Loss	**1**	**2**	**3**	**4**	**5**
High					P.P.2
Moderate					P.B.2
Low					P.B.1; P.L.1; P.M.1; P.P.1

Explanation:

Vulnerability Scale	Code	Key Characteristics
Extremely vulnerable		Estimated losses are high, capacity is low
Highly vulnerable		Losses are estimated as medium-high, capacity low-medium
Moderate vulnerable		Losses are estimated to be medium, medium capacity

Low vulnerable		Losses are estimated to be low-moderate, medium-high capacity
Limited vulnerability		Estimated losses are low, capacity is high

The risk vulnerability map is made after obtaining the risk classification and the value of the risk owner's capacity for that risk. Then from these two parameters, a map is obtained in table 8. Table 8 is the result of Risk Management and Vulnerability Assessment mapping for collectors, so it is known that the risk of microbial activity (P.B.1), lack of ice stock (P.B.2), fish damage during the shipping process (P.L.1), fish handling techniques (P.M.1), and fish procurement (P.P.1) has a limited vulnerability category. At the risk of falling fish prices (P.P.2) has a low vulnerable category.

Tier Intermediary Trader

The results of the probability and severity assessment of each middleman trader respondent for each risk faced by the trader are then mapped as follows:

Table 9. Risk mapping at the tier

		Potential Severity of Impact				
		Negligible	Moderate	Considerable	Critical	Catashtopic
Probability of Event	Highly probable					
	Probable					
	Occasional					
	Remote		C.P.1		C.B.2	
	Improbable		C.B.1 C.L.1	C.M.1		

Explanation:

	High Expected Loss
	Medium Expected Loss
	Low Expected Loss

Priority 1 = high loss, high probability and severity.
Priority 2 = medium loss, moderate probability and severity.
Priority 3 = low loss, low probability and severity.

Explanation:

C.B.1 : Short supply of ice
C.B.2 : Increased microbial activity
C.P.1 : Didn't get any fish
C.L.1 : Fresh fish delivery process
C.M.1 : No sorting

In table 9 it can be seen that above the collector level there are 4 priority 3 risks (low expected loss), namely the risk of shortage of ice stock (C.B.1), not getting fish (C.P.1), the process of sending fresh fish (C.L.1), and no sorting (C.L.1). C.M. 1). There is 1 risk priority 2 (medium expected loss), namely increased microbial activity (C.B.2). Then a Risk Management and Vulnerability Assessment is carried out, namely combining the results of the expected loss assessment with the capacity to manage that has been carried out by the risk owner which has a scale of 1 to 5 to assess its effectiveness.

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Tabel 10 Mapping of risk vulnerabilities at the tier

	Capacity to Handle Risk				
Expected Loss	**1**	**2**	**3**	**4**	**5**
High					
Moderate					C.B.2
Low				C.B.1	C.P.1; C.L.1; C.M.1

Explanation:

Vulnerability Scale	Code	Key Characteristics
Extremely vulnerable		Estimated losses are high, capacity is low
Highly vulnerable		Losses are estimated as medium-high, capacity low-medium
Moderate vulnerable		Losses are estimated to be medium, medium capacity
Low vulnerable		Losses are estimated to be low-moderate, medium-high capacity
Limited vulnerability		Estimated losses are low, capacity is high

The risk vulnerability map is made after obtaining the risk classification and the value of the risk owner's capacity for that risk. Then from these two parameters, a map is obtained in table 10. Table 10 is the result of Risk Management and Vulnerability Assessment mapping on intermediary traders, so it is known that the risk of shortage of ice stock (C.B.1), increased microbial activity (C.B.2), not getting fish (C.P.1), the process of sending fresh fish (C.L.1) , and no sortation (C.M.1) has a limited vulnerability category.

Tier Fish Market Traders

The results of the probability and severity assessment of each fish market trader respondent for each risk faced by fish market traders are then mapped as follows:

Table 11. Risk mapping at the tier

		Potential Severity of Impact				
		Negligible	Moderate	Considerable	Critical	Catashtopic
Probability of Event	Highly probable					
	Probable					
	Occasional			D.B.1		
	Remote	D.P.3		D.P.1		
	Improbable	D.P.2	D.B.3	D.B.2 D.B.4 D.M.1		

Explanation:

	High Expected Loss
	Medium Expected Loss
	Low Expected Loss

Priority 1 = high loss, high probability and severity.
Priority 2 = medium loss, moderate probability and severity.
Priority 3 = low loss, low probability and severity.

Explanation:

D.B.1 : Microbial activity
D.B.2 : Lack of ice stock
D.B.3 : Increased microbial activity
D.B.4 : Fish storage time
D.P.1 : Procurement of fish many physical

defects
D.P.2 : Didn't get any fish
D.P.3 : Fish are not sold
D.M.1 : No sorting

In table 11 it can be seen that above the level of fish market traders there are 6 priority 3 risks (low expected loss), namely the risk of lack of ice stock (D.B.2), increased microbial activity (D.B.3), length of time for storing fish (D.B.4), not getting fish (D.P.2), fish are not selling well (D.P.3), and there is no sorting (D.M.1). There are 2 priority 2 risks (medium expected loss), namely microbial activity (D.B.1) and the supply of fish with many physical defects (D.P.1). Then a Risk Management and Vulnerability Assessment is carried out, namely combining the results of the expected loss assessment with the capacity to manage that has been carried out by the risk owner which has a scale of 1 to 5 to assess its effectiveness.

Table 12. Mapping of risk vulnerabilities at the tier

	Capacity to Handle Risk				
Expected Loss	**1**	**2**	**3**	**4**	**5**
High					D.B.1
Moderate					
Low				D.B.3; D.B.4	D.B.2; D.P.1; D.P.2; D.P.3; D.M.1

Explanation:

Vulnerability Scale	Code	Key Characteristics
Extremely vulnerable		Estimated losses are high, capacity is low
Highly vulnerable		Losses are estimated as medium-high, capacity low-medium
Moderate vulnerable		Losses are estimated to be medium, medium capacity
Low vulnerable		Losses are estimated to be low-moderate, medium-high capacity
Limited vulnerability		Estimated losses are low, capacity is high

The risk vulnerability map is made after obtaining the risk classification and the value of the risk owner's capacity for that risk. Then from these two parameters, a map is obtained in table 12. Table 12 is the result of the Risk Management and Vulnerability Assessment mapping of fish market traders, so it is known that the risk of a lack of ice stock (D.B.2), increased microbial activity (D.B.3), length of time fish are stored (D.B.4), fish procurement has many physical defects (D.B.4). D.P.1), did not get fish (D.P.2), fish were not sold (D.P.3), and no sortation (D.M.1) were categorized as limited vulnerability. At the risk of microbial activity (D.B.1) it has a low vulnerable category.

Tier Retailer

The results of the probability and severity assessment of each retailer respondent for each risk faced by the trader are then mapped as follows:

Table 13. Risk mapping at the tier

		Potential Severity of Impact				
Probability of Event		Negligible	Moderate	Considerable	Critical	Catashtopic
	Highly probable					
	Probable					
	Occasional					
	Remote				E.B.2	
	Improbable		E.B.1; E.P.1; E.L.1	E.M.1		

Explanation:

	High Expected Loss
	Medium Expected Loss
	Low Expected Loss

Priority 1 = high loss, high probability and severity.
Priority 2 = medium loss, moderate probability and severity.
Priority 3 = low loss, low probability and severity.

Explanation:

E.B.1 : Short supply of ice
E.B.2 : Increased microbial activity
E.P.1 : Didn't get any fish
E.L.1 : Fresh fish delivery process
E.M.1 : No sorting

Table 13 shows that above the retailer level, there are 4 priority 3 risks (low expected loss), namely the risk of shortage of ice stock (E.B.1), not getting fish (E.P.1), process of sending fresh fish (E.L.1), and no sorting (E.M. 1). There is 1 risk priority 2 (medium expected loss), namely increased microbial activity (E.B.2). Then a Risk Management and Vulnerability Assessment is carried out, namely combining the results of the expected loss assessment with the capacity to manage that has been carried out by the risk owner which has a scale of 1 to 5 to assess its effectiveness.

Table 14. Mapping of risk vulnerabilities at the tier

	Capacity to Handle Risk				
Expected Loss	**1**	**2**	**3**	**4**	**5**
High					
Moderate				E.B.2	
Low				E.P.1	E.B.1; E.L.1; E.M.1

Explanation:

Vulnerability Scale	Code	Key Characteristics
Extremely vulnerable		Estimated losses are high, capacity is low
Highly vulnerable		Losses are estimated as medium-high, capacity low-medium
Moderate vulnerable		Losses are estimated to be medium, medium capacity
Low vulnerable		Losses are estimated to be low-moderate, medium-high capacity
Limited vulnerability		Estimated losses are low, capacity is high

The risk vulnerability map is made after obtaining the risk classification and the value of the risk owner's capacity for that risk. Then from these two parameters, a map is obtained in table 14. Table 14 is the result of Risk Management and Vulnerability Assessment mapping on retailers, so it is known that there is a risk of shortage of ice stock (E.B.1), not getting fish (E.P.1), the process of sending fresh fish (E.L.1), and no sorting (E.M.1)) has a limited vulnerability category. At the risk of increasing microbial activity (E.B.2) it has a low vulnerable category.

Risk Evaluation

Risk evaluation aims to make decisions based on the results obtained from the risk analysis regarding what actions should be taken against each risk with predetermined risk criteria. This stage compares the estimated level of risk with pre-existing criteria and considers the balance between the potential gains and losses that will be incurred.

Table 15. Risk categories in the capture fish supply chain

Tier	No	Risk Code	Parameter	Expected Loss	Vulnerability Risk Event
Fisherman	1	N.C.1	Maritime weather	*Medium*	*Low vulnerable*
	2	N.B.1	Increasing activity microbial	*Medium*	*Limited vulnerability*
	3	N.M.1	Catch fish handling techniques	*Medium*	*Limited vulnerability*
	4	N.M.2	Delay in catching fish put into the hold of the ship	*Medium*	*Limited vulnerability*
	5	N.M.3	Determination of fishing points by captains	*Low*	*Limited vulnerability*
	6	N.L.1	Conditions of storage of caught fish	*Medium*	*Moderate vulnerable*
	7	N.L.2	Fishermen run out of supplies	*High*	*Low vulnerable*
	8	N.L.3	Ship engine damage	*Medium*	*Extremely vulnerable*
	9	N.P.1	Decline in the price of caught fish	*Low*	*Limited vulnerability*
Fish auction	10	T.B.1	Microbial activity	*Low*	*Limited vulnerability*
	11	T.M.1	Fish handling techniques	*Low*	*Limited vulnerability*
Collector	12	P.B.1	Microbial activity	*Medium*	*Limited vulnerability*
	13	P.B.2	Lack of ice stock	*Low*	*Limited vulnerability*
	14	P.L.1	Fish damage during the delivery process	*Low*	*Limited vulnerability*
	15	P.M.1	Fish handling techniques	*Medium*	*Limited vulnerability*

	16	P.P.1	Procurement of fish	*Low*	*Limited vulnerability*
	17	P.P.2	Fish prices down	*Medium*	*Low vulnerable*
Intermediary trader	18	C.B.1	Lack of ice stock	*Low*	*Limited vulnerability*
	19	C.B.2	Increased microbial activity	*Medium*	*Limited vulnerability*
	20	C.P.1	Didn't get any fish	*Low*	*Limited vulnerability*
	21	C.L.1	Fresh fish delivery process	*Low*	*Limited vulnerability*
	22	C.M.1	Tidak adanya sortasi	*Low*	*Limited vulnerability*
Fish market traders	23	D.B.1	Microbial activity	*Medium*	*Low vulnerable*
	24	D.B.2	Lack of ice stock	*Low*	*Limited vulnerability*
	25	D.B.3	Increased microbial activity	*Low*	*Limited vulnerability*
	26	D.B.4	Fish storage time	*Low*	*Limited vulnerability*
	27	D.P.1	Procurement of fish many physical defects	*Medium*	*Limited vulnerability*
	28	D.P.2	Didn't get any fish	*Low*	*Limited vulnerability*
	29	D.P.3	Fish are not sold	*Low*	*Limited vulnerability*
	30	D.M.1	No sorting	*Low*	*Limited vulnerability*
Retailer	31	E.B.1	Lack of ice stock	*Low*	*Limited vulnerability*
	32	E.B.2	Increased microbial activity	*Medium*	*Limited vulnerability*
	33	E.P.1	Didn't get any fish	*Low*	*Limited vulnerability*
	34	E.L.1	Fresh fish delivery process	*Low*	*Limited vulnerability*
	35	E.M.1	No sorting	*Low*	*Limited vulnerability*

Source: Processed Data, 2023

Keterangan:
Ex.vu (*extremely vulnerable*) : Big loss, low handling capacity
Hi.vu (*highly vulnerable*) : Medium-high loss, low-medium handling capacity
Mo.vu (*moderate vulnerable*) : Moderate loss, low-medium handling capacity
Lo.vu (*low vulnerable*) : Small-medium loss, medium-high handling capacity
Li.vu (*limited vulnerability*) : Small loss, high handling capacity

Table 15 above explains the categories of risks based on the level obtained from the risk analysis results. At the fisherman tier, there are nine risks, the collectors' tier is six risks, the intermediary trader's tier is five risks, the fish market traders' tier is nine risks, and the retail traders are five risks. From table 15 it can be seen that the fishermen tier has

1 risk of extreme vulnerability and 1 risk of moderate vulnerability. This shows that actually the fishermen tier is the tier that has the greatest risk in the capture fish supply chain. From table 15 the risk categories in the capture fish supply chain show that the tier that is closer to the consumer will have a smaller number of expected loss parameters. This can be seen by the absence of extremely vulnerable or highly vulnerable tier collectors, intermediary traders, fish market traders, and retailers. The following describes each risk in its respective vulnerability category:

Risk Mitigation and Treatment

The stages of risk mitigation and handling are the final stages in the risk management analysis. This stage will determine both mitigation and handling actions that are adjusted to the categorization of each risk from the previous stage. Mitigation and risk management are given to risks that have been found in the capture fish supply chain in Banyuwangi as an effort to reduce the likelihood of their occurrence and also the impact arising from these risks.

For risks that are in the limited vulnerability risk event category, no handling or mitigation activities will be given because the risks are at an acceptable level and are capable of being handled by the risk owners in the capture fish supply chain. The results of the risk analysis obtained are then cross-checked with the risk owner to determine mitigation actions. Risk mitigation measures are carried out with the aim of reducing the impact and probability of the risk itself and in RapAgRisk it is referred to as ex-ante. Settlement actions through handling risks that have occurred in RapAgRisk are referred to as ex-post

Table 15. Ex-ante (risk mitigation) and ex-post (risk handling)

Tier	No	Risk Code	Parameter	Risk Group	Risk Activity	
					Ex-ante	Ex-post
Fisherman	1	N.C.1	Maritime weather	*Lo.vu*	- Before embarking on a fishing voyage, fishermen first check the latest weather through the meteorological, climatological and geophysical agencies - The government through related agencies needs to make efforts to stabilize the welfare of fishermen by providing various types of skills, improving education levels, and creating jobs besides capture fisheries sector.	Suspending fishing operations until maritime weather improves
	2	N.B.1	Increased microbial activity	*Li.vu*	-	-
	3	N.M.1	Catch fish handling techniques	*Li.vu*	-	-

	4	N.M.2	The delay in catching fish is put into the hold of the ship	*Li.vu*	-	-

Table 15. Ex-ante (risk mitigation) and ex-post (risk handling)

Tier	No	Risk Code	Parameter	Risk Group	Risk Activity	
					Ex-ante	Ex-post
Nelayan	5	N.M.3	Determination of fishing points by captains	*Li.vu*	-	-
	6	N.L.1	Conditions of storage of caught fish	*Mo.vu*	-Provide additional storage space in the form of a cool box	The vegetable storage area in the ship's hold is used to store the fish caught
	7	N.L.2	Fishermen run out of supplies	*Lo.vu*	- Calculating the exact amount of supplies to be brought for fishing operations - Added safety stock of supplies	- The ship immediately pulled over to the pier - Contact the ship's investors to add supplies by entrusting them to the ship that is about to set sail
	8	N.L.3	Ship engine damage	*Ex.vu*	- The machine is regularly maintained - Ship engines are checked before being used for fishing operations - Using skippers or crew who are skilled in machine maintenance and repair	The ship immediately pulled over to the dock by being pulled by another ship
	9	N.P.1	Decline in the price of caught fish	*Li.vu*	-	-
Fish Auction	10	T.B.1	Microbial Activity	*Li.vu*	-	-
	11	T.M.1	Fish handling techniques	*Li.vu*	-	-
Collector	12	P.B.1	Microbial activity	*Li.vu*	-	-
	13	P.B.2	Lack of ice stock	*Li.vu*	-	-
	14	P.L.1	Fish damage during the delivery process	*Li.vu*	-	-

Table 15. Ex-ante (risk mitigation) and ex-post (risk handling)

Tier	No	Risk Code	Parameter	Risk Group	Risk Activity	
					Ex-ante	Ex-post
Collector	15	P.M.1	Fish handling techniques	*Li.vu*	-	-
	16	P.P.1	Procurement of fish	*Li.vu*	-	-
	17	P.P.2	Fish prices down	*Lo.vu*	- Purchasing damaged fish at a price of 50% of the normal price or lower according to the agreement	- Damaged fish are sold to salting fish, fish flouring, fish smoking or fish processing
Intermediary trader	18	C.B.1	Lack of ice stock	*Li.vu*	-	-
	19	C.B.2	Increased microbial activity	*Li.vu*	-	-
	20	C.P.1	Didn't get any fish	*Li.vu*	-	-
	21	C.L.1	Fresh fish delivery process	*Li.vu*	-	-
	22	C.M.1	No sorting	*Li.vu*	-	-
Fish market traders	23	D.B.1	Microbial activity	*Lo.vu*	- Fish that is placed in an open environment when selling is added to crushed ice cubes so that the fish stays fresh - Fish is stored in a cool box and/or styrofoam when selling	- Fresh fish put in cool box and/or styrofoam - Fish immediately processed.
	24	D.B.2	Lack of ice stock	*Li.vu*	-	-
	25	D.B.3	Increased microbial activity	*Li.vu*	-	-
	26	D.B.4	Fish storage time	*Li.vu*	-	-
	27	D.P.1	Procurement of fish many physical defects	*Li.vu*	-	-
	28	D.P.2	Procurement of fish	*Li.vu*	-	-

Table 15. Ex-ante (risk mitigation) and ex-post (risk handling)

Tier	No	Risk Code	Parameter	Risk Group	Risk Activity	
					Ex-ante	Ex-post
Fish market traders	29	D.P.3	Fish are not sold	*Li.vu*	-	-
	30	D.M.1	No sorting	*Li.vu*	-	-
Retailer	31	E.B.1	Lack of ice stock	*Li.vu*	-	-
	32	E.B.2	Increased microbial activity	*Li.vu*	-	-
	33	E.P.1	Didn't get any fish	*Li.vu*	-	-
	34	E.L.1	Fresh fish delivery process	*Li.vu*	-	-
	35	E.M.1	No sorting	*Li.vu*	-	-

Source : Processed Data, 2023

Based on table 15, the ex-ante and ex-post measures provided are adjusted based on the amount of risk and tier so that mitigation and handling can be carried out effectively. Mitigation steps and risk management in table 15 can be used as guidelines and strategies to reduce the impact and anticipate the occurrence of risks in the capture fish chain. Ex-ante is a risk prevention effort that can be carried out by the fishermen tier, collector tier, trader tier (intermediary traders, fish market traders, and retailers), as well as financial losses. Most of the ex-ante and ex-post are suggestions for prevention and treatment that have been carried out by the risk owners. There are also ex-ante and ex-post obtained from literature studies, interviews with risk owners and experts.

The risks in the categories of extreme vulnerability, high vulnerability, and low vulnerability belong to the fishermen tier. Some of the risks at the fish market collectors and traders tier are included in the low vulnerability category and most are included in the limited vulnerable category. The risks at the intermediary and retailer traders tier are included in the limited vulnerability category. Therefore, at extreme vulnerability, high vulnerability, moderate vulnerability, and low vulnerability, recommendations, ex-ante and ex-post actions will be given for this risk.

Conclusion

Fishermen tier risk mitigation, namely regular machine maintenance; ship engines are checked before use; employ skilled fishermen in machine repair; provide additional storage space; current weather check; looking for more distant fishing grounds; through the government providing a wide range of skills, improving education levels, and creating jobs outside the capture fisheries sector during inclement weather; take into account the amount of supplies; and adding supplies. Mitigation of collector tier risks, namely buying fish at a price of 50% of the normal price or lower. The risk handling for the collector tier is that the fish is sold to salting, flouring, smoking or steaming. Tier risk mitigation for fish market traders is adding ice when selling and storing fish in cool boxes and/or styrofoam when selling. Tier risk management for fish market traders, namely fish immediately put in a cool box and/or styrofoam and fish immediately processed.

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