VULNERABILITY AND STAKEHOLDER CONVERGENCY OF LARGE PELAGIC FISH SUPPLY CHAIN TO FACE ENVIRONMENTAL UNCERTAINTY IN EAST JAVA INDONESIA

TIWI NURJANNATI UTAMI[1]*, DJOKO KOESTIONO[2], NUDDIN HARAHAB[1], SYAFRIAL[2] AND MANGKU PURNOMO[2]

[1]*Veteran Street No. 1, Faculty of Fisheries and Marine Science, Universitas Brawijaya Malang, East Java, Indonesia.*
[2]*Veteran Street No. 1, Faculty of Agriculture, Universitas Brawijaya Malang, East Java, Indonesia.*

Corresponding author: tiwi@ub.ac.id

Abstract: The supply chain of large pelagic fish in Indonesia is a complex system with high environmental uncertainty. This study aims to describe the supply chain, the level of business vulnerability and convergency of actors on the supply chain of large pelagic fish in East Java, Indonesia. The population is the business actors in the supply chain in East Java Province of Indonesia. The sample is obtained using the purposive sampling method. The data are gathered from interviews with the business actors, supported by questionnaires and focus group discussions. This study uses supply chain analysis, business vulnerability index, and analysis using the Matrix of Alliances and Conflicts: Tactics, Objectives, and Recommendations. The findings indicate that the actors are the fishermen, vessel owners, operational managers, middlemen, manufacturers or processors, distributors, and retailers. The degree of business vulnerability on the supply chain falls to the moderate category. The most substantial objective of the actors is the improvement in income. The main actors who owned the biggest power to influence the supply chain are the middlemen and the operational managers. The implication is that these actors have a significant role in improving the product competitive advantage.

Keywords: Vulnerability, convergency, stakeholder, supply chain, large pelagic fish.
Abbreviations: Tuna-Skipjack-Mackerel (TSM).

Introduction

Large pelagic fish, in the *scomroidei* family, especially the group of tuna – skipjack – mackerel (TSM), is a commodity with significant economic value. Indonesia has the highest TSM production value, with the total value of the tuna production being IDR 10,982,906,784,000, skipjack production IDR 10,855,639,127,000, and the mackerel production IDR. 9,665,484,975,000 (Central Bureau of Statistic/ CBS, 2020; Ministry of Marine Affair of Fishery [MMF], 2020). In Indonesia, the TSM fish group ranks second after shrimp in terms of export value at US$176.63 million or 14.23% (CBS, 2020; MMF, 2020). This production value is due to the Indonesian Ocean being a suitable habitat for the growth of the TSM fish, having a warm temperature, with an abundance of food, and is the migration path of the fish (MMF, 2020). The natural resources also support the development of the agro-industry of TSM fish in Indonesia. Indonesia is among the top 10 exporter of canned processed products derived from TSM fish (MMF, 2020). The supply chain of TSM fishery is also supported by the availability of human resources. It is recorded that 2,359,064 people, or 0.8% of the Indonesian population, are fishermen (Central Bureau of Statistics, 2020; MMF, 2020; FAO, 2020). East Java is one of the TSM fish processing areas that belongs to the Fisheries Management Areas of the Republic of Indonesia 735 and 712. East Java is a huge contributor to the TSM export in Indonesia. (MMF, 2014).

However, behind such a large potential of natural resources, the supply chain of large pelagic fish faces a complex system that has many relationships among its actors or stakeholders, considering how great the uncertainty is, such as the weather, season,

fish price and the different urgencies of each actor. The sustainability of the fishery of large pelagic fish of the TSM group in East Java is found to be low, especially in the biology, social and institution dimensions (Harahab *et al.*, 2021). The actors in the supply chain of large pelagic fish from the sub-system of the front-end is found to be unintegrated, yet they face uncertainties involving the environment, such as the weather (with the indicators of tide level, wave, flow, wind, rainfall, thunder); the social environment, such as the culture and custom, as well as personal conflict among the actors; the business environment, such as consumers and customers; and, the applied rules and regulation. If such aspects are not managed well, it may cause the failure in achieving the objectives of the actors in terms the supply chain of the fishery business of large pelagic fish of the TSM group.

Several researchers have studied supply chain vulnerability, some of which involve the supporting factors of the vulnerability (Itano *et al.,* 2000; Macusi *et al.*, 2021), the vulnerability on fish catching (Fredou *et al.,* 2017), and risk assessment on sea fauna (Roberson *et al.,* 2022). However, there are only a few studies on the convergency of the actors in facing business vulnerability to achieve the objective of improving the competitive advantage of the products on the supply chain for TSM fish.

Business vulnerability is a condition where the companies are not able to avoid or must face the risk from the external environment, such as natural disasters, policy changes and developments of technology (Verbano &Venturini, 2013; Wagner & Neshat, 2012). Vulnerability in facing the external environment is a negative factor that has an immense potential in decreasing the competitive level of a business. For example, Arend and Wisner (2005) studied the business of rice commodity in flood-prone areas. There are several types of business vulnerability, such as financial (Verbano & Venturini, 2013), suppliers, labour, and customers vulnerabilities (Wagner & Neshat, 2012; Thapa *et al*., 2018).

The role of the stakeholders in facing business vulnerability will potentially strengthen the competitive level of a supply chain. This study focuses on business vulnerability in the supply chain and the possibility of the actors cooperating to face it. The actors involved in a network of supply chain of large pelagic fish experience an adaptation of the surroundings, especially the external environment, so that it creates a unique relationship pattern. Thus, this study aims to analyse the degree of business vulnerability on the supply chain of large pelagic fish, as well as to analyse the objective and the convergency of the actors in the supply chain in an attempt to improve the competitive value of the large pelagic fish in East Java.

Materials and Methods

Study Location

This research is conducted in East Java, under the consideration that the region has a marine overfishing areas of large pelagic fish (Harahab *et al.,* 2020). And, there are still many problems found in East Java, particularly in the upstream sector, such as the fluctuation of raw material availability from fishing, low technology adaption in fishing, low standard of quality in fishing, and lack of integrated social relationship with the actors in the upstream sector (MMF, 2020). The research location is shown in Figure 1.

Data Collection

The information required in this study is collected from the actors of the fishery business involved in the large pelagic fish supply chain in East Java. The key actor is represented by the manufacturer companies, determined through the purposive sampling technique and continued with snowball sampling to identify the actor. Interviews are conducted with 25 informants as the actors and or experts of the supply chain, who consist of fishermen who own the ship and the ship captains, *pengambak,* middlemen in the Sendangbiru Coast in Malang Regency, Prigi
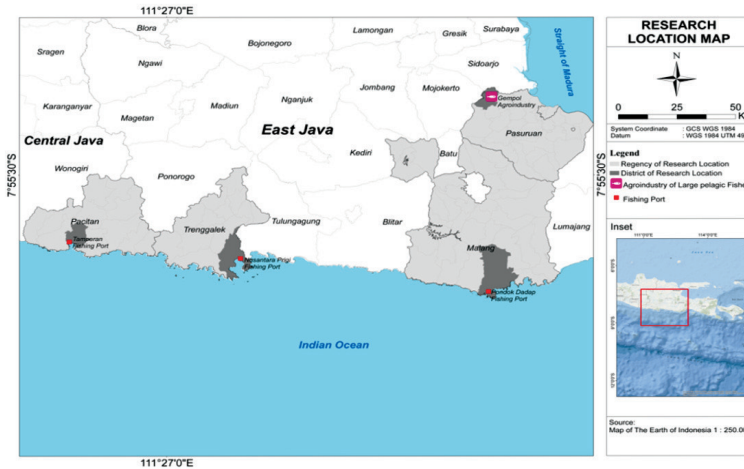
Figure 1: Research location map in East Java Province, Indonesia

Coast in Trenggalek Regency, and Tamperan Coast in Pacitan Regency, the managers of fish manufacturer in Pasuruan Regency, exporters, academicians of Fisheries and Marine Science Faculty of Brawijaya University, government staff of the Marine Affairs and Fisheries of East Java Province, located in Malang Regency, Banyuwangi Regency and Trenggalek Regency.

An observation and interviews on the actors' activity, which are fishing, transporting, selling, and manufacturing fish. Further interviews are also carried out with the actors to identify the supply chain. This technique could be well suited for exploring the informants' perceptions and opinions, and it required more knowledge and clarification of the response (Bloomberg & Volpe, 2019). Then, a quisionaire is used to gain data on vulnerability and convergency of the actors in the supply chain.

Method Analysis

This study uses the multi-methods approach (Ostlund *et al.*, 2011; Fauzi, 2019), which consists of the supply chain identification in a certain area, business vulnerability analysis on the threat in the environment, as well as objectives and convergency analysis involving the business actors in the supply chain of large pelagic fish in East Java.

The population of this research consists of the companies in the supply chain of large pelagic fish that are in the low-sustainable area, the Pacitan Regency, Trenggalek Regency, and Malang Regency of East Java Province, Indonesia. This study uses the direct survey method for the businesses in those area. This study uses primary data, which is on the vulnerable areas and the levels of vulnerability of the companies. Data collecting is done using direct interview with the actors with questionnaires and focus group discussion (FGD) on the vulnerability aspect regarding the environment. The data analysis in this study uses the methods of descriptive analysis, business vulnerability index and prospective analysis using the Matrix of Alliances and Conflicts: Tactics, Objectives, and Recommendations (MACTOR).

The descriptive analysis is used to describe the chain supply of large pelagic fish in the studied area. The method to determine the sample in this study us purposive sampling to identify the focal firm, which is the manufacturers. Then, it is continued with the snowball sampling method to choose the other actors within the same supply chain network.

The vulnerability index of a company regarding the environment is calculated with all the vulnerability aspects, which are the variables of suppliers' vulnerability, labour vulnerability, capital vulnerability and consumer vulnerability. FGD is conducted to weigh each variable.

Then, the vulnerability index is formulated by multiplying the total score of all indicators and the weight of each variable to all the vulnerability variables (Weis *et al.,* 2016). The vulnerability index of a company is determined using the following formula (Weis *et al.*, 2016; Isa, 2018):

$$IKU = \sum_{i=1}^{4}(w1 * X1) + (w2 * X2) + (w3 * X3) + (w4 * X4) \quad (1)$$

Where IKU = business vulnerability index for environment; W1 = the weight of supplier vulnerability; X1 = supplier vulnerability score; W2 = the weight of labour vulnerability; X2 = labour vulnerability score; W3 = the weight of capital vulnerability; X3 = capital vulnerability score; W4 = the weight of customer vulnerability; and, X4 = customer vulnerability score. The IKU score is categorised into low vulnerability (index value ≤ 0.33), moderate vulnerability (index value between 0.34 and 0.66) and high vulnerability (index value ≥ 0.67) (Luni *et al.*, 2012).

The prospective analysis on the actors in this study is done using MACTOR. According to Godet (1991), the analysis of influences and interests of actors, consisting of raw material suppliers, wholesalers and consumers, can be effectively performed using MACTOR. The steps of MACTOR are the determination of 1) important variables and actors; 2) table of actors; 3) strategic issues and objectives; 4) convergence and divergence matrices; 6) power matrix with direct and indirect relationship; 7) the position matrix value; and, 8) strategic recommendation of each actors (Godet, 1991; Fauzi, 2018).

Results and Discussion

The Supply Chain of Large Pelagic Fish.

Supply chains can be defined as a trading process from the suppliers, in the form raw materials, to the exporters as the final retailer (Nguyen *et al.*, 2019). It may also be defined as the flow of raw materials and processed goods that is the result of the manufacturing process (Liu &Zhou, 2017). The supply chain of large pelagic fish in East Java is shown in Figure 2. The actors involved are presented according to a sequential pattern, starting from the fishermen who catch the fish, to the distributors who deliver the commodity to the hands of consumers.
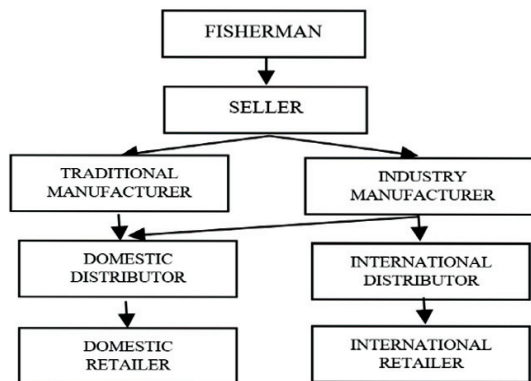

Figure 2: The supply chain of large pelagic fish in East Java

The main players that have importance in the management of the supply chain is the suppliers, manufacturers, distributors, retailers, and customers (Copra & Meindl, 2007a). The structure of the supply chain of the large pelagic fish consists of the main players, which are the suppliers, manufacturers, and distributors, who conduct the activities based on the flow of goods, money, and information, with a sequential relationship from obtaining the fish until it becomes the finished products that are ready to be sold from the perspective of the supply chain. The informants' explanation on the structure of the supply chain of the large pelagic fish in East Java is presented on Figure 3.

Figure 3 describes the structure of the supply chain of the large pelagic fish in East Java conducted by the actors with the dynamic flow of goods, money, and information. The actors in the supply chain of large pelagic fish are interconnected to each other in terns if fishing activities. The actors in the front-end sector involve fishermen that consists of the 1) ship owner, 2) captain of the ship, and 3) ship crews. In most areas on the coast of East Java, there are actors known as the *pengambak*, or the manager of the ship who will provide the needed funding for the fishermen to go out to sea. Then, there are traders that consist of 1) the middlemen, who are traders who obtain fish through several

mechanisms, through auctions, regular non-auction trading patterns, or through relationships with other actors, and they distribute it to the manufacturing company and/or to the retailers; and, 2) the retailers, who are traders who buy fish from the fishermen, ship crew members who obtain fish as a gift (*lawuhan*) and they distribute it to local consumers, or traders that usually buy fish from middlemen and distribute it to the domestic market. The distributors of the processed fish are parties who distribute the processed fish products from the manufacturers to the retailers of the processed fish, then the retailers of the processed fish will distribute it from the distributors to the consumers. The large pelagic fish manufacturers process the large pelagic fish traditionally, that is by boiling and smoking, which then are distributed to the domestic market. Meanwhile, big-scale fish manufacturers process fish using modern technology, which the end products are canned fish, fish fillet, frozen products and other kinds of processed fish, where most of them are exported and a small portion are distributed to the small domestic markets.

Actors in the upstream sector mostly carry out business processes based on long-standing habits and informal agreements, especially between fishermen, ship owners and developers. According to Satria (2016),
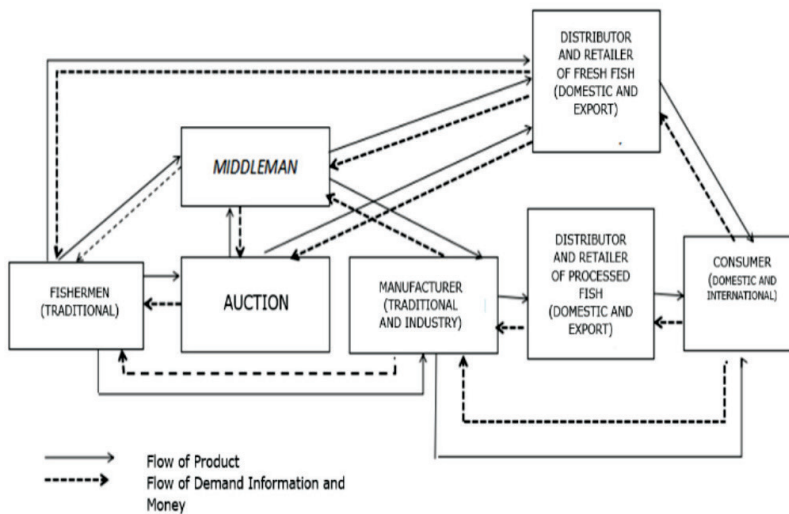

Figure 3: Structure of the supply chain for large pelagic fish in East Java

there is a distinctive relationship in the capture fisheries business based on trust between actors, whereas in the downstream sector, such as traders and processors, as well as processors and distributors or retailers, business processes mostly involve formal agreements or contracts. Copra and Meindl (2007) explain that large-scale businesses usually have a strategic goal that is designed efficiently and effectively. They tend to use formal agreements or contracts with their business partners to decrease the probability of failure in achieving their objectives.

Business Vulnerability due to Environmental Uncertainty

Business vulnerability is a condition that cannot be avoided, or face the risks from the external environment, such as natural disasters, changes ub policies and technological developments (Luets, 2005; Isa *et al.,* 2015). If a company has low business vulnerability, then it will improve its competitive value. The business vulnerability involving the environment, such as the weather, is one of the vulnerabilities that companies faces, considering that their performance will be affected in the short term (Hess *et al.*, 2016). The findings indicate that the business vulnerability index for the environment for the supply chain of large pelagic fish is 0.47, which means that it falls to the moderate category. Fishermen are the most vulnerable parties with a vulnerable index of 0.55, followed by the middleman at 0.48, the processing industry at 0.46, and finally, the distributor t 0.43. Fishermen have the highest vulnerability index, considering that they are responsible for catching fish, in

which they face uncertainties from the external environment, such as unpredictable weather, the location of fish migration, and other kinds of natural disasters. The business vulnerability in the researched area is presented on Table 1.

Based on the aspects of the business vulnerability, the results of the study shows that the companies in the supply chain fall in the vulnerability category of moderate, with a score of 0.47, with the suppliers' vulnerability having the highest score of 0.5. When the actors experience issues in the business, then the suppliers will face the most difficult position in in terms of recouping the money invested and whether to continue the business (Gosman, 2008).

If it is analysed deeper, the detail on the degrees of vulnerability of each actor vary. On the fishermen side, the capital or financial vulnerability has the highest score. This is because most fishermen are business actors with limited capital. With the turmoil from the environment, it is easy to cause another turmoil to the business actors (Poh, 2017). Meanwhile, the suppliers and labour vulnerabilities rank the second highest. When the external environment presents a problem, like dangerous weather forecast and the changing of the season, then many fishermen, the captain, and the crews, would decide not to go to sea. They would choose to rest or look for alternative jobs. The consumers are the one with the lowest rank because once the demand level of a product is high, then the demand for the middleman will be high as well.

Table 1: Business vulnerability index in the areas

Vulnerability Index	Fishermen	Middlemen	Processor	Distributors	Retailers	INDEX
Supplier vulnerability	0,60	0,70	0,50	0,40	0,30	0,50
Capital vulnerability	0,65	0,45	0,35	0,40	0,35	0,44
Labour vulnerability	0,60	0,40	0,50	0,40	0,50	0,48
Consumers vulnerability	0,35	0,35	0,50	0,50	0,60	0,46
INDEX	0,55	0,48	0,46	0,43	0,44	0,47

The middleman ranks the second in terms of vulnerability, especially the suppliers. Middleman will be short in supply if the fishermen are not successful in their catch. The capital and labour vulnerabilities are also lower because capital is seen to be available, as well as labour. Meanwhile, the consumers have a lower vulnerability compared with the others since if the demand of the product is high, then the demand for the processing is also high. On the other hand, the processing company rank third in terms of vulnerability, having the same score with the suppliers, labour, and consumers. The lowest vulnerability score is for the processing company, especially in terms of capital vulnerability, as manufacturers have an enormously powerful capital, as big companies with a focus of worldwide export.

The distributors and retailers seem to have the lowest average vulnerability score, as they are not connected directly to the raw material suppliers, so they are less vulnerable compared with the suppliers. They are also considered sufficient in terms of capital because they have a lot of cooperation with the processing companies that can ease their need for capital. However, they are quite vulnerable in terms of consumers, since consumers can have plenty alternatives retailers and distributors that fulfil their needs on the processed TSM fish products. The consumers commonly want enough products available, in standardised quality, and at an affordable price (Kottler, 2000). The consumers can also switch retailers if their needs and expectations are not fulfilled.

Objectives and convergence of stakeholders in the large pelagic fish supply chain

A. Identification of the actors and their objectives

The stakeholder's analysis using MACTOR is conducted to identify and discuss the objective of the stakeholders, as well as the convergency on the supply chain of the large pelagic fish. The analysis is used to identify and understand the interests, passions and perceptions of the stakeholders in improving the competitive advantage of the products (Godet, 1991; Fauzi, 2019) in the East Java region.

Based on the literary study and the questions to the business actors of the supply chain of the large pelagic fish, there are 6 actors. Each actor has their role and objective in the management of the supply chain, in which the objectives are: (1) increasing income; (2) increasing the amount caught; (3) fish quality; (4) availability of raw material; (5) final product quality; (6) accuracy of delivery; (7) adhering to the fishery-related law on sustainable fishing; and, (8) production continuity.

B. MACTOR Input Matrix

There are two types of relationships that are needed in this analysis, the relationship between all the actors and the relationship between the actors and the objectives. The actors-to-actors relationship matrix shows the direct relationship between the actors. Meanwhile, the relationship between the actors and objectives matrix shows the position of each actor in relation to each objective.

Actors-to-Actors Matrix

The actors-to-actors matrix, using the matrix of direct influences, describes the interaction among the actors and it indicates the influence of actor "i" to actor "j". The input of the matrix follows the following rule:

- If actor i can question the existence of actor j, the value is equal to 4;

- If actor i can question the fulfillment of missions of actor j, the value is equal to 3;

- if actor i can question the success of the projects of actor j, the value is equal to 2;

- If actor i can question, in a limited way, given the space and time, the operating processes of management of actor j, the value is equal to 1; and,

- If actor i do not have much influence on actor j; the value is equal to 0.

The final actors/actors matrix of direct influence is shown in Table 2.

Tabel 2: Actors-to-actors matrix mid (matrix of direct influences)

	A1: Fisherman	A2: Vessel owner	A3: Manager operational	A4: Middleman	A5: Fishing Industry	A6: Distributor/ Retailer	Sum Aj
A1: Fisherman	0	3	2	1	0	0	6
A2: Vessel owner	3	0	1	1	0	0	5
A3: Manager of operational	4	4	0	3	0	0	**11**
A4: Middle-man	2	1	2	0	3	0	8
A5: Fishing industry	0	0	0	3	0	4	7
A6: Distributor	0	0	0	0	3	0	3
Sum Ai	9	8	5	8	6	4	

From the table above, it can be concluded that the party of operational manager (A3) has the biggest influence on other actors, with the highest Aj sum of 11. Meanwhile, the fishermen (A1) have the lowest influence with the lowest Aj score of 3. The fishermen (A1) are the party that is largely influence by the other parties, with a sum Ai score of 9.

Actors-to-Objectives Matrix: Valued Positions Matrix

The matrix of score position (actors to objectives) 2MAO can describe the priority score in sequence on the objectives of every actor. These scores gained from the simple position matrix 1MAO that is estimated by the intensity of the position of each actor, using the scale of the degree of opposition or approval from the levels of very high, high, medium, or low. If the actor feels an objective is particularly important for them, then the objective will be given a bigger score.

- If the objective implicates the actor in his existence or is indispensable to his existence, the value is equal to 4;

- If the objective questions the fulfillment of the missions of the actor or is indispensable in his missions, the value is equal to 3;

- If the objective questions the success of the projects of the actor or is indispensable to his projects, the value is equal to 2;

- If the objective questions or favours, in a limited way in terms of time and the space, the operating processes or is indispensable in its operating processes, the value is equal to 1; and,

- If the objective is of little consequence, the value is equal to 0.

The actors-to-objectives matrix is presented in Table 3. It is found that the objective O2: "increase in income" becomes the objective of all actors, as well as objective 1: "increasing the number of fish caught". However, objective 8: "adhering to the rules or regulations related to fisheries and trade" show the biggest disagreement.

Table 3: Actors to Objectives Matrix 2MAO (Valued Position Matrix)

Objectives / Actors	O1 Catches	O2 Income	O4 Raw Qquality	O5 Raw stock	O6 Product Quality	O7 Delivery	O8 Law	O9 Production sustainability	Sum of Abs
A1 Fisherman	4	4	3	1	0	0	-2	-2	11
A2 Vessel owner	4	4	3	1	0	0	-2	-2	12
A3 Manager operational	4	4	3	3	0	0	-2	-1	15
A4 Middleman	4	4	4	4	1	3	1	2	27
A5 Fishing industry	3	4	4	4	4	3	1	2	**29**
A6 Distributor	3	4	2	2	3	4	1	2	25
Number of agreements	22	24		19	15	8	10	3	6
Number of disagreements	0	0		0	0	0	0	0	-5
Number of positions	22	24		19	15	8	10	9	11

Table 3 shows that the objective with the highest score is "increase in income" and the second is "increasing in the number of fish caught". The objective with the lowest score is "product quality" and "adhering to the rules and regulations related to fisheries and trade". Several actors do not really pay attention obeying the rules and regulations on fisheries and trade, as well as product quality. This is supported by the real-life conditions in which several actors do not fully obey the rules, such as filling in the paperwork for fishing for the fishermen, which they feel that it complicates their efforts in achieving their main objective.

Figure 3 indicates the position of each actor in the aspects of influence and dependency. The findings show that the map is separated into four quadrants: the first quadrant is the actors, the second quadrant is the players, the third quadrant is the subjects, and the fourth quadrant is the bystanders (Godet, 2009; Fauzi, 2019). The first quadrant is the position where the actors have low degrees of interest, but a strong level of interdependency in improving the competitive advantage of the products. Based on the results of the analysis, no actor falls under this quadrant. The second quadrant involves the most active actors who attempt to improve the competitive capacity of the products because they have a prominent level of interest and interdependency. The actors that fall under the second quadrant are the operational managers and the middlemen. The actors in the quadrant are known to have the financial resources (capital), information and the facility that is sufficient in the network of supply chain. They have the value to manage the fish availability and to purchase the raw materials in the area. On the other hand, the operational managers and the middlemen cannot achieve their objectives without the fishermen. The influence of each actor on this quadrant is high, but they are influenced by other actors in a high degree, too. With that, the focus should be on a programme to improve the products' competitive advantage to esnure the availability, access and use of fish as a food source for society.

The actors in the third quadrant have important roles, but their effect in improving the competitive advantages of the products is small. This quadrant is filled by the fishermen and the vessel owner. These actors, the fishermen and the vessel owner, have significant roles as the parties who provide the fish. However, they are influenced more by other actors, like the operational managers, who provide the funding for the fishing expedition.

The actors on the fourth quadrant have a low level of interest and influence in improving the competitive advantage of the products, which are the distributors and the processing manufacturers. The distributors play the role as the intermediary between the processing manufacturers and consumers. They have several product alternatives that are produced by other manufacturers, so they are not dependent on a single manufacturer only. Also, the distributors cooperate with several retailers so that they are not dependent on only one retailer
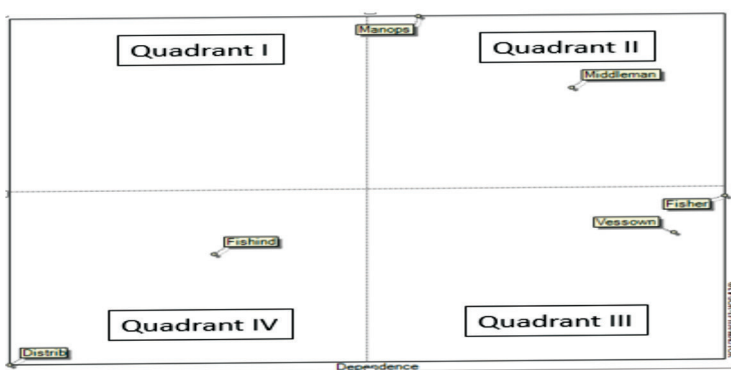

Figure 4: A map of influence and interdependence between actors

as well. Distributors also have little influence on other actors, considering that the processing manufacturers have more than one distributor they cooperate with.

Figure 5 explains the distance of the actors in achieving the objective of improving the competitive advantage. From the figure above, the distance between the actors is shown generally.

Figure 6 show the convergency map for the related actors. The convergency show the tendencies among the actors in agreeing to initiate a partnership to achieve the objectives of several actors in a programme, which is the activities related to improving the competitive advantage of the products by involving the fishermen, vessel owners, operational managers, middlemen, processing manufacturers, and distributors.

Figure 7 shows the actors who can initiate a partnership in achieving the objectives of several actors, such as between the processing manufacturers and the middlemen. They can create an agreement in achieving the objective of improving the competitive advantage of the products. Meanwhile, in the front-end
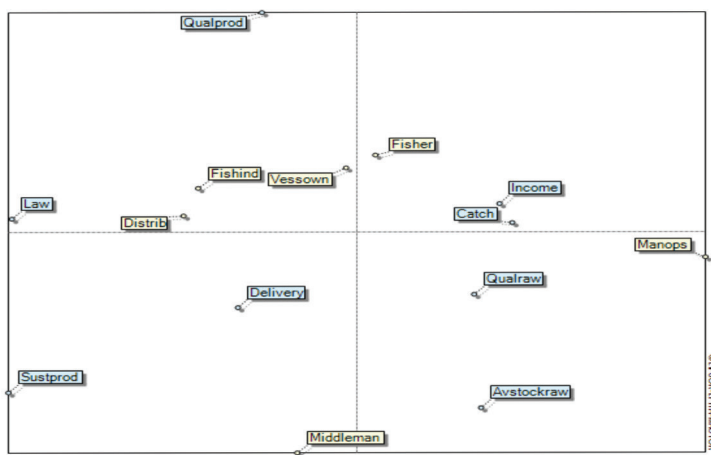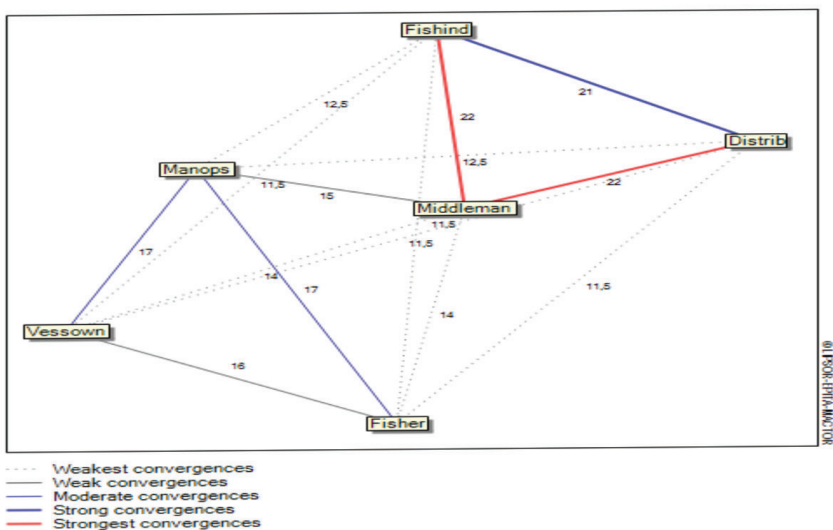

Figure 5. Actors-toobjectives relationship

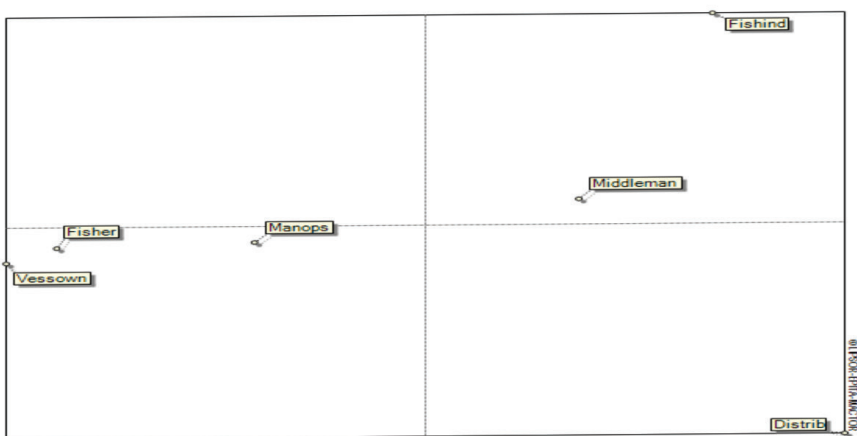Figure 6: Graph of convergence between actors

Figure 7: Map of convergence between actors

sector, the fishermen, vessel owners and the operational managers can cooperate in achieving the objective in improving the competitive advantage of the products. The actors in a network of supply chain must work together to improve the competitive advantage (Wagner & Neshat, 2018). According to Su *et al.* (2008), and Fynes and Marshal (2004), supply chain relationship quality should be considered in terms of cooperative strategy to improve performance.

Conclusion

The study shows that the supply chain of large pelagic fish in the East Java region consists of the fishermen, vessel owners, operational managers, middlemen, processing manufacturers and the distributors of the processed products and consumers. Based on the actors, it can be concluded that the fishermen are the most vulnerable actors, followed by the middlemen, processing manufacturers, retailers, and distributors. The score of business vulnerability falls under the moderate category. Meanwhile, based on the vulnerability aspect, it is found that the suppliers are the most vulnerable, followed by labour, capital, and consumers. All the actors in the supply chain have a role in achieving competitive prominence. The external environmental conditions with great uncertainties are a threat that needs special attention to reduce the vulnerability so that

harmful impacts can be decreased and the competitive advantage of the products can be improved at the same time.

The main actors are the business actors in a network of supply chain of large pelagic fish. They have 8 objectives, with the main objective being increasing income and the weakest objective is the adherence to the rules and regulations related to fisheries and trade.

The findings show that the stakeholder map is divided into four quadrants: the first (actors), second (players), third (subjects), and fourth (bystanders). The actors are the parties with low dependencies, but have a strong influence in improving the competitive advantage of the products. The players are the most active parties in the attempt to improve the competitive advantage of the products. The subjects are the parties that are incredibly significant, but with a small influence towards the objective of improving the competitive advantage. Meanwhile, the bystanders are parties with power who have a low ability to influence and be influenced in terms of improving the competitive advantage of the products. The actors that initiate a partnership to achieve several objectives are the processing manufacturers with the middlemen, who fall under group 2 of the actor convergency map. Meanwhile, the fishermen, vessel owners, and the operational managers may initiate a partnership to achieve the objectives, and they fall under group 4 on the actors convergency

map. Groups 2 and 4 fall under the category of weak convergency level. This indicates that the parties that initiate a partnership with those of higher level of convergency can discuss and plan a programme to be agreed upon and then execute it together in the attempt to achieve the objective. As the front-end sector, between the fishermen, vessel owners and the operational managers, they have established dealings, albeit an informal one. They need to renegotiate the deal so that it can support the other actors, as well reduce the vulnerability due to the changes in nature and great uncertainties, such as the harsh weather that can have a negative impact on and increase the vulnerability of the supply of raw materials, the workforce, and funding.

Acknowledgements

References

Akhmad Fauzi. (2010). *Ekonomi perikanan: Teori, kebijakan, dan pengelolaan*. (Fishery Economic: Theory, Policy & Management). PT Gramedia Pustaka Utama.

Bandura, A. (1989). Social cognitive theory. In R. Vasta (Ed.), *Annals of child development. Six theories of child development* (Vol. 6. pp. 1-60). Greenwich, CT: JAI Press.

Bloomberg, L. D., & Volpe, M. (2019). *Completing your qualitative dissertation: A road map from beginning to end* (4th ed.). Thousand Oaks, California: Sage Publication.

Boardman, J. T., & Clegg, B. T. (2001). Structured engagement in the extended enterprise. *International Journal of Operations and Production Management, 21*(5-6), 795-811. https://doi.org/10.1108/01443570110390471

Bovet, D., & Martha, J. (2000). *Value nets: Breaking the supply chain to unlock hidden profits*. NewYork, NY: John Wiley & Sons.

Chandrashekar, A., & Schary, P. B. (1999). Toward the virtual supply chain. *International Journal of Logistics Management, 10*(2), 27-40. DOI:10.13140/RG.2.2.14438.63043

Chopra, S., & Meindl, P. (2007a). *Supply chain management: Strategy, planning & operation* (3rd ed.). Pearson Prentice Hall.

Chopra, S., & Meindl, P. (2007b). Supply chain management strategy, planning, and operations by Chopra S. Meindl P. In *Kemampuan Koneksi Matematis (Tinjauan Terhadap Pendekatan Pembelajaran Savi)*. 53 (9).

Cresswell, J. (2014). *Reserach Design* (V. Knight (ed.)). Sage Publications. Inc.

Davis, E. W., & Spekman, R. E. (2004). *The extended enterprise: Gaining competitive advantage through collaborative supply chains*. Englewood Cliffs, NJ: FT Prentice-Hall.

Emerson, R. M. (1976). Social Exchange Theory. *Annual Review of Sociology*, *2*, 335-362. http://www.jstor.org/stable/2946096.

FAO. (2019). *The State of World Fisheries and Aquaculture*. https://www.fao.org

Fredoue. (2017). Vulnerability of teleosts caught by the pelagic tuna longline fleets in South Atlantic and Western Indian Oceans. *Deep Sea Research, 140*, 230-241. https://doi.org/10.1016/j.dsr2.2016.10.008

Fynes, B., & Marshall, D. (2004). Environmental uncertainty, supply chain relationship quality and performance. *Journal of Purchasing and Supply Management, 10*, 179-190. https://doi.org/10.1016/j.pursup.2004.11.003

Giddens, A. (2010). *Teori strukturasi: Dasar-dasar pembentukan struktur sosial masyarakat.* Yogyakarta: Pustaka Pelajar.

Giménez, C., & Ventura, E. (2003). Supply chain management as a competitive advantage in the Spanish grocery sector. *The International Journal of Logistics Management*, *14*(1), 77-88. https://doi.org/10.1108/09574090310806558

Godet, M. (1991). Actors' moves and strategies: The mactor method: An air transport case study. *Futures, 23*(6), 605-622. https://doi.org/10.1016/0016-3287(91)90082-D.

Halldorsson, A., Kotzab, H., Mikkola, J. H., & Skjøtt-Larsen, T. (2007). Complementary theories to supply chain management. *Supply Chain Management*, *12*(4), 284-296. https://doi.org/10.1108/13598540710759808

Hallikas, J., Karvonen, I., Pulkkinen, U., Virolainen, V. M., & Tuominen, M. (2004). Risk management processes in supplier networks. *International Journal of Production Economics*, *90*(1), 47-58. https://doi.org/10.1016/j.ijpe.2004.02.007

Harahab, N., Abidin, Z., Supriyadi, D., Sofiati, M. P., Wardani, A., & Anandya, M. G. (2021). Sustainability analysis of tuna fishing in waters South East Java Indonesia. *Technology Reports of Kansai University*, *63*(2), 7204-7216. DOI:10.13140/RG.2.2.32057.90721

I Nyoman Pujawan. (2010). *Supply chain management* (2nd ed.). Guna Widya.

Isa, M., Sugiyanto, F. X., & Susilowati, I. (2015). Adaptation and mitigation model for people to restore their ecosystem from flood in Semarang, Indonesia. *Jurnal Ekonomi Pembangunan*, *16*(2). https://doi.org/10.23917/jep.v16i2.1461.

Isa Muzakar, M. Farid Wajdi, Mabruroh & Siti Fatimah Nur Hayati. (2021). Sustainability of rice business in flood-prone areas. *Journal of Environmental Research, Engineering and Management, 77*(4), 6-18. http://dx.doi.org/10.5755/j01.erem.77.4.28096.

Itano, David, G., Kim, N., & Holland, B. (2000). Movement and vulnerability of bigeye (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*) in relation to FADs and natural aggregation points. *Aquatic Living Resource, 13*(2000), 213-223. DOI: 10.1016/S0990-7440(00)01062-7

Karningsih, P. D., Anggrahini, D., Kurniati, N., Suef, M., Fachrur, A. R., & Syahroni, N. (2018). Mapping risks of Indonesian tuna supply chain. *IOP Conference Series: Materials Science and Engineering*, *337*(1). https://doi.org/10.1088/1757-899X/337/1/012035

Luni, P., Keshav, L. M., & Dan Niraj, P. J. (2012). Vulnerability of rural households to climate change and extremes: Analysis of Chepang households in the mid-hills of Nepal. In *Prosiding, the International Association of Agricultural Economists* (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, August, pp. 18-24. DOI: 10.22004/ag.econ.126191

Luers, A. L. (2005). The surface of vulnerability: An analytic framework for examining environmental change. *Global Environmental Change*, *15*, 214-223. https://doi.org/10.1016/j.gloenvcha.2005.04.003

Macusi, D. E., Rollan, C. G., & Mudjekeewis, D. S. (2021). Vulnerability drivers for small pelagics and milkfish aquaculture value chain determined through online participatory approach. *Marine Policy*, *133*, 104710. https://doi.org/10.1016/j.marpol.2021.104710

Marimin, Taufik Djatna, Syarif Hidayat, Didit N Utama & Retno Astuti, S. M. (2013). *Teknik dan analisis pengambilan keputusan fuzzy dalam Manajemen Rantai Pasok* (Technique & analysis of fuzzy decision making on Supply Chain Management) (1st ed.). IPB Press.

Ministry of Marine Affair and Fishery. (Kementerian Kelautan dan Perikanan) (2018). *Satu Data Produksi Kelautan dan Perikanan Tahun 2017 (One data of production in Marine & Fishery Year 2017)*.

Pusat Data Statistik dan Informasi KKP (Central Data of Statistic & Informastion of Ministry & Marine Affair). www.kkp.go.id

Ministry of Marine Affair and Fishery. (Kementerian Kelautan dan Perikanan) (2020). *Satu Data Produksi Kelautan dan Perikanan Tahun 2017 (One data of production in Marine & Fishery Year 2019)*. Pusat Data Statistik dan Informasi KKP (Central Data of Statistic & Informastion of Ministry & Marine Affair). www.kkp.go.id

Nguyen, H. T. (2019). *Global supply chain and logistics management*. Rohini, Delhi, India: Academic Publication.

Ostlund, E., Lisa Kidd, Yvone, W., & Neneh, R. D. (2011). Combining qualitative and quantitative research within mixed method research designs: A methodological review. *Journal Nurse Stud. March*, *48*(3), 369-83. DOI: 10.1016/j.ijnurstu.2010.10.005

Poh, L. M., & Sabri, M. F. (2017). Review of financial vulnerability studies. *Archives of Business Research*, *5*(2), 127-134. URL: http://dx.doi.org/10.14738/abr.52.2784.

Roberson, Chris Wilcox, Germain Boussarie, Emma Dugan, Cristina Garila, Kristofer Gonzalez, Madeline Green, Salit Kark, Kristin Kaschner, Carissa J. Klein, Yannick Rousseau, Dan Vallentyne, James E. M. Watson & Jeremy J. Kiszka. (2022). Spatially explicit risk assessment of marine megafauna vulnerability to Indian Ocean tuna fisheries. *Fish and Fisheries*. John Wiley & Sons Ltd.

Rudberg, M., & Olhager, J. (2003). Manufacturing networks and supply chains: An operations strategy perspective. *Omega*, *31*(1), 29-39. https://doi.org/10.1016/S0305-0483(02)00063-4

Satria, D., & Elton Li. (2016) Contract engagements in the small-scale tuna-fishing economies, East Java, Indonesia. *Bulletin of Indonesian Economical Studies*. DOI: 10.1080/00074918.2016.1198467

Statistics, Central Beureau. (*Biro Pusat Statistik*). (2020). https://www.bps.go.id/

Su, Q., Song, Y. Tao, Li, Z., & Dang, J. xiang. (2008). The impact of supply chain relationship quality on cooperative strategy. *Journal of Purchasing and Supply Management*, *14*(4), 263-272. https://doi.org/10.1016/j.pursup.2008.08.002

Thibaut, J. W., & Kelley, H. H. (1959). *The social psychology of groups*. NY: John Wiley & Sons.

Wagner, S., & Neshat, N. (2012). A comparison of supply chain vulnerability indices for different categories of firms. *International Journal of Production Research*, *50*(11), 2877-2891. https://doi.org/10.1080/00207543.2011.561540

Weis, S. W., Agostini, V. N., Roth, L. M., Gilmer, B., Schill, S. R., Knowles, J. E., & Blyther, R. (2016). Assessing vulnerability: An integrated approach for mapping adaptive, sensitivity, and exposure. *Climate Change, 136*, 615-629. https://doi.org/10.1007/s10584-016-1642-0

Thapa, T. L., C. Bhattai, & B. Khatri. (2018). Supply chain analysis of rice sub-sector in Dang District, Nepal. *International Journal of Applied Science & Biotechnology, 6*(4), 319-326 DOI: https://doi.org/10.3126/ijasbt.v6i4.22109

Verbano, C., & K. Venturini. (2013). Managing risks in SMEs: A literature review and research agenda. *Journal of Technology Management & Innovation, 8*(3), 186-197. DOI:10.4067/S0718-27242013000400017