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Supply Chain Development of Tuna Fishery in Bulukumba Regency, South Sulawesi Province

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ABSTRACT
Bulukumba Regency is the highest contributor to tuna production in South Sulawesi in 2023 (Fisheries Statistics, 2023), with a tuna resource utilization rate of around 55% of the permitted catch (JTB), which means it can still be increased. However, 40-60% of tuna production landed in Bulukumba Regency experiences a decline in meat quality, causing losses to various stakeholders, such as fishermen, distributors, and exporters. This research, with a qualitative-quantitative descriptive approach, was carried out to determine supply chain development optimization strategies using FFA (Field Force Analysis) analysis to find the driving and inhibiting factors that have the most influence on tuna fisheries supply chain management. It was determined that the Bulukumba Regency tuna fishery supply chain consists of six routes. Nine driving factors were found with a value of 68.36, such as adequate workforce and high market demand.14 inhibiting factors were found with a value of 67.46. The priority strategic direction that can be taken is development and education regarding innovation and fish handling methods for fishermen. The results of this research support the sustainable development goals program related to improving people's health and welfare, eliminating poverty, decent work and economic growth, as well as responsible consumption and production.

INTRODUCTION

Indonesia is among the world's top seven countries producing captured fisheries with a contribution of almost 50 percent of total production **(FAO, 2020)**. According to **Wulandari and Karawang (2023)**, Indonesia has a very high demand for fishery products. As one of the largest exporters of fishery commodities in the world, Indonesia has a superior commodity, namely tuna, which is the main commodity in exports and contributes to an increase in exports of more than 18.57 % of the average. Tuna fish has high economic value and it spreads throughout almost all Indonesian waters, so this provides an opportunity for Indonesia to improve its economy by utilizing its fisheries resources.

Bulukumba Regency in South Sulawesi province is in the 10th place with the highest tuna production in Indonesia. Based on 2023 fisheries statistical data, Tables (1, 2) show that Bulukumba Regency is the area that produces the largest tuna fish in South Sulawesi Province with a contribution of 47.16%, namely 12,899.2 tons of the total amount of tuna production in South Sulawesi Province in the third quarter of 2023, with an average contribution from 2019-2023 of 47.15%. The following is a list of districts that contribute to the amount of tuna production spreading across South Sulawesi in 2019-2023.

Table 1. Percentage of Regency tuna production contribution to South Sulawesi in 2019-2023

No	Year	Regency			
		Bulukumba	**Bone**	**Sinjai**	**Luwu**
1	2019	42.81%	20.63%	8.45%	11.28%
2	2020	42.82%	23.15%	12.77%	11.55%
3	2021	49.92%	15.00%	7.31%	10.89%
4	2022	53.02%	18.23%	17.32%	11.24%
5	2023	47.16%	13.74%	20.22%	4.36%
TOTAL		**47.15%**	**18.15%**	**13.21%**	**9.87%**

Source: South Sulawesi Fisheries Statistics Book 2017-2022

Table 2. Total contribution of regency tuna fish production to South Sulawesi in the third quarter of 2023

No	Regency	Volume production (ton)
1	Bulukumba	12,899.2
2	Bone	3,759.4
3	Sinjai	5,529.8
4	Luwu	1,193.4
5	Pare Pare	683.3
6	Selayar Island	634.3
7	Wajo	6.7
8	Makassar City	90.3
9	Pangkajene Island	56.6
10	North Luwu	6.0
Total volume		**24,859.0**

Based on the data in Tables (1, 2), tuna fisheries in Bulukumba have a great potential to be optimized. According to the **Radar Selatan Fajar article (2023)**, in general, this tuna catch can only meet the local market in Indonesia. If it is exported abroad, such as in Japan, the price can be higher with the condition that the quality must be grade A and B. This happens because the requirements for exporting tuna and other fish abroad are not fulfilled due to the quality after the catch by fishermen is generally only at grade C level and D. For example, the price of grade A tuna is 135 thousand per kilogram, but because so far the quality of fishermen's catch is generally only grade D and C, and thus the highest selling price is only 45 thousand per kilogram. This gap in fish quality is a problem facing fishermen or fish entrepreneurs in Indonesia in case they want to export fish. From these facts, it can be concluded that there is a problem in handling the supply chain and the marketing of tuna, and from the existing potential, tuna fisheries in Bulukumba Regency should become one of the commodities that must be paid attention to and can become a source of pride for the region improving the welfare of the community.

Najamuddin (2014) reported that fisheries business activities are an agribusiness system consisting of five subsystems: (1) fisheries ecosystem, (2) production, (3) processing, (4) marketing, and (5) supporting subsystems. The fisheries ecosystem subsystem includes fisheries habitat and resources, which are the fundamental basis for the sustainability of fisheries businesses

Supply chain management in fresh tuna commodity fisheries is indispensable because tuna commodities have high demand, economic value, and great benefits for fishermen and the community. Proper supply chain management in the tuna fisheries sector in Bulukumba Regency to add value, maintain stock and quality, and be easily accessible to the public needs attention. Catch production is strongly influenced by the demand for a commodity **(Prayoga *et al.*, 2018).**

Studies related to future fisheries development through alternative solutions that are suitable to potencies and existing conditions are still very necessary. In this research, an assessment was carried out regarding strategies for optimizing the development of tuna fisheries. Analyzing tuna fisheries supply chain activities based on driving and inhibiting factors would provide information needed for optimization strategies for future tuna fisheries development **(Fatih, 2010).**

MATERIALS AND METHODS

1. Study area

Determining the research area was carried out using a purposive method. The research location focused on 4 tuna center sub-districts in Bulukumba Regency, namely the fish dock/port in Bontobahari District, Bonto Tiro District, Herlang District, and Kajang District as well as the Makassar Industrial Area (KIMA) in Makassar City, South Sulawesi Province. The location selection was based on the fact that Makassar City is the center for processing and exporting tuna fish and Bulukumba Regency is the district with the highest tuna production in South Sulawesi Province, which is a leading national commodity. However, based on the results of interviews, around 40-60% of Bulukumba's total tuna production ran into a drastic decline in meat quality until it reached Grade D. Therefore, it is necessary to know the management of each tuna fishery supply chain to find out the problems that occur.

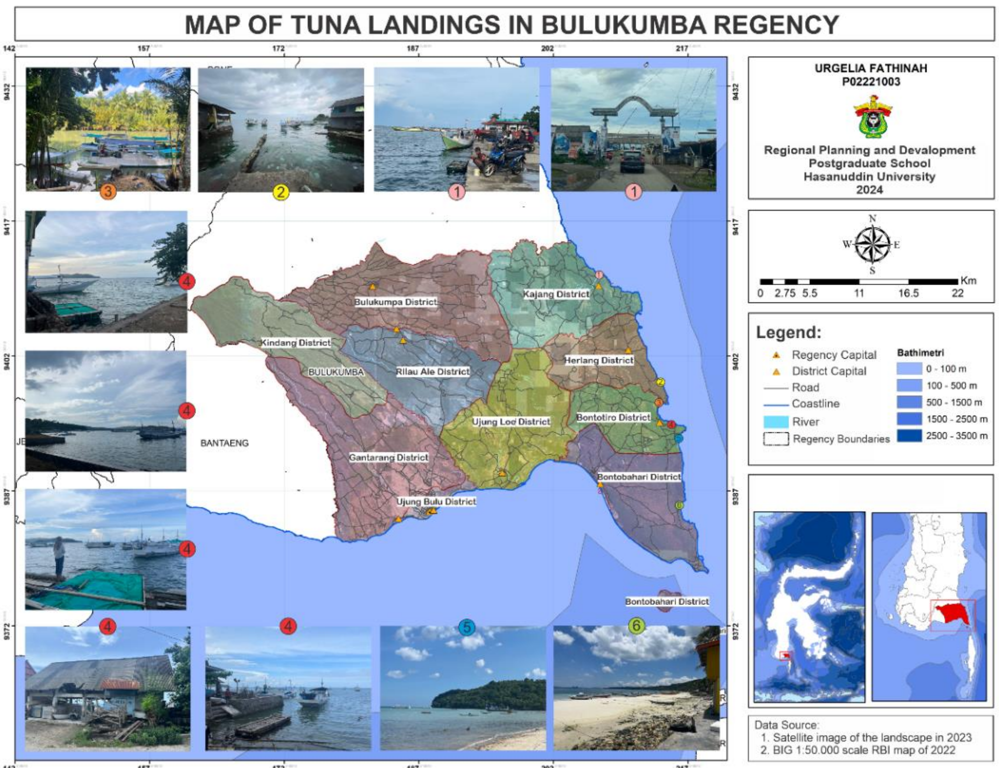

Fig. 1. Research locations in Bulukumba Regency

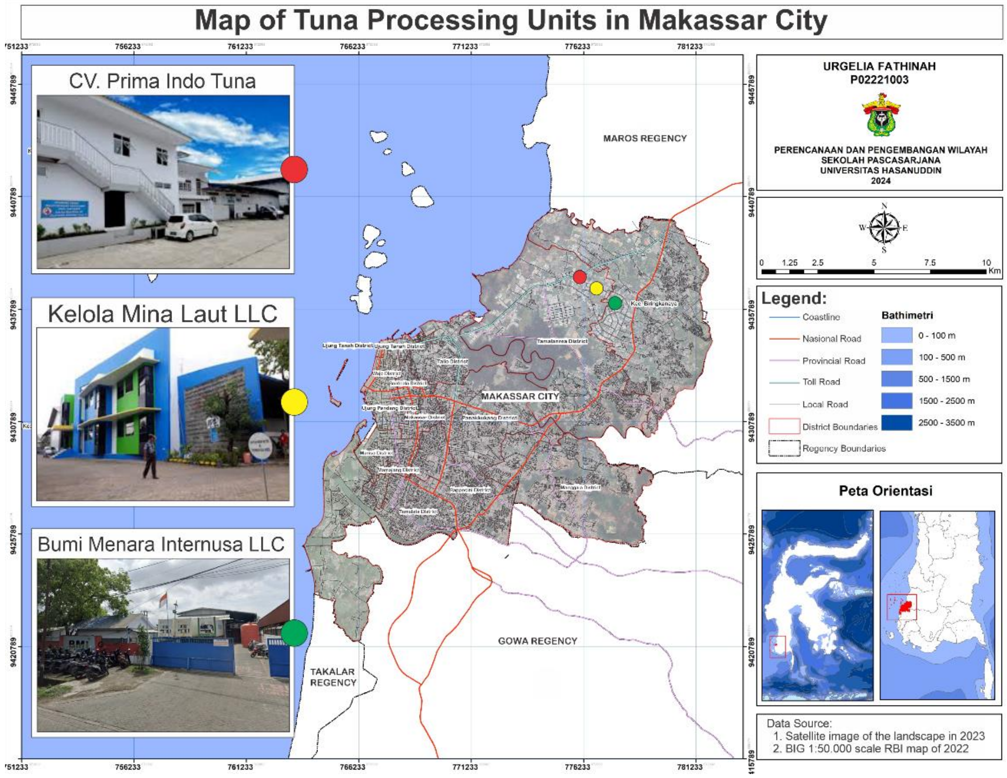

Fig. 2. Research locations in Makassar City

2. Data collection and sample method

The sample in this research was determined using the snowball sampling method, which is one of the most popular sampling methods in qualitative research **(Parker *et al.*, 2020)**. This sampling method is illustrated like a snowball because, technically the sample is obtained on a rolling basis from one respondent to the next **(Lenaini, 2021).** This method is a non-probability sampling method (samples with unequal probabilities), where this kind of sampling procedure is specifically used for community/group data from respondents/samples. In other words, snowball sampling is a method of taking samples in a chain manner **(Salganik & Douglas, 2007)**. The appropriate population for snowball sampling is a group with a single personality or the same characteristics **(Supriyanto, 2006)**. Sampling begins with determining the key person (Q person) to start conducting interviews or observations.

The Q person chosen in this research is the staff of the Bulukumba Regency Fisheries and Maritime Service who has data regarding groups of tuna fishermen, tuna collectors, MSME fish processors (Micro, Small, and Medium Enterprises), and Fish Processing Units, traders/exporters who received tuna fish from Bulukumba Regency.

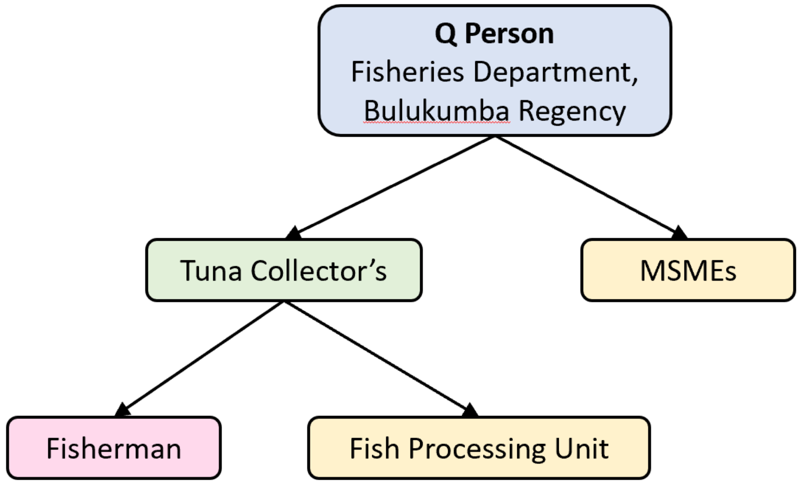

Fig. 3. Snowball sampling diagram of this research

The number of respondents obtained was 1 from the Bulukumba Fisheries Service (Q Person), 7 from fish collectors, 40 from tuna fishermen, 2 from the MSMEs group, and 3 from the Fish Processing Unit. These respondents are needed to know the current condition of the tuna supply chain. The primary data needed is the supply chain flow starting from:

- The production stage includes production numbers, human resources, infrastructure, management, regulations, institutions and science and technology
- The collecting stage includes the amount of tuna supply, human resources, infrastructure, management, regulations, institutions, and science and technology
- The processing stage includes the amount of tuna supply, human resources, infrastructure, management, regulations, institutions, and science and technology
- The marketing stage includes traders, exporters, consumers, human resources, infrastructure, management, regulations, institutions and science and technology

3. Research procedures

This research uses a qualitative-quantitative descriptive approach to describe the optimization of tuna fisheries supply chain development in Bulukumba Regency. According to **Nazir (2014),** descriptive analysis is a method for examining the status of a group of people, an object, a set of conditions, a system of thought, or a class of events in the present. Meanwhile, to determine the optimization strategy for developing the tuna fisheries supply chain, researchers used FFA analysis (Field force analysis), where this analysis was used to determine the strategy for optimizing the tuna fisheries supply chain in Bulukumba Regency on a regional basis. Giving a score to each factor is based on its level of importance/urgency, level of support for the goals to be achieved, and the level of interrelationship between each factor, so that we can find the driving and inhibiting factors that have the most influence on tuna fishery supply chain management. According to **Entang and Sianipar (2003)**, the stages in FFA analysis are as follows:

a. Identify Encouraging and Inhibiting Factors

The assessment of the factors was carried out qualitatively which was quantified using the Likert scale method, namely:

b. Assessment of Encouraging and Inhibiting Factors

1) Determination of Urgency Value (UV) and Score Factor (SF).

2) Determination of Support Value (SV) and Support Score Value (SKV).

3) Determination of Linkage Value (LK) Determination of TLV (Total Linkage Value)

4) Average Linkage Value

5) Linkage Score Value

6) Determining the Total Factor Score Value

c. Determination of SKF (Success Key Factor) and Force Field Diagrams

1) Ways to determine SKF include the following:

a) Selected based on the largest Total Score Value (TSV)

b) If TSV is the same, choose the largest SF

c) If SF is the same, choose the largest SKV

d) If the SKV is the same then choose the largest LSV

e) If LSV is the same, choose based on experience and rationality considerations.

2) Force Field Diagram

If the TSV of the driving factors is greater than the TSV of the inhibiting factors, it means that the system has an advantage in its development, in other words, it is prospective for development. On the other hand, if the number of TSV driving factors is smaller than the TSV inhibiting factors, the system is no longer prospective for development.

RESULTS

Tuna fishing centers in Bulukumba Regency are in 4 (four) sub-districts, namely Bontobahari District, Bonto Tiro District, Herlang District, and Kajang District. The tuna fisheries supply chain scheme can be seen in the following picture:

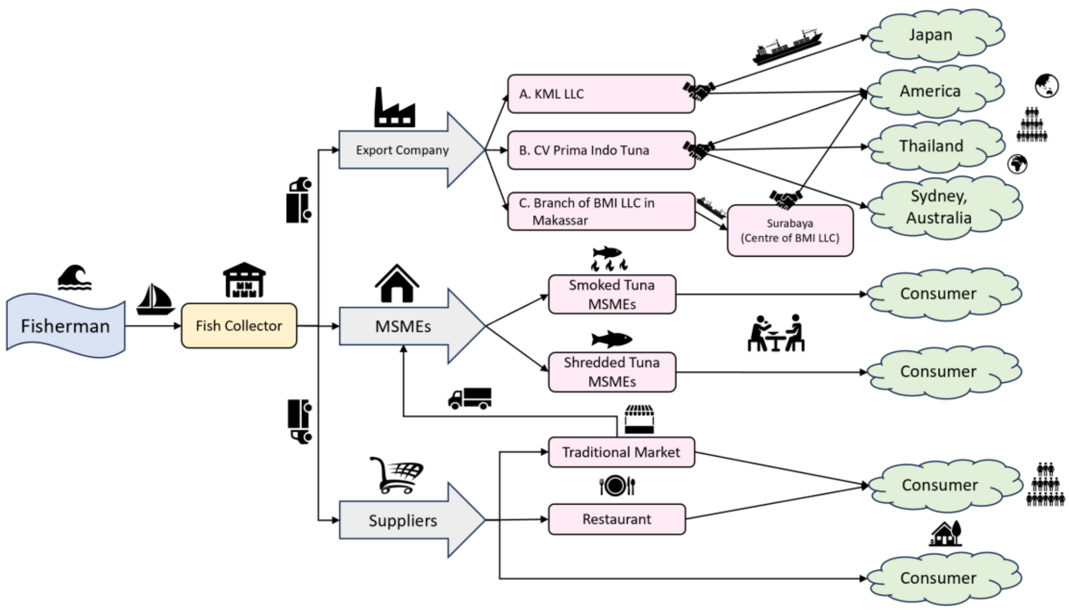

Fig. 4. Tuna fisheries supply chain flow in Bulukumba Regency

Based on the 2021 fisheries statistics report, the amount of tuna exports in South Sulawesi Province was 1,880.1 tons with a value of 17,766,835.0 USD. Until now, the demand for foreign tuna has been very high. Thus, the development of tuna fisheries deserves serious attention.

Based on Fig. (4), the tuna fisheries supply chain is divided into 6 (six) paths as follows:

1. Fisherman – Collector – Exporter – Consumer
2. Fishermen – Collectors – MSMEs – Consumers
3. Fishermen – Collectors – Suppliers – Traditional Markets – MSMEs - Consumers
4. Fishermen – Collectors – Suppliers – Traditional Markets - Consumers
5. Fishermen – Collectors – Suppliers – Restaurants – Consumers
6. Fisherman – Collectors – Supplier – Consumer

Fig. (4) shows that the tuna supply chain in Bulukumba Regency has quite a long flow. Starting from the fishermen catching the fish, which takes a long time (2-17 days), then selling it to collectors/fishermen as whole fish, then taking it to processing companies/exporters. Tuna fish that are categorized as Grade A/B, Grade C, Grade D1 sashi, and Grade D2 white will be processed into 2 parts, namely natural tuna loin and CO (carbon monoxide) treated tuna loin. Natural tuna loins are usually ordered by buyers from Japan who will be processed into tuna slices and hazai (leftover pieces from slices), while CO-treated loins are requested by buyers from America, Thailand, and Australia which they then process into pocket tuna, tuna cubes and ground beef. Tuna loin treated with CO is a tuna loin that is injected/sprayed using CO (Carbon Monoxide) compounds which function to maintain the natural red color of tuna meat. A small number of buyers from export destination countries ask for Grade D quality, but most will prefer high quality (Grades A and B). Meanwhile, tuna with a grade that is not in the export category, or in other words, does not meet export quality will be sold to suppliers who will sell it directly to traditional markets, local communities, or restaurants. Some whole tuna fish from collectors or markets are purchased by tuna fish processing MSMEs, such as smoked tuna and tuna shredded processing. Based on the analysis of existing conditions in the tuna fisheries supply chain above, it is known that this tuna fishery has great potential for development. However, several problems cause the development of the tuna fisheries supply chain to be nonoptimal.

Currently, from an economic and quality perspective, the tuna that makes the best contribution is the exporter route. Because at the exporter stage, only grade A, B, and C quality tuna fish are accepted and get high prices, while grades C and D quality go to MSMEs and suppliers. Even though the price of tuna at the exporter route is higher, fishermen have not been able to maintain the quality of the fish because the fact in the field is that the number that meets this grade is still limited.

The force field analysis (FFA) technique states that a system in a state of equilibrium occurs because a balance of factors plays a role in the system **(Sianipar and Entang, 2003)**. The factors that play a role in the system consist of driving and inhibiting factors. Driving factors will strengthen the balance toward what is desired, in the form of strength (strength) and opportunity (opportunity), which in this research are represented by variables D1 to D8. Inhibiting factors (will hinder the balance from moving away from what is desired, either in the form of Weakness (weakness) or Threat (constraint), which in this research is represented by variables H1 to H13. An overview of the driving and inhibiting factors along with the value of the encouragement and obstacles is presented in Table (3).

Table 3. Supporting and inhibiting factors in the tuna fisheries supply chain in Bulukumba Regency

No.	Supporting factors	TSV	No.	Inhibiting factors	TSV
	Strength			*Weakness*	
D1	The number of human resources/labor in each supply chain is sufficient	12.80	**H1**	Production: Lack of fishing skills	8.15
D2	Production: High tuna production yields	9.35	**H2**	The road infrastructure from the fish landing site to the city center is narrow and poor	7.84
D3	Processing (UPI): The production process for export follows applicable standards	7.87	**H3**	Collector: Cold storage/warehouse infrastructure is inadequate	7.80
D4	There is government program support to increase the number of FADs	5.35	**H4**	Production: Fishing facilities and infrastructure are inadequate	7.24
D5	Collector: District Collector. Bulukumba can accommodate large numbers of fish	3.99	**H5**	Production: The fishing point is far from the fish landing place	6.09
D6	Production: Strong fishermen group institutions	0.76	**H6**	Production: PPI facilities and infrastructure are inadequate	5.81
			H7	Production: One trip takes a long time (5-17 days)	4.32
			H8	MSME Processing: Tuna fish processing infrastructure is inadequate	4.18
			H9	MSME Processing: The production process does not comply with SNI (Indonesian National	3.42

				Standard)	
			H10	Production: Fishermen still use traditional methods to find fishing points	1.17
	Total strength	40.12		Total weakness	56.02
	Opportunities			*Threats*	
D5	Marketing: High and broad foreign and domestic market demand	10.99	**H10**	Production: Fuel and block/bulk ice supply is unstable	4.96
D6	The entire area is covered by road access, communication networks, electricity and clean water	6.75	**H11**	Production: Fishermen's catches are uncertain/fluctuation	3.56
D7	Production: MSY of Flores sea tuna is still 44%	5.57	**H12**	Collector: The distance from the warehouse to UPI is quite far and takes a long time	1.98
D8	Tuna is Indonesia's leading commodity	4.93	**H13**	Marketing: The export distribution process to America increased due to the Israeli-Palestinian war	0.94
	Total opportunities	28.24		Total threats	11.44
	Total opportunities factors	**68.36**		Total threats factors	**67.46**

Based on the analysis of the driving and inhibiting factors for tuna fisheries development in Bulukumba Regency in Table (3), indicates that the tuna fisheries sector in Bulukumba Regency is worth developing. The score figures for the driving factors and inhibiting factors are almost the same; this shows that there are still many problems that occur because the inhibiting factors are more significant than the driving factors. Thus, several strategies are needed to deal with various existing problems.

DISCUSSION

The key factors in optimizing the tuna fisheries supply chain development in Bulukumba Regency can be identified by determining the key success factors (KSF). This FSF is obtained by determining the variable with the highest score in driving and inhibiting factors (Table 3).

Based on the results of force field analysis (FFA), several strategies can be formulated that can be implemented according to existing conditions. The strategy that can be implemented is based on a collection of activities identified from all the problems for which a solution can be obtained. It is hoped that the supply chain optimization plan for developing tuna fisheries will spur the growth and development of other fisheries. This design links the entire chain in a system for optimizing the tuna fisheries supply chain in Bulukumba Regency. Optimization strategies that can be implemented in the development of tuna fisheries in Bulukumba Regency are as follows:

Table 4. Strategy for key success factors in the tuna fisheries supply chain in Bulukumba Regency

Internal Factor / **External Factor**	**Opportunity (O)** Marketing: High and broad foreign and domestic market demand	**Threat (T)** Production: Unstable supply of fuel and block/slurry ice
Strengths (S) The number of workers in each supply chain is sufficient	**SO Strategy:** Fulfillment of market demand both in terms of quantity and quality	**ST Strategy:** 1. Providing fuel filling facilities at each fishing-based center 2. Provision of ice factories according to the volume of ice required at each fishing center
WEAKNESSES (W) Production: Lack of fishing skills	**WO Strategy:** Guidance and counseling regarding innovation and ways of handling fish	**WT Strategy:** 1. Collaborate with provincial and national governments to ensure consistency and coordination in diesel distribution policies. 2. WT Counseling and assistance on ALDI engineering hatch cooling machine innovation (cooled sea water)

After assessing the weight of internal factors (IFAS) and external factors (EFAS), a strategic position can be made using the grand strategy matrix. The IFAS difference value is -15.90 and the EFAS value is 16.80, indicating that the position of the grand strategy for optimizing tuna supply chain development in Bulukumba Regency is in Quadrant III (Fig 4).

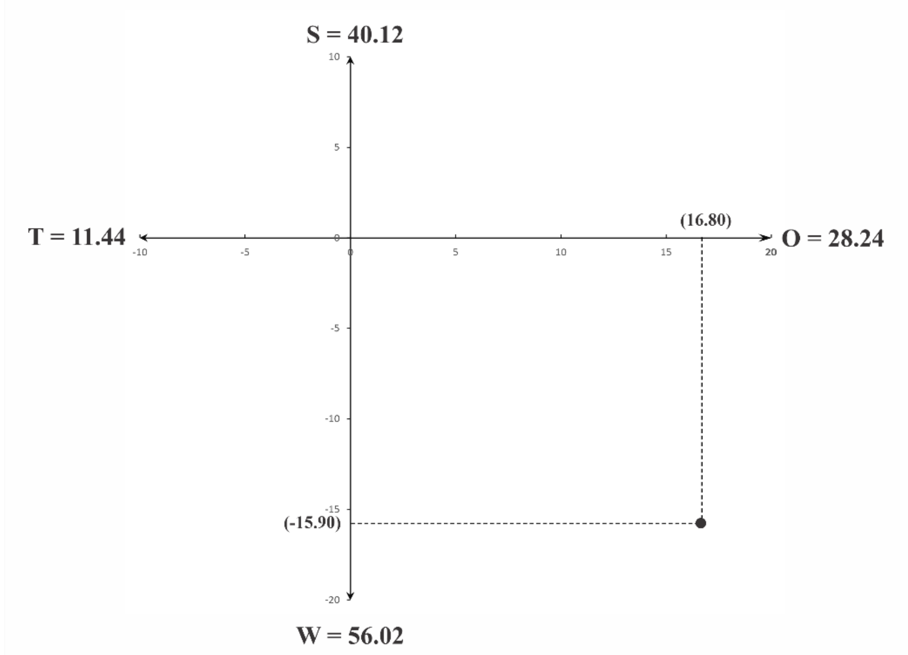

Fig. 5. Grand strategy matrix for optimizing tuna fisheries supply chain development in Bulukumba Regency

Based on the Grand Strategy matrix above, the IFAS and EFAS factors position is in the weakness-opportunity (WO) position. Quadrant III shows that key weaknesses can be combined with key opportunities as a WO strategy to create stability or rationalization or invest/divest in a certain series to achieve predetermined goals or opportunities that promise a brighter future.

1. SO strategy (Utilizing strengths and opportunities)

1.1 Fulfillment of market demand both in terms of quantity and quality

The level of utilization of potential tuna resources shows that the average tuna catch in that period was still below the permitted catch amount, thus tuna production in the District. Bulukumba can still be optimized. Fishing efforts must be appropriate in quantity, position, and time to optimally exploit tuna resources in the Flores Sea at the number of catches allowed level as revealed by the research results of **Zainuddin *et al.*, (2015)**.

Research by **Rahmawaty *et. al*. (2013)** shows that the productivity and marketing of marine products in Indonesia must be developed together with improving the quality and safety of products to increase the competitiveness of Indonesian seafood products. Increasing the overall competitiveness of marine products also requires developing production processes, post-harvest handling, and product processing so that the quality produced can compete with other exporting countries **(Sirait, 2013).**

Public demands for food safety have led importing countries to implement regulations on imported products, such as Japan with The Food Safety Basic Law which began to be implemented in 2003, and the USA with HACCP in 1997, **(Nguyen & Wilson, 2009; Juarno, 2012)**. Improving the quality of seafood products will in turn increase the competitiveness of products in the market. One of the main values that producers of a product must be able to increase their competitiveness is operational excellence, namely where producers must be able to maintain efficiency and improve the quality of the system/process that produces the product and the service system provided always to satisfy consumers.

2. WO strategy (Utilizing opportunities to reduce weaknesses)

2.1 Guidance and education regarding innovation and fish handling methods

Based on observations and interviews with fishermen, information was obtained regarding tuna handlers, starting from how to catch, kill, and store tuna that does not meet standards. For example, to kill caught tuna, fishermen hit the head repeatedly using a hammer which causes a lot of movement in the fish. Fish movements such as thrashing during capture and landing cause adenosine triphosphate (ATP) and lactic acid to accumulate, which causes a decrease in pH in the fish muscles. This change causes damage to fish flesh **(Maeda *et al.*, 2014).** Likewise, fishermen use a ratio of fish to ice of around 1: 0.5 when storing tuna, which is less than optimal for maintaining the quality of tuna meat. To maintain freshness, the internal temperature of tuna fish must be immediately reduced to 0^oC and then maintained during storage on board **(Irianto, 2008)**. Thus, fishermen must pay attention to the amount of ice appropriate to the volume of tuna obtained. In addition, they must have adequate post-catch fish handling skills.

The market price of tuna will be based on species and quality indicators, handling methods, and market conditions **(Huang *et al.*, 2011)**. Quality control issues include reductions in product quality due to fishing activities and on-board handling. The lack of sanitation and hygiene standards and facilities may be the cause, especially in the community fisheries sector **(Sunoko & Huang, 2014)**. The quality of fresh fish is affected by all aspects of handling, including catching and landing, holding before processing, and killing the fish, as well as nerve damage, bleeding, and cooling.

In the fish processing sector, it is recommended to strive to have a HAACP Certificate to increase product competitiveness because by having this certificate the product is included in the food product qualifications that meet health and food hygiene standards so that it is suitable for consumption. The fish processing industry is expected to provide regular training to employees to reduce work errors while increasing work efficiency so that the order delivery process can be shorter. Having an SOP regarding cleanliness and health in fish processing places is important because tuna is a food product that will be consumed raw or processed afterward thus a clean and healthy work process guarantees the product is free of disease germs.

Based on the Indonesian National Standard (SNI) number 7787:2013 concerning Handling fish on boats - Fresh tuna on tuna longliners, there are several steps that fishermen must take to handle tuna that has been caught so that the quality of the tuna is maintained properly.

3. ST strategy (Utilizing strengths to overcome threats)

3.1 Providing fuel-filling facilities at each fishing-based center

The lack of facilities and infrastructure at fish landing sites will have an impact on product quality and high economic costs **(Sunoko & Huang, 2014).** Therefore, in every fishing activity center, functional and supporting facilities must be available. Minister of Maritime Affairs and Fisheries Regulation Number PER.08/MEN/2012 states that provisions in planning supporting facilities for fishing ports are additional facilities needed to support fishing port activities. These functional facilities are the port administration office, fish auction site, clean water supply, fuel storage, ice depot, and parking area, each of which is calculated based on the available land area and the amount needed. The availability of fuel is very important in fishing activities. **Mullon *et al.* (2017)** included increased fuel use in future scenarios for the global tuna supply chain. According to **Tyedmers and Parker (2012)**, tuna fishers consume great amounts of fuel, and fuel costs are an important part of the total fishing costs. **Lam *et al.* (2011)** reported that fuel is only about 20% of the total cost of fish.

3.2 Provision of ice factories according to the volume of ice required at each fishing-based center

Silva *et al*. (2006) stated that high temperature is one of the parameters that causes increased histamine levels in fish. At ideal humidity and temperatures above 27˚C, microbial growth has a high rate, causing histamine levels to increase **(Wodi *et al*., 2014). Kim *et al.*, (1999)** also added that the biogenic amine compound from histamine can only be formed at an optimum temperature of 25˚C. Histamine is usually formed due to errors during the handling and processing process at temperatures above 20˚C **(Wodi & Cahyono, 2021).** This is supported by the statement **(Wang *et al.*, 2020)** that histamine produced by bacteria can be formed optimally at a temperature of 20˚C and neutral pH. This availability of ice in adequate quantities is very necessary.

An ice factory is one of the functional facilities that must be present at every fishing port to support capture fisheries activities more effectively. Vessels carrying out fishing operations require ice to handle fish on board. To produce high-quality fishery products, it is necessary to have ice as a good fish preservative. The availability of ice can be supported by the existence of an ice factory in the port area as an important facility needed to ensure sufficient ice supply for fisheries activities, especially fishing activities **(Mudjari, 2010)**.

Currently, there are only 4 ice factories in Bontobahari District and 3 ice factories in Kajang District. At the same time, Bontotiro District and Herlang District have 190 tuna fishing boats, busy fishing routines, and there are no ice factories. Hence, fishermen in this sub-district have to travel quite far to stock up on ice. The impact was that the ice purchased had melted a lot when it arrived at the ship's departure location. Based on these conditions, building an ice factory in each fishing base area is necessary by considering the amount of ice needed.

4. WT strategy (Reducing weaknesses and avoiding threats)

4.1 Collaborate with provincial and national governments to ensure consistency and coordination in diesel distribution policies

Collaboration with provincial and national governments is essential to ensure consistency and coordination in diesel distribution policies. Steps that can be taken include:

- Establishment of a Collaboration Forum: A collaboration forum can be formed between representatives from the provincial government, national government, solar industry, and civil society to discuss diesel distribution policies regularly.
- Information Exchange: Organize regular meetings among all relevant parties to share the latest information on solar distribution projects, policy changes, and other related issues.
- Joint Policy Making: Jointly develop consistent and sustainable policies regarding diesel distribution, including regulations related to financing, incentives, and quality standards.
- Infrastructure Coordination: Coordinate with the government to ensure that the infrastructure required for solar distribution, such as the power grid and energy storage, is adequate and integrated.
- Public Education: Conduct educational campaigns to increase public awareness about the benefits of solar and how to adopt it effectively.
- Regular Evaluation: Regularly evaluate existing diesel distribution policies and programs to identify successes, obstacles, and opportunities for improvement.

Strong collaboration between the provincial government, national government, and other stakeholders will help create a conducive environment for the growth of the solar energy sector and ensure its sustainability in the long term

4.2 Counseling and assistance on RSW (refrigerated sea water) engineering hatch cooling machine

According to **Blanc *et al*. (2005)**, to obtain the best quality tuna, it is recommended to use the following two-stage procedure:

- Reducing the internal temperature of tuna fish by placing it in seawater cooled with ice (RSW).

  Storing fish in a cooling hold uses a storage technique using chilled water. Storage in a hold filled with seawater and cooled using a machine and kept at a constant temperature of 0^oC. This technique is also RSW (refrigerated sea water). In the RSW technique, fishermen must continue to control the temperature, care must be taken to ensure that the fish does not freeze. This depends on the length and distance of each fishing trip. The RSW technique requires additional costs for ship operations, but this technique guarantees better fish quality **(Nurani *et al.*, 2016)**.

- After 24 hours, the tuna is transferred to the hold and then iced. Furthermore, no other treatment is needed until the tuna is landed **(Irianto, 2008)**.

  When the temperature of the tuna reaches 0^oC, the tuna is removed from the cooling container and is moved to an insulated hold. During the moving process, ganco should not be used since it can cause physical damage if pulled along the deck. In the hold, the ice and fish are arranged sequentially in layers, such as ice and fish. If more than three layers of fish are arranged, this can cause physical damage to the fish in the bottom layer due to the weight of the fish and the ice above them. Therefore, it is recommended that the fish with the largest weight be placed in the bottom layer. After icing, the fish are not treated until they are unloaded. Fish can be stored for up to two weeks with this storage method **(Irianto, 2008)**.

CONCLUSION

The Bulukumba Regency tuna fisheries supply chain consists of six routes, three routes consisting of four stratifications of market players, two routes consisting of five market stratifications, and one route consisting of six market stratifications. Currently, from an economic and quality perspective, the tuna that makes the best contribution is the exporter route. Because at the exporter stage, only grade A, B, and C quality tuna fish are accepted and get high prices, while grades C and D quality go to MSMEs and suppliers. Even though the price of tuna at the exporter route is higher, fishermen have not been able to maintain the quality of the fish because the fact in the field is that the number that meets this grade is still limited. Based on the results of the field force analysis, it is stated that the tuna fisheries sector in Kab. Bulukumba deserves to be developed. In the Grand Strategy matrix above, the position of the IFAS and EFAS factors is in the weakness-opportunity (WO) position. The strategic direction that can be taken is coaching and counseling regarding innovation and how to handle fish for fishermen

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