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RISK MITIGATION OF TUNA SUPPLY CHAIN IN TERNATE CITY

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Abstract: Tuna is believed to be one of the world's most popular fish with high economic value. Tuna is very sensitive to temperature changes; therefore, quality control must be carried out from the supplier to the customer stage. The quality of tuna then impacts the amount of revenue received by each supply chain. The objectives of this research are to identify the configuration of the tuna supply chain in Ternate City, analyze the risk of the tuna supply chain, and propose risk mitigation strategies for the tuna supply chain in Ternate City. The research focuses on fishermen, traders, and processors. Sampling was based on non-probability sampling, where the collection of information and knowledge from experts used a purposive sampling method to determine the experts involved in the research. The number of respondents was two fishermen, two traders, and three processing companies. Potential risks were analyzed in fuzzy (Hor-1). Furthermore, several mitigation actions were carried out, which were then analyzed using fuzzy (Hor-2). Risk agents and risk events were identified based on all activities mapped using the Supply Chain Operations Reference (SCOR) model. Most tuna is delivered to fulfill domestic needs, with 58% going to inter-island traders and large processors or exporters. The ARP value with a cumulative 80% indicates that there are seven priority risk agents in fishermen, four priority risk agents in traders, and thirteen priority risk agents in processors that need to be mitigated. Training for fishermen on good fish handling on board and fish handling training for traders and processors are priority mitigation strategies that can be carried out to maintain the quality of tuna in all members of the supply chain.

Keywords: fuzzy -HOR, risk management, SCOR, tuna supply chain

Abstrak: *Tuna dianggap sebagai salah satu ikan populer di dunia yang memiliki nilai ekonomi tinggi. Ikan Tuna adalah produk yang sangat sensitif terhadap perubahan suhu, oleh karena itu pengontrolan kualitas harus dilakukan dari pemasok hingga ke tahap pelanggan. Kualitas ikan tuna kemudian berdampak pada besarnya pendapatan yang diterima oleh setiap rantai pasok. Tujuan Penelitian ini adalah mengidentifikasi konfigurasi rantai pasok ikan tuna di Kota Ternate dan menganalisis risiko rantai pasok tuna dan strategi mitigasi risiko rantai pasok ikan tuna di Kota Ternate. Potensi risiko dianalisis di fuzzy (HOR-1). Selanjutnya dilakukan beberapa aksi mitigasi, kemudian dianalisa dengan menggunakan fuzzy HOR-2. Penelitian difokuskan pada nelayan, pedagang pengumpul dan pengolah. Kejadian risko dan sumber risiko diidentifikasi berdasarkan Semua aktivitas yang dipetakan dengan menggunakan model Supply Chain Operations Reference (SCOR). Ikan tuna paling banyak dikirim untuk memenuhi kebutuhan domestik sebesar 58% dikirim kepada pedagang antar pulau dan pengolah besar atau eksportir. Nilai ARP dengan kumulatif 80% menunjukkan bahwa terdapat 7 sumber risiko prioritas pada nelayan, 4 sumber risiko pada pedagang pengumpul dan 13 sumber risiko pada pengolah yang perlu dimitigasi. Pelatihan pada nelayan tentang penanganan ikan yang baik di atas kapal dan pelatihan penanganan ikan bagi pengumpul dan pengolah merupakan strategi mitigasi yang dapat dilakukan untuk mengatasi sumber risiko dalam menjaga kualitas ikan tuna di semua anggota rantai pasok.*

Kata kunci: *fuzzy-HOR, manajemen risiko, SCOR, rantai pasokan tuna*

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INTRODUCTION

Tuna commodity is one of the leading commodities in the industrialization program because tuna is a type of high economic fish (FAO, 2017) and the second foreign exchange earning commodity for fisheries after shrimp (Yusuf et al. 2017). North Maluku Province is the third-largest tuna producer in Indonesia after North Sulawesi and Maluku. North Maluku has a fisheries processing industry development area, including tuna commodities, in Ternate City, Morotai Island Regency, South Halmahera Regency, and North Halmahera. Tuna production in Ternate City reached 9,090 tons in 2021. Tuna fishing in Ternate is quite dominant because the level of utilization has not been overexploited, making it a possibility for the development of the future tuna fishing industry (Amin and Kasim, 2015).

The development of the fisheries industry can focus on the production system from upstream to downstream to increase added value, productivity, and scale of production of marine and fishery resources, one of which is tuna (Rahmayanti et al. 2017). Tuna and its fish processing industry are included in the category of high-risk food and industry (FAO, 2017). Fresh foods, such as tuna, represent perishable products, with a limited shelf time frame. To secure competitiveness, stakeholders as supply chain actors must be effectively managed (Karningsih et al. 2018).

Tuna has high consumer demand due to the shift in world consumer tastes from red meat to white meat. With its potential and large market opportunities, it is not surprising that most of Indonesia's tuna production is exported to several destination countries such as Japan, the European Union, and the United States of America (Yusuf et al. 2017). Fishery commodities, including tuna, are perishable products that require more complex logistical handling and highly expensive costs, especially for storage that requires a separate cooling device (Batubara et al. 2018). There have been cases of rejection of fishermen's tuna catches by processing companies in North Maluku due to the decline in fish quality. Mistakes in maintaining the temperature of the fish were the cause of such a decline. The handling on the vessel demands cold and clean storage to secure food safety. Some tuna receives the lowest grade due to poor handling on the vessel. Lower quality entails a lower price. The limited capacity for storing and handling tuna auctions in the ports, no cold storage, and no separation between clean and dirty areas in the port can also affect the quality of the tuna.

The previous study involved risk mitigation based on advances in food product traceability technology. A case study of the supply, processing, and distribution of caught tuna provides the background for describing and analyzing the risk agents and how they are interrelated in the supply chain (Parenreng et al. 2016). This study develops previous research with an expert assessment approach involving business actors. The study analyzes the risk and how mitigation strategies can be carried out.

The assessment of the impact and the incidence rate in the House of Risk (HOR) model uses the same assessment method as the FMEA method. In this study, to ensure that expert judgment is not multi-interpretative and remains consistent, the impact assessment model and the risk event level follow the fuzzy assessment model. The rating scale modeled in a fuzzy triangle is used because it can overcome the ambiguity of judgments and conflicting judgments (Lee et al. 2015). The results of the ARP show the seriousness of potential failures; the higher the ARP value, the higher the risk control priority. The supply chain of tuna fish products can be robust if there is an integrated product process and integration between business actors throughout the supply chain.

The characteristics of an agro-industry supply chain, including fisheries, involve long supply chains that require proper supply chain management to maintain quality and price. Risk and uncertainty have always been important issues in supply chain management, making it an industry necessity. Addressing supply chain risk requires supply chain risk management, which comes in the form of supply chain risk management (Aini et al. 2014). The objectives of this research are (1) to identify the configuration of the tuna supply chain in Ternate City, (2) to analyze the risk of the tuna supply chain in Ternate City, and (3) to analyze the risk mitigation strategy of the tuna supply chain in Ternate City.

METHODS

This research was conducted at the supply chain level of fishermen, traders, and tuna processing units operating at the Perikanan Nusantara Port in Ternate City. The research was conducted from January to June 2022. Sampling was based on non-probability sampling, where the collection of information and knowledge from experts used a purposive sampling method to determine the experts involved in the research.

The number of respondents taken as a sample for tuna supply chain mitigation measurements in Ternate City were two fishermen, two traders, and three processing companies. The two fishermen who became respondents were the heads of the Sigaro Fishermen's Group with 32 members and the Marimoi Fishermen's Group with 25 members, who are members of the Fair Trade Fishermen of Ternate City. The Fair Trade Fishermen Group is a group of fishermen who are Fair Trade certified, making them eligible to sell to fishing companies that sell to the United States of America. The selected intermediary trader respondents were the two traders with the highest tuna sales during 2021. Two processing companies were companies whose tuna sales have reached foreign markets, and one small-scale processor.

The identification of the tuna supply chain configuration was conducted using a descriptive-quantitative method, interviews, field observation, and literature review, following the supply chain identification model by Vorst (Vorst, 2006). All activities were mapped using the Supply Chain Operations Reference (SCOR) model. The research focused on fishermen, traders, and processors. Potential risks were analyzed in fuzzy (HOR-1) with expert aggregation calculated using the order-weighted average (OWA) approach developed by Yager (1993). Furthermore, several mitigation actions were carried out, which were then analyzed using fuzzy HOR-2.

The potential of the fishing industry, especially tuna, is increasing with the growth of the fleet, thereby increasing the production of tuna in the province of North Maluku. The city of Ternate is one of the centers of the fishing industry in North Maluku Province. However, there are still problems in managing the tuna supply chain. These problems cause slow production and have a direct effect on the quality of the fish produced. Proper risk management can reduce the impact of the risk. Risk management requires an in-depth risk identification step for each member of the supply chain (Septiani and Djatna, 2015). There are many problems faced by tuna fisheries in Indonesia, for example, from management aspects (e.g., policy implementation and enforcement of rules and institutions), resource aspects (e.g., overfishing and overcapacity, juvenile capture tuna), and technological aspects (e.g., still high bycatch rates, number and type of fleet, and fishing gear that has not been optimally controlled). If these problems continue, they can cause a decline in the supply of tuna resources in nature and threaten business results, as well as the Indonesian tuna business. The supply chain risk management model is the best solution for managing risk in a supply chain. The results of this study are expected to be able to help manage risk and assist in the management of the tuna supply chain, especially in maintaining quality (Parenreng et al. 2016). Schematically, the thinking-concept framework of the study is shown in Figure 1.

RESULTS

Tuna Supply Chain Configuration

Tuna Supply Chain Structure

The supply chain structure in Figure 2 illustrates the flow of the tuna supply chain, in general, from farmers to end consumers. The tuna supply chain flow in Ternate City was adapted from (Karningsih et al. 2018) and then adjusted to the tuna supply chain situation in Ternate City.

The catches of tuna fishers are marketed in local markets, domestic markets, and are exported (BKIPM, 2021). The most dominant tuna market among these channels is the inter-provincial market, namely domestic delivery to inter-island traders and large processors or exporters, accounting for 58% in the form of whole tuna and tuna loin products. The local market, sales through retail traders in the market, reaches 36%. Direct exports to Singapore and Vietnam amount to 6% in the form of whole tuna and tuna loin. Deliveries are made to several provinces in Indonesia. The largest delivery is to East Java Province, namely Surabaya City and Gresik Regency. The second-largest is to North Sulawesi Province, namely shipments to Manado City and Bitung City.

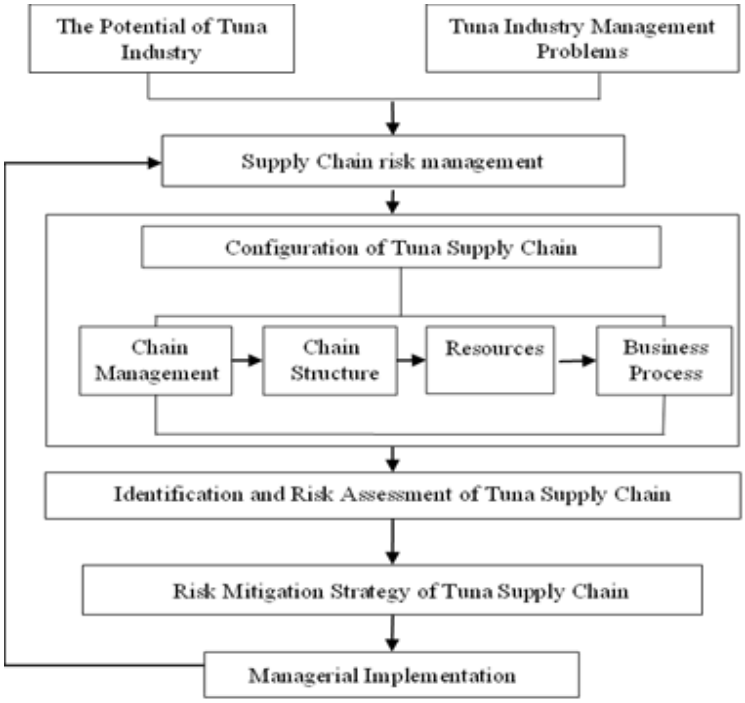

Figure 1. Research framework

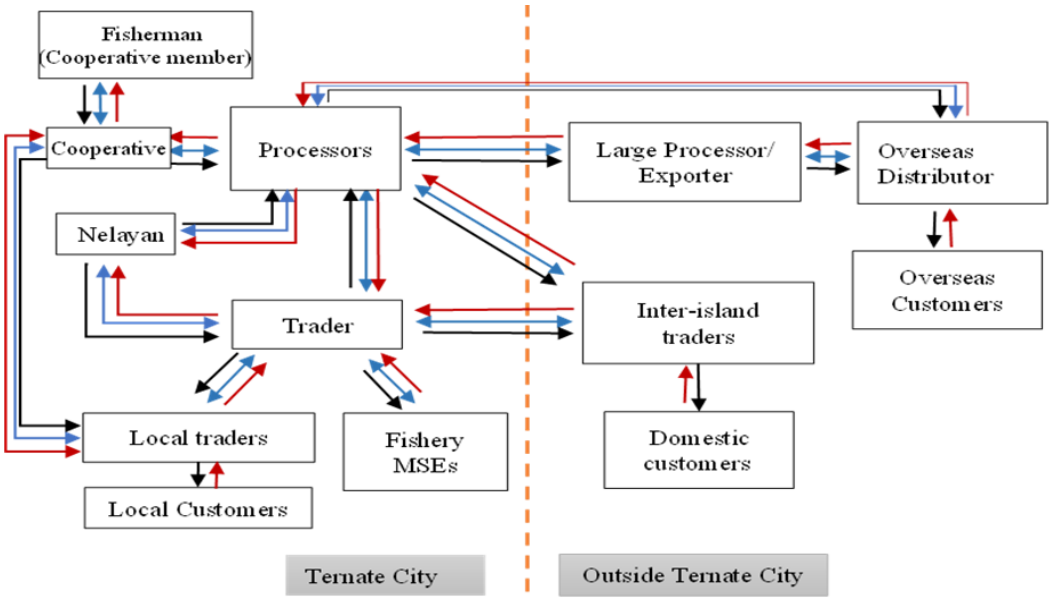

Figure 2. Tuna supply chain flow in Ternate City

Chain Management

The first partnership pattern is found in large processors or exporters with processing companies in Ternate. This partnership pattern occurs because large processors or exporters need tuna raw materials with good quality and complete fishing documents for product traceability. The next partnership pattern is found between fishermen and fish processors. Fish processors have partner fishermen who will supply tuna. The partner fishermen are Fair Trade certified fishermen. The transaction system used is cash and carry. The ability of fishermen to contribute to determining the price of tuna is weak (Prayoga, 2017). Tuna price determination is carried out by processing companies and traders. The price of tuna is influenced by fish size, fish quality, and fishing season. During the fishing season, the catch of fish will be more abundant.

Resources

The physical resources of the tuna supply chain can be viewed from two aspects, namely the availability of a fleet of fishing vessels and a cold chain system. The fleet of fishing vessels in Ternate City consists of 246 vessels of 1 - 5 GT. Strengthening the physical fleet resources is also supported by infrastructure such as Fish Landing Centers (TPI) and Fishing Ports. Physical resources in the form of a cold chain system are essential in the tuna supply chain. Cold chain facilities and infrastructure include ice factories, cold storage, air blast freezer (ABF) machines, and cooling cars. The local government, through KPBP Tuna, has formed a group of fishermen which is being developed into a Fisheries Cooperative.

Business Process

The business process activities of each supply chain member are broken down into sub-activities of the business process framework according to the Supply Chain Operation Reference (SCOR). The business processes plan, source, make, deliver, and return. The business processes in each supply chain can be seen in Table 1.

Tuna Supply Chain Risk Identification and Assessment

Risk Identification and Assessment of Tuna Supply Chain in Fishermen

Risk events that have a High (H) impact are unfairness in the price of fish sold (FPE1), incomplete licenses (FPE2), high costs for operations (FSE3), too small fish size (FME6), poor quality of fish before sale (FME4), and degradation of fish quality during delivery (FDE8). These risks relate to the quality and operational costs as well as the price of fish (Karningsih et al. 2018).

There are 14 risk agents identified in tuna fishermen. The expert assessment shows that there are four risk agents with a low incidence rate (L), five risk agents with a medium incidence rate (M), and three risk agents with a high incidence rate (H). The risk agents with a high occurrence rate (H) are fish mishandling on board (FA11), harvest season (FA9), and weather factors (FA9). Fish mishandling on board is a risk agent of internal risk. Harvest season and weather factors are risk agents of external risk (Karningsih et al. 2018). Unpredictable weather in the last two years (2015 to 2016) also affected the lack of captured fish. The assessment of each risk event and risk agent and their correlation in tuna fishermen can be seen in Table 2.

Table 1. Tuna supply chain activities

Business Process	Business Sub-Process		
	Fishermen	Traders	Processors
Plan	Catch Plan	Order Quantity Planning	Order Quantity
			Delivery Schedule
			Inventory Calculation
			Production Plan
Source	Operational Support Purchasing	Fish Purchase	Fish Purchase
		Fish Reception	Fish Reception
Make	Catch Process	Washing Process	Producing Process
	Storage	Sorting Process	Product Packaging
		Product Packaging	Product Storage
		Product Storage	
Deliver	Unloading Process	Document Preparation	Document Preparation
	Delivery	Product Delivery	Product Delivery
Return			Product Return from Customers

Table 2. HOR phase 1 (Fishermen)

Risk Event	Risk Agent														Si
	FA1	FA2	FA3	FA4	FA5	FA6	FA7	FA8	FA9	FA10	FA11	FA12	FA13	FA14	
FPE1	H		H		L						M	L			H
FPE2		M													H
FSE3				L		H									H
FSE4				L	H	H									M
FME5			H		M		L		L	L			L		M
FME6						M							M		H
FME7					H			L			H			M	H
FME8														L	H
Oj	M	M	M	L	M	M	M	L	H	L	H	H	M	L	
ARP	359.8	188.2	331.6	75.7	927.8	472.6	84.3	76.3	109.7	58.9	781.6	143.1	88.4	184.9	
Rank	4	6	5	13	1	3	11	12	9	14	2	8	10	7	

Risk Identification and Assessment of Tuna Supply Chain at Traders

Risk events that have a High (VH) impact are (TME11) Product damaged in cold storage and (TDE11) Decrease quality in delivery. Nine risk agents assessed by experts showed that there are three risk agents with a low incidence rate (L) and six risk agents with a medium incidence rate (M). Risk agents with a medium incidence rate (M) are low commitment with business partners (TA1), minimal maintenance of processing equipment (TA3), insufficient number of fish containers (TA5), employee negligence (TA6), and inadequate transportation equipment (TA9), which are internal risk agents for Traders. Meanwhile, the risk agent of rotating blackouts (TA8) is an external risk related to third parties. The assessment of each risk event and risk agent and its correlation in tuna Traders can be seen in Table 3.

Risk Identification and Assessment of Tuna Supply Chain at Processors

The aggregated results of expert judgment on 21 risk events show six risk events with a low severity rate (L), six risk events with a moderate severity rate (M), six risk events with a high severity rate (H), and three risk events with a very high severity rate (VH). Risk events that have a very high impact (VH) are damaged products in cold storage (IME17), contaminated products (IME18), and damaged products (returned from customers) (IRE21). Tuna is a perishable commodity (Bell et al. 2015), and product quality is highly dependent on the cold chain system. Tuna with good quality can be sold at a high price. Therefore, when damage occurs, it will greatly affect the selling price, and processors can experience losses when these risks occur.

Of the 27 risk agents assessed by the experts, there is one source of risk with a very low incidence rate (VL), five risk agents with a low incidence rate (L), 20 risk agents with a medium incidence rate (M), and one source of risk with a high incidence rate (H). The source of risk with a high incidence rate (H) is an error in sorting (IA19). The assessment of each risk event and risk agent and their correlation in tuna processing can be seen in Table 4.

Tuna Supply Chain Risk Prioritization

The HOR Phase 1 assessment is then sorted using a Pareto diagram with the 80:20 rule. Based on the Pareto diagram, mitigation will only be carried out on 20 percent of the risk agents that cause 80 percent of the problems in the supply chain. The ARP value with a cumulative 80% indicates that there are 7 priority risk agents that need to be mitigated. The risk agents include (FA5) Ice Limitation, (FA11) Fish Mishandling on Board, (FA6) Fuel Limitation, (FA1) Low Commitment with Business Partners, (FA3) Uncertain catch, and (FA2) Delay in Licensing. The fishermen risk agent that has the highest ARP value is (FA5) Ice Limitation of 927.8.

Table 3. HOR phase 1 (Traders)

Risk Event	Risk Agent									Si
	TA1	TA2	TA3	TA4	TA5	TA6	TA7	TA8	TA9	
TPE1						M				M
TPE2		L								M
TSE3		L			L					H
TSE4		L					M			H
TSE5						M				H
TME6						M				M
TME7			M	M		M				H
TME8						M				M
TME9						M				H
TME10	M					M			M	H
TME11								H		VH
TDE12									H	VH
Oj	M	L	M	L	M	M	L	M	M	
ARP	247.2	93.2	247.2	168.2	109.7	1574.1	129.2	74.0	321.1	
Rank	3	8	4	5	6	1	7	9	2	

The results of the ARP value analysis with a cumulative 80% indicate that there are 4 priority risk agents that need to be mitigated. The risk agents include (MA6) employee negligence, (MA9) inadequate transportation equipment, (MA1) low commitment with business partners, and (MA3) minimal maintenance of processing equipment. The fishermen risk agent with the highest ARP value is (MA6) employee negligence. The results of the ARP assessment and calculation at the tuna processors are shown in Figure 4. The results of the ARP value analysis with a cumulative 80% indicate that there are 13 priority risk agents that need to be mitigated. The risk agents include (IA18) Errors in sorting, (IA14) Limited skilled employees, (IA11) Lack of quality, (IA2) Increasing the number of impromptu orders, (IA20) Limited cold storage, (IA1) Poor communication within the company, (IA9) Duration of waiting for approval from the director/ branch manager, (IA19) Limited human resources in production, (IA17) Limited/inadequate tools, (IA8) Fluctuation in raw material prices, (IA3) Damaged raw materials, (IA10) Errors in planning calculations, and (IA23) Inadequate amount of transportation. The processing risk agent that has the highest ARP value is (IA18) Errors in sorting with a value of 1.307. The priority of risk agents in fishermen, traders, and processors can be seen in Figure 3.

Tuna Supply Chain Risk Mitigation Assessment

Risk Mitigation Assessment of Tuna Supply Chain in Fishermen

The results of the mitigation priority analysis indicate that there are three mitigation priorities that can be carried out, as can be seen in Figure 4. (FPA1) Training fishermen in handling fish on board is the most effective mitigation strategy, and it is also easy to implement. The aspect of handling fish when caught is very important to note, especially in tuna fisheries because it involves how to maintain good quality tuna (Mboto et al. 2014). Training fishermen in Good Handling Practices can support the improvement of export-worthy fish quality. (FPA5) Collaborating with companies as processors is a mitigation strategy that can be taken to improve business networks. Business networks are formed due to similarities in the production and distribution of resources, leading to parties having the power or ability to control resources and parties that are controlled (Mirajiani et al. 2014). (FPA7) Licensing socialization by the government is a strategy from external fishermen. Problematic fishing permits can cause delays and disruptions to the fishing process. Additionally, with a fishing boat permit, it will be easier for fishermen to buy fuel at the Fisherman Fuel Filling Station (SPBN) at the Fishing Port.

Table 4 HOR phase 1 (Processors)

Risk Event	Risk Agent																										Si
	IA1	IA2	IA3	IA4	IA5	IA6	IA7	IA8	IA9	IA10	IA11	IA12	IA13	IA14	IA15	IA16	IA17	IA18	IA19	IA20	IA21	IA22	IA23	IA24	IA25	IA26	IA27	
IPE1	M						M																					L
IPE2	L	M								M					L													L
IPE3	M													H														H
IPE4		H																										L
IPE5	M					H				M																		L
ISE6	L							M																				M
ISE7				M				M																				M
ISE8									M																			L
ISE9										L																		M
ISE10			L	M	H						M	L						M	M									H
ISE11		H	L								H			M				M										H
ISE12		H									H							M										H
IME13		H							H				H							H		L						L
IME14														M		L			M									H
IME15														H		L			L									H
IME16				M	M				H						M					H								M
IME17											H						M			H	L		L					VH
IME18			M														M			H	L		L	M				VH
IDE19	M																											M
IDE20			M						H													L	L					M
IDE21			M																						M	M	L	VH
Oj	M	M	M	M	L	M	M	M	M	M	M	L	L	M	M	M	M	H	L	L	M	M	M	M	L	M	VL	
ARP	836	861	349	329	252	180	129	367	798	342	1147	76	124	1214	238	216	409	1307	468	847	244	141	333	283	191	283	13	
Rank	6	4	11	14	17	22	24	10	7	12	3	26	25	2	19	20	9	1	8	5	18	23	13	15	21	16	27	

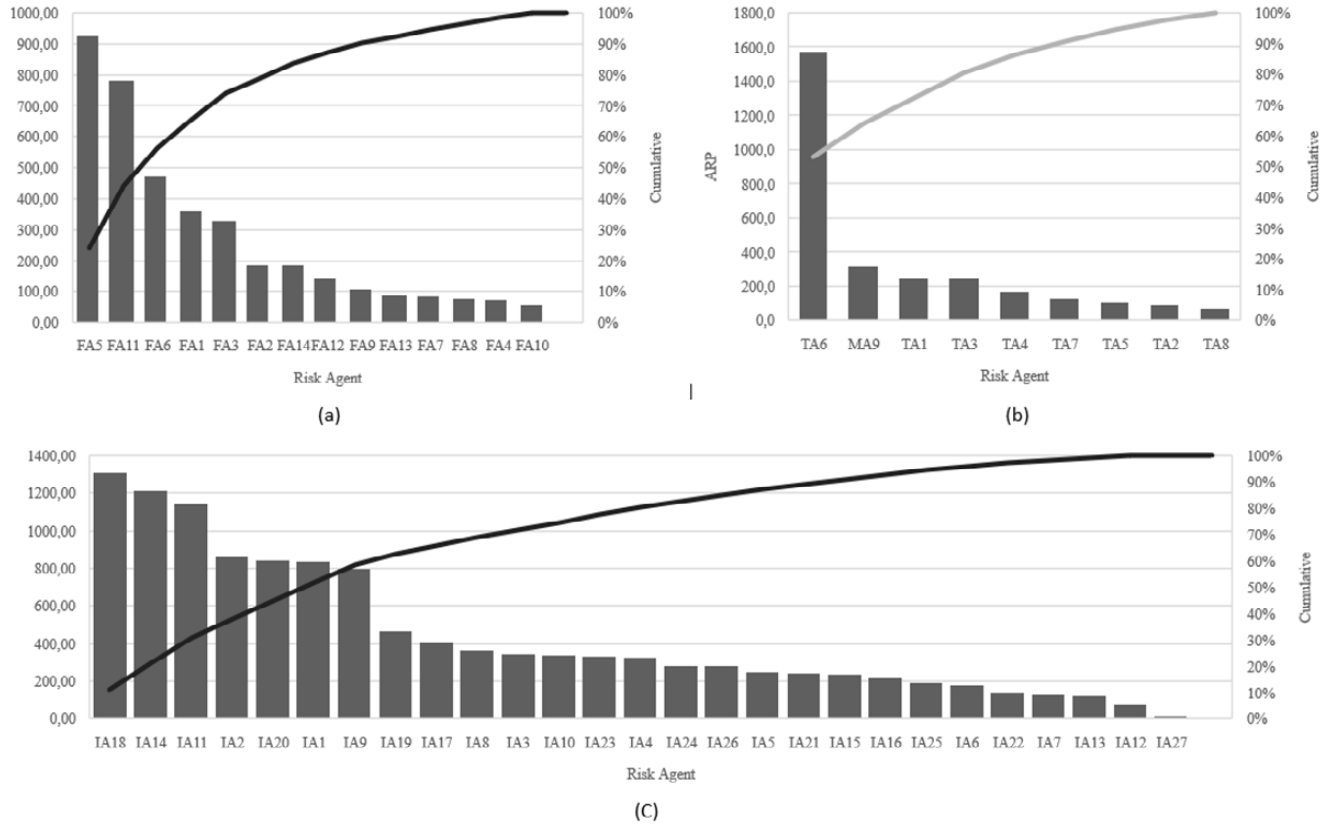

Figure 3. Pareto diagram of risk agents priority in (a) Fisherman; (b) Trader; (c) Processors

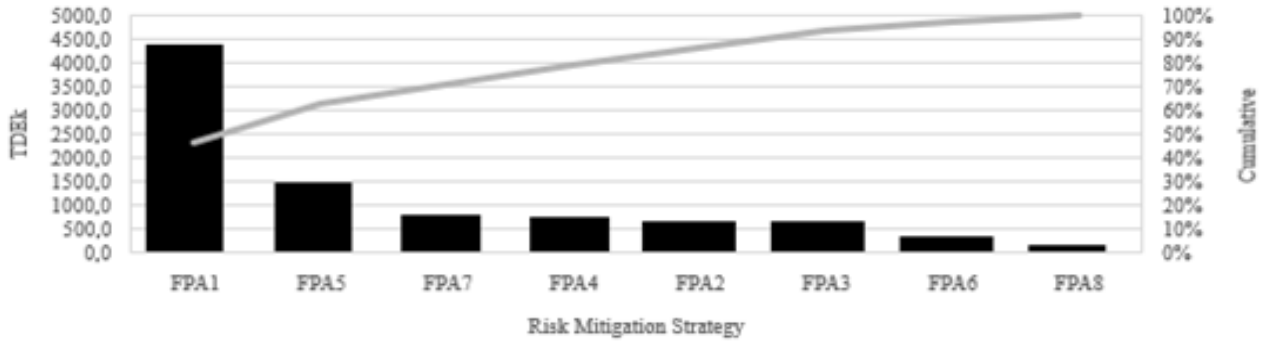

Figure 4. Pareto diagram of risk mitigation strategy in fishermen

Risk Mitigation Assessment of Tuna Supply Chain in Traders

Risk assessment with HOR Phase One has resulted in four priority risk agents for Traders. The analysis indicates two priority mitigation strategies that can be carried out. The first is conducting routine training for Traders (TPA2), which is the easiest mitigation strategy to implement. Training is an effort to improve talents, skills, proficiency, abilities, and expertise in dealing with tasks (Sulaimiah et al. 2020).

The second mitigation strategy is to implement standardized and certified production processes (TPA5). Traders must also be certified because they carry out ordering activities for tuna. The mandatory certificates are Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP) from the Ministry of Marine Affairs and Fisheries. Improved worker discipline is necessary to guarantee the production of good quality products. Workers who have a high level of work discipline will continue to work in accordance with the procedures to produce the highest quality products without needing

constant monitoring (Purwaditya et al. 2018). The priority of risk mitigation strategies for traders can be seen in Figure 5.

Risk Mitigation Assessment of Tuna Supply Chain in Processors

Based on the results of the analysis, the most effective and easy-to-implement mitigation strategies are: (1) regular training for employees (IPA2). Employee training and development should be utilized to improve managerial and operational skills (Jehanzeb and Beshir, 2013; Rodriguez, 2017); (2) implementation of strict quality control of raw materials (IPA1). A possible hazard at the raw material receiving stage is the decomposition that may have occurred due to spoilage microorganisms in the tuna body (Abdullah and Tangke, 2020). The benefits of the company's internal standards will be perceived by the company's internals, suppliers, and customers. If the company wants its products/services to be widely accepted, the company needs to apply higher-level standards such as association standards, national standards, and international standards (Linthin et al. 2018); (3) minimum and maximum stock (IPA5). This strategy is carried out to avoid accumulation in the cold chain or cold storage system when there is a lot of fish during the harvest or when waiting for tuna delivery. A good company condition is when inventory holdings and turnover are always in a state of balance. Consumer needs must be met, so the company must ensure that the goods needed are always available (Asana et al. 2020), as can be seen in Figure 6.

Managerial Implication

The mitigation in the tuna processing supply chain highlights the crucial role of fishermen and employees in handling fish from catching, production, to delivery. Good Fish Handling Training provides guidelines for the requirements and proper production procedures for a fish processing unit, ensuring product quality and guaranteeing a basic level of food safety control. It also provides quality assurance and safety for fishery products handled in the collector/supplier unit. The role of employees in maintaining the quality of tuna helps minimize product returns from buyers.

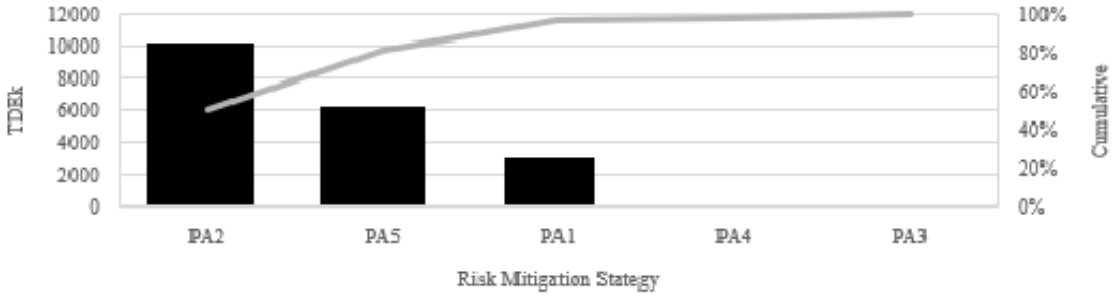

Figure 5. Pareto diagram of risk mitigation strategy in traders

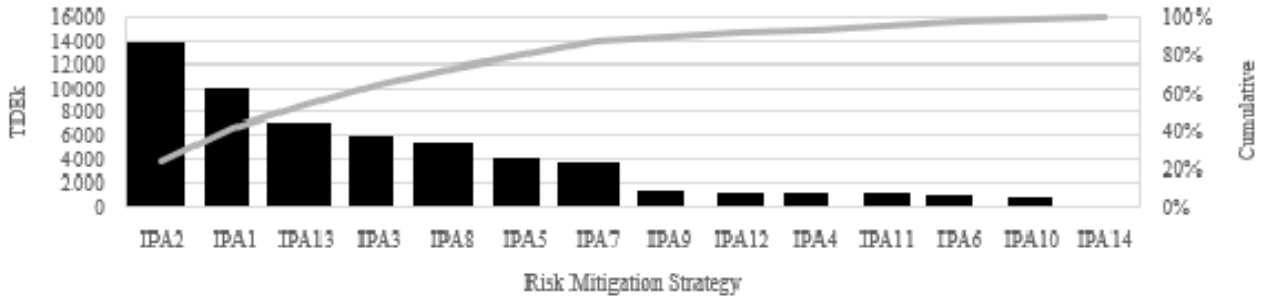

Figure 6. Pareto diagram of risk mitigation strategy in processors

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The tuna supply chain in Ternate City involves various members, including fishermen, traders, processors, local traders, fisheries MSEs, and consumers. The inter-provincial market is the most dominant channel for tuna sales. Domestic delivery to inter-island traders and large processors or exporters accounts for 58% of the total, mostly in the form of whole tuna and tuna loin. Tuna from Ternate City is mainly sold in domestic markets such as East Java and North Sulawesi. Partnerships are commonly established between fishermen and traders, with benefits such as fishing operational capital loans and fast fish sales guaranteed by traders. The buyers set the prices.

The identification and assessment of supply chain risks show that fishermen, traders, and processors face risks in the business process of purchasing or procuring (source), catching (make). Priority risk agents for fishermen include storage errors in the hold of the ship. The priority risk for traders is employee negligence, while priority risk agents for processors include errors in sorting. Training fishermen in good fish handling on board and providing fish handling training for traders and processors are essential in maintaining the quality of tuna in all stages of the supply chain.

Recommendations

Continuous assistance by the government is needed so that all business actors in the tuna supply chain can adopt good fish handling practices. Further research can be conducted to determine the factors that influence the interest of business actors in the tuna supply chain in adopting good fish handling methods. Training strategies for fishermen in good fish handling on board and providing fish handling training for collectors and processors are crucial in maintaining the quality of tuna across all members of the supply chain.

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