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Analysis of the Impact of Subsidized Fuel Oil Policy on Tuna Fisheries Business in East Morotai District, Morotai Island Regency, Indonesia

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ABSTRACT
The increase in fuel prices has an impact on fishermen's catches which has led to a decrease in fishermen's income. To overcome the increase in fuel prices, the Morotai Island Regency Government through the Fisheries and Marine Office issued a subsidized fuel policy for fishermen. The purpose of this study was to analyze the catch and income of tuna fishers based on subsidized fuel and unsubsidized fuel and also to analyze the impact of subsidized fuel and catch on the income of tuna fishers. The results showed that the amount of tuna catch, based on unsubsidized fuel, is higher compared to the amount of tuna catch depending on subsidized fuel. It is partially influenced by the distance of the fishing area and simultaneously influenced by the period of fishing, fishing trip, and distance of the fishing area. The income of tuna fishers based on unsubsidized fuel is higher than that of tuna fishers based on subsidized fuel. Fuel subsidies and fish catches significantly impact the income of tuna fishers. Specifically, fuel subsidies negatively affect fuel prices, whereas higher catches contribute positively to fishers' income.

INTRODUCTION

Morotai Island Regency is one of the regions in the northern part of North Maluku Province, Indonesia. This region is a tuna producer with a potential of 1,714,158 tons per year. The increased demand for fish has a certainly positive impact on fisheries development. However, the higher demand for a resource is followed by the higher exploitation pressure **(Irham *et al*., 2023)**. Fuel oil is a crucial component of fishing activities. If the fuel price increases, an impact would be posed on the increase in fishing operational needs (**Kamal, 2015**). It is an important component in capture fisheries since fuel accounts for 60% of the total cost of fishing operations **(Hermawan, 2006)**. The amount of fuel used for fishing activities is influenced by several factors including the size of the vessel, the period at sea, the number of fishing trips made in a period, and the distance of the fishing area.

The increase in operational costs due to the increase in fuel prices has an impact on fishermen's catches, which has led to a decrease in fishermen's income. To overcome the increase in fuel prices, the Morotai Island Regency Government through the Fisheries and Maritime Affairs Office issued a subsidized fuel policy for fishermen from October 2022 to

December 2023. This policy is expected to reduce the operational costs of fishermen to obtain good catches, which in turn can increase the income of fishermen.

The purpose of this study was to analyze the catch and income of tuna fishers based on subsidized fuel and unsubsidized fuel and to analyze the impact of subsidized fuel and catch on the income of tuna fishers.

MATERIALS AND METHODS

1. Time and location of research

This research was conducted from January to June 2024. The research location was in the East Morotai District, Morotai Island Regency, Indonesia (Fig. 1).

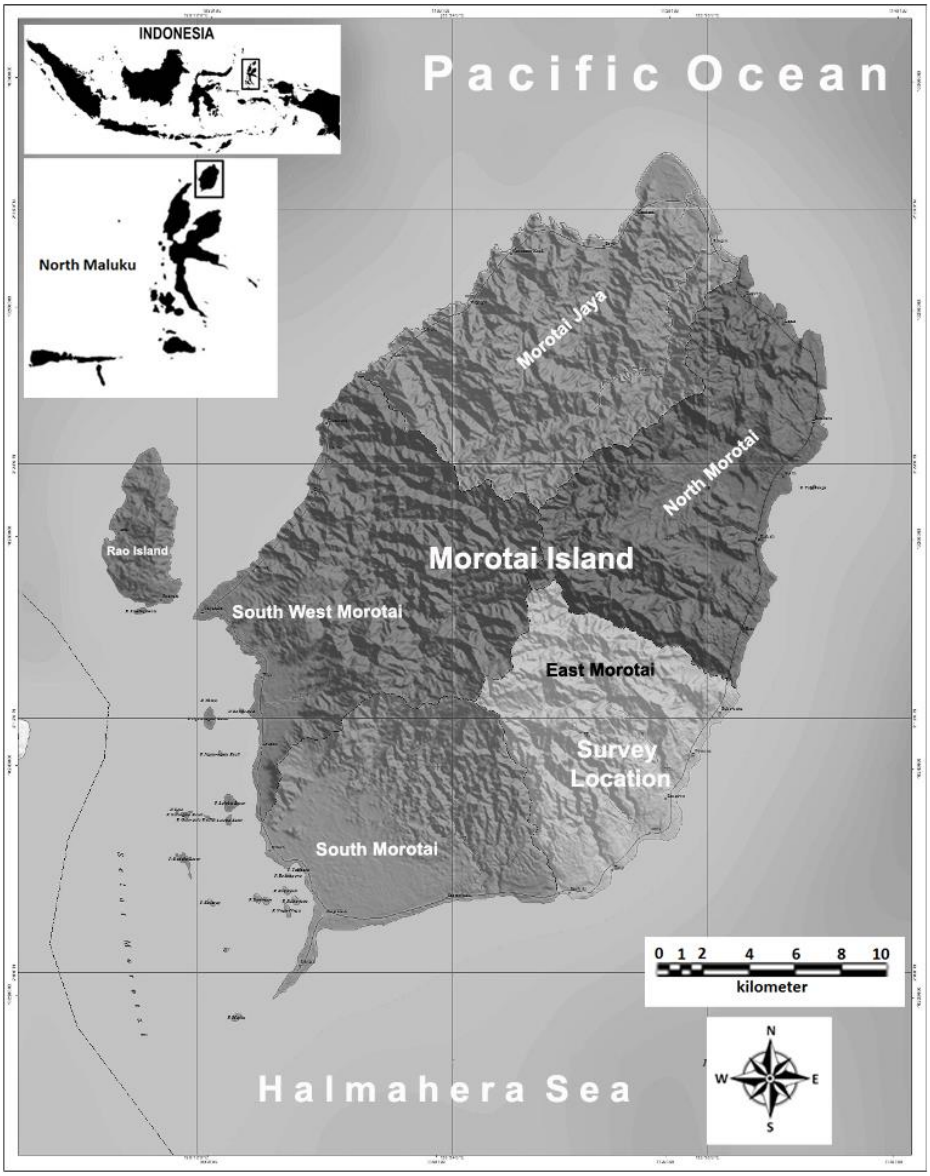

Fig. 1. Research location

2. Data collection

The data used in this study were primary and secondary. Primary data include tuna fishermen's catch data, fishing operations, fuel prices and quantities, and tuna fish commodity prices. Fishing operational data consists of the size of the ship, the period of fishing, the number of fishing trips, and the distance traveled to the fishing area. While secondary data are all data from related agencies by research needs.

The data collection technique was carried out using the purposive sampling method, where respondents were taken randomly based on a grid or boundaries determined in the study. Data collection was carried out by interview with a questionnaire guide.

3. Data analysis

The determination of respondents was carried out using the Slovin formula **(Sugiyono, 2007)**, namely:

$$n = \frac{N}{1 + Ne^2}$$

Where:

n = number of respondents

N = total number of tuna fishermen

e = confidence tolerance limit (0.1)

The effect of catch operations on catches was assessed using multiple regression analysis **(Sugiyono, 2007)**, namely:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e$$

Where:

Y = catch (kg)

β_0 = y-intercept

$\beta_1, \beta_2, \beta_3, \beta_4$ = slope coefficients for each explanatory variable

X_1 = boat size (GT)

X_2 = period at sea (hours)

X_3 = fishing trip (trip/day)

X_4 = fishing area distance (miles)

e = residual (error)

Analysis of fishermen's income was calculated using the formula:

$$\pi = TR - TC$$

Where:

π = profit

TR = total revenue

TC = total cost

The effect of subsidized fuel and catch on fishermen's income was calculated using multiple regression analysis **(Sugiyono, 2007)**, namely:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e$$

Where:

Y = fishermen's revenue (Rp)

β_0 = y-intercept

$\beta_1, \beta_2, \beta_3, \beta_4$ = slope coefficients for each explanatory variable

X_1 = catch (kg)

X_2 = amount of fuel (liter/trip)

X_3 = fuel price (Rp/trip)

e = residual (error)

RESULTS

1. Effect of fishing operations on catch

Tuna fishing operations involve several factors, including boat size (UK), fishing period (JWM), fishing trip duration (TP), and distance to fishing areas (JDP). The fishing vessels used are motorized boats with a capacity of 3 GT, measuring 8 to 12 meters in length, 1.8 to 2 meters in width, and 1 meter in height. These boats are constructed of fiberglass and are powered by outboard motors with capacities of 15 to 40 HP.

Fishing trips typically last between 12 to 24 hours, depending on the distance to the fishing area. Fishermen usually depart for distant areas around 16:00 to 17:00 WIT (afternoon), while trips to closer areas start at 21:00 to 22:00 WIT (night) to arrive before dawn. Fishing activities occur from dawn until morning, specifically from 06:00 to 09:00 WIT. After catching tuna, fishermen return, arriving between 14:00 and 17:00 WIT (Table 1).

Fishermen undertake one trip per day, as the vessels are categorized as small-scale. In a month, each vessel makes 20 to 22 trips during lean, medium, and peak seasons. The lean season lasts for three months (January to March), resulting in 60 to 66 trips per vessel per season. The medium season also spans three months (July to September), with a similar number of trips. The peak season extends over six months (April to June and October to December), allowing for 120 to 132 trips per vessel per season.

With a total of 54 fishing boats, the monthly fishing trips amount to 1,096. In the lean and medium seasons, this totals 3,288 trips per season, while the peak season sees 6,576 trips. The annual total comes to 13,152 trips.

The distance to tuna fishing areas varies from 7 to 60 nautical miles from the coastline. Tuna fishing is conducted at Fish Aggregating Devices (FADs) scattered throughout Morotai waters, located 7 to 30 nautical miles offshore. In open waters, fishermen pursue schools of tuna rays 40 to 60 nautical miles from the coastline, using kite fishing gear. The total catch is 85,500 kg during the lean season, 135,540 kg during the medium season, and 465,120 kg during the peak season, resulting in an annual total of 686,160 kg (Table 1).

Table 1. Boat size (UK), fishing period (JWM), fishing trip (TP), fishing area distance (JDP), and catch for a year on subsidized fuels (Sub) and un-subsidized fuels (U Sub)

Season		UK (GT)	Fishing operations			Catch (Kg/year)
			JWM (Hours/year)	JWM (Trip/year)	JWM (Miles)	
Famine	Sub	3	33876	1311	7 - 60	34146
	U Sub	3	44712	2007	7 - 60	51354
	Total		**78588**	**3318**		**85500**
Moderate	Sub	3	33876	1311	7 - 60	54120
	U Sub	3	44712	2007	7 - 60	81420
	Total		**78588**	**3318**		**135540**
Peak	Sub	3	67752	2622	7 - 60	185490
	U Sub	3	89424	4014	7 - 60	279630
	Total		**157176**	**6636**		**465120**
Totals	Sub		135504	5244		273756
	U Sub		178848	8028		412404
	Total		**314352**	**13272**		**686160**

Based on the results of the study, it was shown that partially the operational variable that affects the catch is the distance of the catch area (JDP), with a significant value of 0.000 < 0.05 and tit > ttab, namely 6.810 > 2.021. Simultaneously, the findings showed that the three variables, namely the period of fishing, fishing trips, and distance of the fishing area, have a significant effect on catches with a significant value of 0.000 < 0.05 and Fhit > Ftab, namely 53.149 > 2.56. The R^2 value of 0.761 indicates that the three operational variables significantly influence 76.1% of the catch, while the remaining 23.9% is affected by other factors.

Fuel oil requirement

Fuel requirements for tuna fishing depend on various factors, including vessel type, fishing distance, and the number of fishing trips. For 54 vessels, the fuel consumption ranges from 50 to 150 liters per trip per day, resulting in a total fuel need of 3,680 liters per trip per day. Monthly fuel needs vary based on the number of trips, which is typically 20 to 22 trips per month. During the lean and medium seasons, the fuel requirement is 226,076 liters each, while during the peak season, it rises to 452,153 liters. Consequently, the total annual fuel demand is 904,306 liters.

The government subsidizes 360,960 liters of fuel, accounting for 39.81% of the total fuel needs of fishermen. The remaining unsubsidized fuel requirement is 543,346 liters, or 60.19% (Table 2).

Table 2. Fuel requirements for tuna fishing activities

Season	Fuel requirement (Liter)		Total
	Subsidized	Unsubsidized	
Famine	90240	135836	226076
Moderate	90240	135836	226076
Peak	180480	271673	452153
Total	**360960**	**543346**	**904306**

2. Fishermen's income

Fishermen's income is divided into 2 approaches, namely income based on subsidized fuel and income based on unsubsidized fuel. The total income of fishermen is obtained from the sum of the two types of income based on the fishing season (Table 3).

Based on the results, the total income of fishermen in the lean season was recorded to be Rp. 2,793,558,600 or $ 174,597.41; the medium season recorded was Rp. 4,428,525,528 or $ 276,782.85, and the peak season was assessed to be Rp. 15,196,958,784 or $ 949,809.92. Therefore, the total amount of income for a year is Rp. 22,419,042,912 or $1,401,190.18.

The total expenditure of fishermen in the lean season and medium season is Rp. 3,706,704,000 or $ 231,669 respectively, and the peak season is Rp. 7,413,408,000 or $ 463,338. Threrefore, the total amount of expenditure for a year is Rp. 14,826,816,000 or $926,676.

Based on the research results, it showed that in the lean season, fishermen experience losses, while in the medium and peak seasons, fishermen experience profits. Overall for a year, fishermen experienced a profit of Rp. 7,592,226,912 or $ 474,514.18 (Table 3).

Table 3. Total revenue, cost, and profit for a year on subsidized fuel (Sub) and un-subsidized fuels (U Sub)

Season		Revenue		Cost		Profit	
		(1000*Rp)	($)	(1000*Rp)	($)	(1000*Rp)	($)
Famine	Sub	1115659	69,729	1187064	74,192	-71405	-4,463
	U Sub	1677900	104,869	2519640	157,478	-841740	-52,609
	Total	**2793559**	**174598**	**3706704**	**231670**	**-913145**	**-57072**
Moderate	Sub	1768274	110,517	1187064	74,192	581210	36,326
	U Sub	2660252	166,266	2519640	157,478	140612	8,788
	Total	**4428526**	**276783**	**3706704**	**231670**	**721822**	**45114**
Peak	Sub	6060552	378,784	2374128	148,383	3686424	230,401
	U Sub	9136407	571,025	5039280	314,955	4097127	256,070
	Total	**15196959**	**949809**	**7413408**	**463338**	**7783551**	**486471**
Totals	Sub	8944485	559,030	4748256	296,766	4196229	262,264
	U Sub	13474558	842,160	10078560	629,910	3395998	212,250
	Total	**22419043**	**1401190**	**14826816**	**926676**	**7592227**	**474514**

3. Effect of subsidized fuel and catches on fishermen's income

Fishermen's income is determined based on the amount of catch that is influenced by fishing operations, one of which is fuel oil. Fuel subsidy is one of the solutions to ease the

operational costs of fishing. Therefore, the research analyzed the extent to which the influence of fuel subsidies and catches on fishermen's income. The determining variables used are the amount of fuel, fuel price, and catch, while the dependent variable is the fishermen's income.

Based on the results of the study, it showed that the variables that affect fishermen's income were catch and fuel prices. Partially, the catch has a significant effect on fishermen's income with a significant value of 0.00 < 0.05 and tit > ttab, namely 150.546 < 2.021. While the price of fuel hurts fishermen's income with a significant value of 0.670> 0.05 and thit < ttab, namely -0.428 < 2.021. Simultaneously, it was noticed that the variables of catch and fuel price have a significant effect on the catch, with a significant value of 0.000 < 0.05 and Fhit > Ftab, namely 64022.08 > 2.56. The R^2 value of 1.00 indicates that these two variables have a complete 100% effect on fishermen's income.

DISCUSSION

1. Effect of fishing operations on catch

Tuna fishing operations consist of vessel size, fishing period, fishing trips, and fishing area distance. A 3 GT vessel size can usually carry a catch of about 1- 2 tons of fish, depending on the species and fishing method. This capacity includes fuel, gear, and catch. The number of crew or fishermen in the fishing process is 2- 3 people, with 1 person acting as a motorist. The advantages of an Outboard Motor are that it is easy to install and remove, allows use on various types of boats (Flexibility), is easier to repair and maintain compared to a permanently installed engine, can be moved from one boat to another, and does not take up space in the boat because it is installed outside. The stability of the ship is determined by the width and height of the ship, if the width and height values increase, it will make stability good; while on the other hand, result in deteriorating propulsive ability **(Ellies, 2012; Siswandi & Satria, 2020)**.

In the process of tuna fishing the season greatly affects the catch, the lean season runs for 3 months from January to March, the medium season also runs for 3 months from July to September, and the peak season runs for 6 months from April to June and from October to December.

The tuna fishing season in each water body or region has a different season, such as in the Flores Sea, Selayar Islands Regency, the most productive fishing season occurs in September - November, and the lowest fishing season occurs in December - May **(Safruddin *et al*., 2015)**. In Maluku waters, the most productive fishing season occurs in January - May and November - December, while the lean season is in June - October (**Lintang *et al*., 2012**). In the waters of Bone Bay, the productive fishing season occurs in April **(Novitasari *et al*., 2022)**.

The distance of tuna fishing grounds varies greatly depending on the species of tuna targeted, the type of vessel, and the fishing method used. Tuna are large pelagic fish that migrate in the open ocean, therefore their fishing grounds can include coastal waters to deep

sea waters. Based on the study results, fishermen from Sangowo Village conduct tuna fishing in FAD areas and open waters by pursuing schools of tuna.

The distance of the fishing area has a major influence on the use of fuel oil in tuna fishing operations. Longer trips, longer duration of operations, more severe sea conditions, and intensive fishing methods all contribute to increased fuel consumption. Thus, operational efficiency, technology utilization, and appropriate vessel selection are important factors in effectively managing fuel use in the tuna fishing industry **(Suryanto & Wudianto, 2017; Yanti *et al*., 2023)**.

Partially, fishing distance has a significant effect on catch. Fishing grounds farther from shore often offer more abundant and diverse catches than those closer to shore. This is due to several factors, including the lack of overfishing pressure in more distant areas and more stable and less disturbed ecosystems (**Collette & Nauen, 1983; Pauly & Zeller, 2016**).

In addition, deeper waters are usually home to a variety of fish species that are of high economic value and less accessible to fishers using simple fishing gear. However, fishing in more distant areas also requires higher operational costs, such as fuel and longer travel time, so fishers must consider the economic benefits. In addition, weather conditions and safety are also important considerations. Therefore, strategies for selecting the distance of fishing grounds must be done carefully to ensure optimal catches and sustainability of fishery resources (**Jennings *et al*., 2001**).

2. Fuel oil requirement

The types of fuel oil used by fishermen are Pertalite and Pertamax. Pertalite is a type of fuel subsidized by the Morotai Island Regency Government to fishermen spread across 3 sub-districts. Pertamax fuel type is an alternative fuel for fishermen when there is scarcity or insufficiency of subsidized fuel.

For the tuna fishermen, the fuel needs are not fully met by the local government's fuel subsidy program, which covers only 39.81% of their total requirements. To make up for this shortfall, fishermen purchase Pertamax fuel at varying prices; Pertalite, the subsidized fuel, costs Rp. 10,000 per liter, while the retail price of Pertamax is Rp. 15,000 per liter. This insufficiency in subsidized fuel affects the number of fishing trips: fishermen typically make 8 to 9 trips per month using subsidized fuel and 12 to 14 trips when using Pertamax.

Fuel subsidies have a significant influence on tuna catches for fishers. With fuel subsidies in place, fishers can reduce the operational costs associated with traveling long distances to fishing grounds that are richer in tuna populations. Lower fuel costs allow fishers to spend more time at sea, increasing their chances of securing larger and higher quality catches. In addition, with the savings in fuel costs, fishers can invest in advanced technologies such as sonar and GPS that help them locate and catch tuna more efficiently. This not only increases the amount of catch but also reduces the time and effort required to fish **(Gigentika *et al*., 2017)**.

Another impact of fuel subsidies is the ability of fishers to operate vessels more frequently and for longer, which directly contributes to the increased catch volumes. In the long term, fuel subsidies can help fishers sustain tuna populations by enabling them to adhere

to sustainable fishing practices, avoid overfishing, and ensure the sustainability of fish stocks. Overall, fuel subsidies provide fishers with the tools and opportunities to increase their catch, ultimately contributing to the economic and ecological sustainability of tuna fisheries **(**Saputra, 2017; MSC, 2023**)**.

3. Fishermen's income

The income of tuna fishers varies depending on various factors such as the number of trips, fish weight size, market prices, and operational costs. The profit of tuna fishers is obtained from total income minus total expenses. The variable expenditure of fishermen in tuna fishing activities consists of fuel, bait, ice blocks, and consumption **(La Sudiono *et al*., 2015)**.

Fishermen's activities in the process of tuna fishing have been profitable, but the level of expenditure for fuel costs is very high due to the limited subsidized fuel (Pertalite), hence for fishing needs, fishermen use unsubsidized fuel (Pertamax) at a more expensive price. This causes an increase in expenditure costs. Fuel subsidies have a significant impact on the income of tuna fishers. In the fishing industry, operational costs, especially fuel, are one of the largest components. Tuna fishing vessels often have to travel long distances to reach fishing grounds, which requires the use of large amounts of fuel. Fuel subsidies provided by the government can significantly reduce this cost burden **(Carles, 2012; Widiasanti, 2016; FAO, 2023)**.

With lower fuel costs, fishers can allocate more funds for vessel maintenance, purchase of better fishing gear, and improvement of fish detection technology. In addition, reduced operational costs allow fishers to maintain higher profit margins, despite fluctuating tuna prices in the global market (**Sukarwati, 2012; Hadisaputra, 2013; NOAA Fisheries, 2023**).

This positive impact is also seen in the increased competitiveness of fishers in the international market. With lower production costs, fishers can sell their tuna at competitive prices without sacrificing profits. Fuel subsidies also play a role in improving the overall welfare of fishers, as higher incomes allow them to improve their living standards, reinvest in their businesses, and provide better education and healthcare for their families. Thus, fuel subsidies contribute not only to the sustainability of tuna fisheries but also to the overall economic development of fishing communities **(Suryadi, 2015; ISSF, 2023)**.

4. Effect of subsidized fuel and catches on fishermen's income

The price of fuel has a big influence when fuel is scarce thus fishermen cannot carry out fishing activities which affects the income of fishermen. In addition, the price of fuel is a factor that determines the profit of a fishing business, especially tuna fisheries. The higher fuel price affects the expenditure since the profit is obtained from income minus expenses **(Mira *et al*., 2014**).

Fuel subsidies influence fishermen's income since fuel is one of the largest operational cost components in fishing activities. With the fuel subsidy, fishermen's operational costs can be reduced, thereby increasing their profit margins. This allows fishers to increase the frequency of fishing trips and reach more distant fishing grounds, which often offer larger

and more diverse catches. In addition, fuel subsidies can increase the competitiveness of local fishers against imported fishery products. Increased catches in quantity and quality, coupled with lower operational costs, have a positive impact on fishers' income **(Squires & Reid, 2009; Sastrawidjaya, 2018)**.

However, it is important to note that over-reliance on fuel subsidies could also be a problem if these subsidies were suddenly removed, as it could result in a significant increase in operational costs and a decrease in revenues. Therefore, fuel subsidy policies must be balanced with efforts to sustain and diversify sources of income for fishermen **(Suryanto & Wudianto, 2017)**.

CONCLUSION

Catch results are partially influenced by the distance to the fishing area and are simultaneously affected by the duration of time spent at sea, the number of fishing trips, and the distance to the fishing grounds. The tuna fishing business has shown profitability over the course of the year. Additionally, fuel prices and catch volumes significantly impact the income of tuna fishermen.

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