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Sustainable Fishery Management and Controlling Overcapacity in Kelantan State Commercial Fishery, East Coast of Peninsular Malaysia

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Abstract
Trawlers and purse seines are two main fishing nets used by the commercial fishing industry in Malaysia, and assessing their profitability is crucial for managing the fisheries to achieve sustainable fishing. The study's objective is to identify the variations in accounting profit levels in the commercial fishing sector in Kelantan State, east coast of Peninsular Malaysia. Based on an in-depth study of fishing capacity and other economic considerations, a comparison of accounting profits between the trawler and purse seine fisheries by using a revenue and profit approach. Trawlers incurred higher profit than Sein net and causing overcapacity by the trawlers.

Keywords: Accounting Profit; Trawler; Purse Seine; Peninsular Malaysia

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1.0 Introduction

Commercial fishing is a global activity that has been designated as high-risk in several kinds of conditions (Lucas & Case, 2018). Commercial fishing has expanded dramatically in the last decade as worldwide demand for seafood has increased (Mileski et al., 2019). Not only is fish a staple item in the diets of millions of people, but it is also a significant source of money for fishermen and allied industries (Haas et al., 2019). Fish and fish products contribute to over 60% of total animal protein consumed in the country (in comparison to poultry, beef, and pork), which is much more than in other Asian countries (Béné et al., 2015). The commercial fishing sector is the largest in the world, and it contributes to the high mortality rate of marine species (Davis et al., 2019). The majority of marine fish populations are overexploited, and fishing fleets around the world are severely overcapacity.

Overexploitation of marine fisheries is a serious concern around the world, and in fisheries that have also been carefully managed by coastal nations, many uncertainties have considerably limited the effectiveness of traditional fisheries management systems in restoring exploited stocks. Management decisions in the fishing sector can have a direct impact on reducing overexploitation and overcapacity. Overcapacity combined with extreme overexploitation may result in the depletion and maybe extinction of fishing populations in the absence of any control over access or property rights (Sin et al., 2019). Overcapacity refers to a fleet's ability to fish at levels that exceed the sustainable catch level in a fishery, such as when there are too many vessels and/or fishermen. Incentives to the fishing industry are ubiquitous around the world, and these incentives contribute to overcapacity of fishing fleets and overexploitation of fisheries resources.

Sustainable fisheries management can be accomplished through the use of effective laws and other means, such as the implementation of a daily vessel limit in Kelantan State, the approval of net size limitations, and many more. Management authorities

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must produce valid, enforceable, and proven harvest procedures, as well as sufficient rights-based benefits for the fishing community, in order to improve fisheries (Monteiro, 2017). There are some recurring challenges, such as a drop in profitability in the commercial fishing business, which leads to a rise in food security concerns. The impact of profit variables has an impact on other factors. When the profit in a particular fishing ground is great, the fishers will try to increase their fishing efforts, resulting in the fishing ground being heavily exploited by the fishers because the primary vessels will target the same fishing ground. The objective of the research is to concentrate on the profitability of fishermen based on catch and profit data. This research will be useful for future research and the environment, as well as for evaluating the profitability of vessel operations.

2.0 Literature Review

2.1 Overexploitation and Effects on Landing in Marine Fisheries

Most marine fish populations are overexploited, and fishing fleets globally have significant overcapacity. Many fisheries catch across the world have fallen dramatically in recent years or have already failed due to overfishing, and significant fishing grounds are concentrated in areas impacted by pollution, habitat loss, and coastal zone alteration (Monteiro, 2017). Overfishing is sometimes associated with inefficient commercial fishing methods that bring in enormous volumes of undesired fish or other animals, which are subsequently wasted.

Overexploitation of marine fisheries are still a severe problem around the world, and in fisheries that have also been densely managed by coastal nations, multiple uncertainties have significantly hampered the effectiveness of traditional fisheries management strategies in replenishing exploited stocks (Li et al., 2020). Garrett Hardin's research (Hardin, 1968), titled "The Tragedy of the Commons," had a significant impact on the wider topic of resource overexploitation. Hardin's model was only qualitative, but it identified patterns of overexploitation of any resource that is exploited at a level quicker than it can reform itself (Perissi et al., 2017).

2.2 Sustainable Fisheries Management

Sustainability entails addressing our own demands without jeopardizing future generations' ability to meet their own. Fisheries management is the process of developing and enforcing the rules required to prevent overfishing and aid in the recovery of overfished stocks. The sustainability fisheries must be managed to ensure that marine resources are exploited in a sustainable and efficient manner. The necessity to include the economic and social components into the management process has been recognized in recent years, owing to the ecosystem-based fisheries management strategy (Garcia et al., 2017). This fishery's management policy has been focused mostly on fishing effort limitations and technological measures for both professional and recreational fishermen (Castro et al., 2019).

Sustainable fisheries are achieved by establishing a permanent no-take zone to prevent unwanted catches and habitat loss (Garcia-De-Vinuesa et al., 2018). Sustainable fisheries also highly affected by the capture of vessels with high probability of failed to work on the enforcement policies whereas the reducing status of fishing mortality rates are higher according to Schaefer et al.,(2021).

3.0 Methodology

3.1 Descriptive Data: Questionnaire Design

The study used a structured questionnaire survey to examine the accounting profit of the fishermen. The questionnaire is divided into four components to assess profitability. In the Kelantan commercial fishing business, structured questionnaires were utilized to collect information about the fishermen's characteristics and economic aspects. Economic data was gathered, such as (1) fixed costs, such as (a) main vessel skin cost, (b) fuel cost, (c) engine cost, (d) gear cost - trawl net, seine net, tuna net, and other equipment expenses, and (2) variable costs, such as fishing operation costs.

3.2 Accounting Profit Analysis

The variable cost, fixed cost, catch, and fishing effort of the fishery can all have a significant impact on total profit; in fact, profit shows the economic performance of fishing sectors. The analysis is used to investigate the impact of profit, overcapacity, and overfishing. The total revenue of the vessel is computed using two types of vessels: (a) trawlers and (b) purse seines. The economic study examines the economic performance of the trawl and purse seine fleets in terms of income, expenses, and profit. The following adapted equations are used to compute the mathematical specifications for the revenue function, ex-vessel pricing function, total cost function, and total profit (Sin et al., 2019).

$$Total\ Profit:\ \pi_t = Y_t - TC_t \quad (1)$$

$$Total\ Revenue:\ Y_t = \left|\sum_{i=1}^{2}\left(Catch_{t,i} \times P\right)\right| \times \sum_{i=1}^{2} V_{t,i} \quad (2)$$

Equation 1 is used to compute the overall earnings of each trawler and purse seine vessel. Equation 2 calculates the total revenue of each trawler and purse seine vessel, where Y_t = revenue for each trawler and purse, t = time frame, i = gear type, where i1 = trawler and i2 = purse seine, respectively. Each vessel's total cost includes total fixed cost + total variable cost, as shown in Equation 3. Equations 5 and 6 are used to calculate the fixed and variable costs for each vessel in each fisheries gear type.

$$Total\ Cost:\ TC_t = \sum_{i=2}^{2} TFC_{t,i} + TVC_{t,i} \quad (3)$$

$$Total\ Fixed\ Cost:\ TFC_{ti} = fc_{t,i} \times V_{t,i} \quad (4)$$

$$Fixed\ Cost\ per\ vessel:\ fc_{ti} = license\ fee_{t,i} + Other\ fc_{t,i} \quad (5)$$

$$Total\ Variable\ Cost:\ TVC_{ti} = Vc_{t,i} \times V_{t,i} \quad (6)$$

$$Variable\ Cost\ per\ vessel: Vc_{ti} = CrewC_{t,i} + OperaC_{t,i} + LdC_{t,i} + MtnC_{t,i} \quad (7)$$

$$Operating\ Cost: OperaC_{ti} = FuelC_{t,i} + OtherC_{t,i} \quad (8)$$

$$Fuel\ Cost = FuelC_{ti} = SubFuelP_{t,i} \times Quantity_t \quad (9)$$

4.0 Findings

In Kelantan state, the commercial fishing industry is separated into two types: trawl fishery and purse seine fishery. The economic performance of Kelantan's fisheries industry is evaluated based on the type of gear used and the overall performance of both types of fisheries. As illustrated in the equations, total fixed cost (TFC) is divided by fixed cost per unit, and total variable cost (TVC) is divided by variable cost per unit to begin the accounting profit analysis. The economic analysis is based on the equations from the methodology section, which are total cost, total variable cost, total fixed cost, and profitable industry analysis. The total fixed cost, total variable cost, and total cost value of the trawler fishery in Kelantan state are shown in Table 1. The value depicts the offshore and deep-sea vessel based on the fixed and variable cost details provided by the respondent fishermen. Tables 1 and 2 shows RM as a unit and the $\mathrm{Ves}^{-1}\ \mathrm{Year}^{-1}$ denotes Malaysian Ringgit per vessel per year.

To identify the total cost of the trawler in the Kelantan state, need to calculate the total fixed cost, and total variable cost. The total fixed cost of a vessel includes the cost of the (a) vessel skin, (b) echo sounder, (c) fish finder, (d) generator, (e) engine, (f) trawl net, (g) seine net, (h) tuna net and other equipment such as (i) fish container, (j) fish compartments, (k) cooking stove, (l) refrigerator, (m) spotlights and (n) GPS. Each vessel's licensee and insurance fees are also fixed costs per year. The item under the total fixed cost shows the fixed cost of a vessel. The total variable cost (TVC) in this case includes crew wages, operating costs, landing fees, and maintenance costs. The operating costs refer to the cost of fuel and food per vessel per year. The maintenance cost includes the cost of maintaining the vessel, gear, and engine. Crew wages were calculated using primary data from survey analysis. Wages for the captain (Taikong) and other crew members are calculated separately. The average trip for a trawler in a month is three trips, and the average wage for a trip is multiplied by three trips and then calculated for a year. The fuel cost for trawlers is calculated using the subsidies price of RM1.65 per liter.

Furthermore, the average price of an ice block is RM20 per block, and seiners use a minimum of 120 ice blocks in a single trip. Seiners' wages are calculated differently than trawlers. In comparison to trawlers, the crew size is usually between 14 and 20 people. Crew wages are higher on trawlers than on purse seines. The captain (Taikong) is paid by a total percentage of profit, such as 10 to 15% per month. In comparison to the trawler, the rest of the crew is paid on a monthly basis, with wages based on the number of hauls.

The cost is calculated to identify the overall trawl and purse seine fishery input and output by referring to the table for the profit analysis of Kelantan state. The cost is calculated for the average mean of a vessel, multiplied by the number of vessels in each zone, and the total sum of each cost is provided. Table 1 shows the TFC value of trawler is RM78,043 and purse seine is RM85,930 whereas the TFC value of purse seine fishery is higher than trawler in the Kelantan state. The difference between the trawler and purse seine in Kelantan fisheries are enormous. Besides, the TVC value of trawler is RM403,960 and purse seine is RM498,222. Comparably, the TVC of the seiners are higher compared to the trawler in the Kelantan state. In reality, the seiners have more cost than trawlers usually due to the size of the vessels and the needs in the vessels are more than the trawlers. The vessel has a larger capacity to accommodate the large number of crew members and fishing equipment. So, the total cost of seiner is RM584,152 and trawler is RM482,003.

Table 1. Estimation of total cost, total fixed cost and total variable cost of Kelantan state

Item	Trawler	Purse Seine	Unit
Total Fixed Cost (TFC)			
1. Main skin vessel	31,462	30,885	$\mathrm{RM.\ Ves^{-1}Year^{-1}}$
2. Trawl net	7,302	0	$\mathrm{RM.\ Ves^{-1}Year^{-1}}$
3. Seine net	0	6,451	$\mathrm{RM.\ Ves^{-1}Year^{-1}}$
4. Tuna net	0	6,811	$\mathrm{RM.\ Ves^{-1}Year^{-1}}$
5. Engine	7,538	7,485	$\mathrm{RM.\ Ves^{-1}Year^{-1}}$

6.	Echo sounder	5,920	5,923	$\mathrm{RM.Ves^{-1}Year^{-1}}$
7.	Fish finder	10,594	12,108	$\mathrm{RM.Ves^{-1}Year^{-1}}$
8.	Generator	3,748	4,456	$\mathrm{RM.Ves^{-1}Year^{-1}}$
9.	GPS	6,079	6,293	$\mathrm{RM.Ves^{-1}Year^{-1}}$
10.	Other equipment's	1,718	1,514	$\mathrm{RM.Ves^{-1}Year^{-1}}$
11.	Vessel license fee	2,591	2,692	$\mathrm{RM.Ves^{-1}Year^{-1}}$
12.	Insurance fee	1,091	1,310	$\mathrm{RM.Ves^{-1}Year^{-1}}$
	Total	78,043	85,930	$\mathrm{RM.Ves^{-1}Year^{-1}}$
Total Variable Cost (TVC)				
13.	Operating cost	265,317	237,748	$\mathrm{RM.Ves^{-1}Year^{-1}}$
14.	Maintenance cost	23,792	24,115	$\mathrm{RM.Ves^{-1}Year^{-1}}$
15.	Wages of crew	112,259	60,230	$\mathrm{RM.Ves^{-1}Year^{-1}}$
16.	Landing fee	2,592	3,826	$\mathrm{RM.Ves^{-1}Year^{-1}}$
17.	Ice block cost	0	172,303	$\mathrm{RM.Ves^{-1}Year^{-1}}$
	Total	403,960	498,222	$\mathrm{RM.Ves^{-1}Year^{-1}}$
Total Cost (TC)				
Total Cost $(TFC_i + TVC_i)$		482,003	584,152	$\mathrm{RM.Ves^{-1}Year^{-1}}$

5.0 Discussions

The study focuses on the trawler and purse seine fisheries in the Kelantan state fishing industry. According to the author Viswanathan et al., (2001), the most common industrial gear types are trawl (pukat tunda) and purse seine (pukat jerut), with trawl gear harvesting demersal species and purse seines harvesting pelagic species. The world population is frequently cited as a significant driver of increased seafood demand and fisheries development. In reality, income is a more important driver of fish (and other animal-source food) consumption (Béné et al., 2015).

The profit is estimated by calculating the total cost where the total cost will be multiplied by the number of vessels in Kelantan according to the fishery. Then the total revenue is estimated by use the catches per year multiply with the average price of the species. Then, the revenue is multiplied by the total number of vessels as mentioned earlier. The profit is total revenue minus total cost. This will estimate the Kelantan fisheries profit in a year. Table 2 shows the profit estimation of Kelantan state. The trawler catches in a year is 718,867Kg and purse seine is 651,639Kg. The overall profit of Kelantan fishing industry is RM658,293,548.00.

Table 2. The profit estimation of Kelantan state

Item	Trawlers	Purse Seines	Unit
Total Cost of Industry (TC × $V_{t,i}$)	35,668,222.00	36,801,576.00	$\mathrm{RM.Year^{-1}}$
Total Revenue of Industry (TR × $V_{t,i}$)	424,505,887.00	306,257,459.00	$\mathrm{RM.Year^{-1}}$
Total Profit of Industry (TR – TC)	388,837,665.00	269,455,883.00	$\mathrm{RM.Year^{-1}}$
Total Profit of Kelantan Industry (Trawler + Purse Seine)	658,293,548.00		$\mathrm{RM.Year^{-1}}$

Profit always influences fishermen's efforts; the more effort put into fishing; the more overfishing issues arise. Long term, the fishery resources will be fully exploited, and the lack of marine resources will persist if fishing efforts are not controlled by management. Furthermore, fishermen's perspectives on fishing profit and resources are important. Because there are more trawl vessels in the sea, the profit of trawler contribution is higher than that of purse seines in the Malaysian fishery industry. Trawlers are heavily converging on the marine sea zone, particularly in the Kelantan area where the number of vessels of trawler is higher than the purse seine. Kelantan state profit of fishery industry is lower, but it is still a profitable industry.

Nevertheless, rising fish demand and the economic importance of the fishing industry have put significant strain on many fish stocks (Haas et al., 2019). According to the researcher's survey session, fishermen would like to continue fishing in the future due to the large profit gain from the industry. Because of overcapacity, the seiners usually dislike the trawlers. The researcher concludes that trawlers are sea draggers that are highly profitable, and that many foreign fishers work in the trawl fishery. Purse seine fishing is also very profitable, and the crew is mostly made up of locals. Furthermore, the trawl fishery has a high yearly landing because whereas the number of seiners in Kelantan is lower too than trawlers. Based on the cost and revenue, the seiners are competing highly with the trawlers in Kelantan study area. The outcome of profitable analysis shows that Kelantan has vice versa result. The trawl fishery conquered the industry while in Kelantan the seine fishery performs much higher than trawler.

However, profitability has an impact on overfishing. A vessel's catch rate per year is approximately higher. Profitability leads to overcapacity and overfishing. To assume, most marine resources will become extinct within the next 5 decades due to overfishing, and

the marine seabed will be destroyed due to overcapacity. Only the government can control overfishing and overcapacity. Due to uncontrollable catches, the effects of overfishing and vessel overcapacity are severe in Kelantan commercial fishing industry. Long-term profits are good for those fishermen, but it is destroying the marine coast and resources. Stopping or overcoming this management effectiveness is essential for all vessels, particularly trawlers and seiners. The rules and regulations are the only ways of controlling these factors of overcapacity, overfishing and enormously profitable.

6.0 Conclusion and Recommendations

The survey revealed that trawlers predominated in the Kelantan fishing area. Vessels with a high fixed cost investment get a high profit return, which theoretically leads to overcapacity and overexploitation of catches. Commercial fishermen prefer to fish with trawl nets rather than seine nets. According to the conceptual framework model, fishermen's profits have a direct impact on overfishing and overcapacity in the marine commercial fishing business. The study shows that higher revenues lead to more effort, which creates overexploitation and overcapacity on the seafloor. As a result, the report includes a few potential regulations that could be implemented in the future to prevent overfishing and overcapacity. Policies that can be properly implemented in this area include (a) limiting vessel licenses, (b) eliminating fuel price subsidies, and (c) increasing taxation on landing fees. These solutions will help with future commercial fishing sector regulation.

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Paper Contribution to Related Field of Study

Sustainable marine capture fisheries could be achieved by controlling overfishing and overcapacity. The direct relation between profit and overcapacity enhances the exploitation of fishery resources in Malaysia. The research findings highlight the overcapacity of trawlers especially in Kelantan and east coast of Peninsular and it would be effective implementation for sustainable fishery management in Malaysia and ensuring food security.

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