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Research Article

Impact of fishing gear on the income of artisanal fishers in the east coast of Peninsular Malaysia

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Abstract

Artisanal fishers usually utilize various types of traditional fishing gear, including nets, rods, and traps. Since these choices influence their income, the current study examined how different types of fishing gear affect the income of artisanal fishers on the East Coast of Peninsular Malaysia (ECPM). Data were collected through structured interviews with 262 heads of crew, all of whom were artisanal fishers across Kelantan, Terengganu, and Pahang. A set of questionnaires was used to collect the data from October 2023 to February 2024. Since artisanal fishers are scattered along the ECPM, the researchers used a random sampling technique. Data were analyzed using budgetary analysis and one-way ANOVA. The results indicate that trap fishing yields the highest income due to its ability to capture high-value species with lower operational costs, whereas gillnet and hook-and-line fishing provide moderate earnings. The study underscores the importance of selecting appropriate fishing gear to maximize income while minimizing costs.

Article info

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Introduction

Artisanal fisheries are essential for the livelihood of millions of people, particularly in coastal and rural communities where fishing is often the primary source of income and nutrition. The artisanal fisheries sector is dominated by artisanal fishers, who use a variety of artisanal fishing gear. Passed down through generations, this gear embodies the cultural heritage and ecological knowledge of these communities. It includes handlines, traps, gillnets, and cast nets. Unlike modern fishing technology, artisanal fishing gear is typically more affordable and environmentally friendly (Ndiba and Lumpe, 2024), making it accessible to many artisanal fishers. However, debate remains concerning the effectiveness of artisanal fishing gear in ensuring a stable and sufficient income. Compared to modern fishing equipment, artisanal fishing gear often yields smaller catches, which may limit the fisher's earnings.

Malaysia's fishing industry is one of the country's most important economic sectors. According to data from the Department of Fisheries Malaysia (DoFM, 2023), capture fisheries were the leading contributor to Malaysia's fisheries sector from 2015 to 2022, accounting for an average of 76.20% of total production during this period. Aquaculture placed second at an average of 23.48%, followed by inland fisheries with an average of 0.32%. Table 1 shows that the total values of inshore fisheries and deep-sea fisheries were 71.92% (RM12,329.14 million) and 28.08% (RM4,812.65 million) of total production, respectively, from 2015 to 2022. Inshore fisheries, which typically operate closer to shore (in Zone A and Zone B) and with target species such as shrimp, crabs, and pelagic fish, have become increasingly popular, attracting higher numbers of fishers than deep-sea fisheries.

Table 1: Value of inshore and deep-sea capture fisheries in East Coast of Peninsular Malaysia (ECPM), 2015–2022 (RM Million).

Years /State	Inshore				Deep Sea			
	Kelantan	Terengganu	Pahang	Total (RM million)	Kelantan	Terengganu	Pahang	Total (RM million)
2015	2322.95	375.82	295.82	2994.59	524.92	26.01	341.86	892.79
2016	424.43	323.02	413.47	1160.92	671.35	19.61	286.27	977.23
2017	545.06	379.84	569.33	1494.23	620.91	28.87	199.41	849.19
2018	459.81	349.7	740.97	1550.48	269.56	35.05	206.39	511
2019	431.29	362.77	563.41	1357.47	243.06	32.42	168.06	443.54
2020	369.41	280.99	544.23	1194.63	192.07	35.33	143.41	370.81
2021	385.08	323.05	529.48	1237.61	140.85	13.06	212.66	366.57
Total				**12329.14**				**4812.65**

Source: Department of Fisheries Malaysia (DoFM) (2015–2022).

In the study by Islam *et al.* (2014), drift net ($718) fishers earned the highest average income, followed by trap ($681) and hook-and-line ($442) fishers. According to the research, the ability of drift net users to capture valuable shrimp from near-shore locations during the monsoon season may explain their high revenue. Drift net users can easily access shrimp during this season since the shrimp tend to come closer to shore. Furthermore, Soe *et al.* (2022) pointed out that a gillnet's ability to capture particular species (such as *Restrelliger brachysoma*) correlates with its mesh size. Large mesh tends to be more effective in capturing large individuals of commercial fish, whereas smaller fish can be caught using smaller mesh. However, small fish have lower market prices, resulting in their being less commercially valuable than large fish. The study also found that while a 4.5 cm mesh size could result in a higher weight capture, a 3.5 cm mesh size would maximize the number of individual fish caught (Soe *et al.*, 2022).

Interestingly, fishers may earn more if the market demand for larger fish raises the selling price per kilogram (Stevens *et al.*, 2014). Using a 4.5 cm mesh may be more economically advantageous, even though fewer fish are captured overall if the market values larger fish more than it values smaller ones. This disparity emphasizes the importance of choosing the right mesh size, which would influence both the quantity and the quality of the catch. In addition, gear efficiency influences the volume of fish caught, and it varies significantly based on the species targeted and the type of gear used (Zhou *et al.*, 2014).

Given this background, the current study aimed to assess the impact of fishing gear used on the income of artisanal fishers. By evaluating the differences in income arising from the different types of fishing gear used, the study aimed to identify opportunities for enhancing the economic resilience of artisanal fishers while preserving their cultural heritage. The findings will contribute to the ongoing discussion about the future of artisanal fisheries, offering insights into how traditional practices can be adapted to meet future challenges. Ultimately, this research underscores the importance of balancing economic development with cultural and environmental sustainability in the pursuit of equitable and resilient fishing communities.

Materials and methods

This study was undertaken along the coastal area of the ECPM, specifically in Kelantan, Terengganu, and Pahang, as illustrated in Figure 1. It focused on selected fish landing ports along the ECPM. These three states were included in the study due to their locations along the South China Sea and the relatively high populations of artisanal fishers utilizing various types of fishing gear in the states.

To obtain the data, the study used a questionnaire constructed by adopting and adapting the questions used in previous research (*e.g.*, Putri and Wulandari, 2020; Abd Hamid *et al.*, 2022). This procedure was applied to ensure all the required information was collected during the face-to-face interviews. Prior to the real data collection, the researchers conducted a preliminary study and a pilot study. The questionnaire consisted of four sections: demographics of fishers, boat characteristics, operational costs, and fishing gear type. The questionnaire also asked for information on the species caught by each type of fishing gear. Since artisanal fishers are scattered along the ECPM, the study applied a random sampling technique. The DoFM recorded a total population of 4,534 artisanal fishers on the ECPM in 2022, consisting of 918 in Pahang, 2,431 in Terengganu, and 1,185 in Kelantan. Due to the large population size, the study selected only a sample of the population.

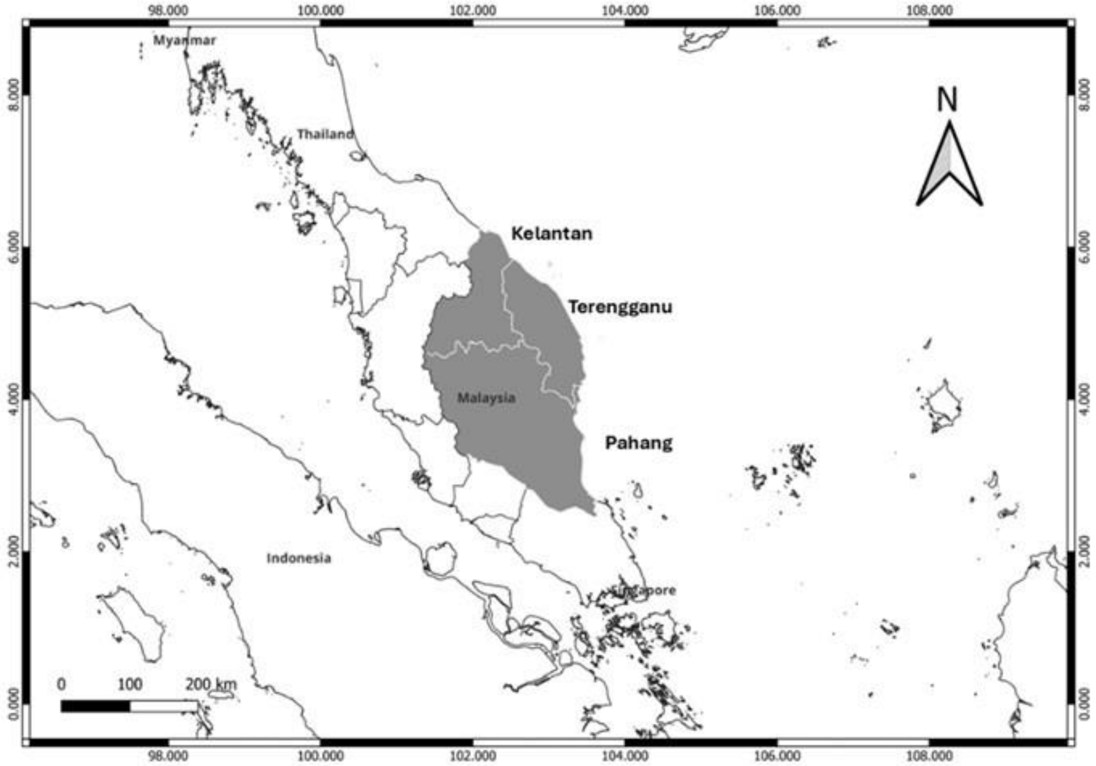

Figure 1: Map of ECPM study area.

The total number of respondents in the sample was determined using Slovin's formula. Then, the number of respondents in each state was determined proportionally, using a 6% margin of error. To ensure the precision of data and to reduce the likelihood of false information, the study held interviews with 262 heads of crew of artisanal vessels (53 from Pahang, 140 from Terengganu, and 69 from Kelantan). Slovin's formula is a widely used statistical tool for determining the sample size, especially when dealing with large populations and when the behaviors or characteristics of the population are not fully known. Slovin's formula assumes simple random sampling and is most appropriate when no prior knowledge about the population's behavior is available (Tejada and Punzalan, 2012). It allows researchers to balance precision with practicality, ensuring the sample is large enough to yield reliable insights while avoiding unnecessary data collection that can be time-consuming and costly.

The preliminary and pilot studies were conducted in September 2023, involving artisanal fishers to gather initial insights and data. The pilot study involved 10% of the actual study's number of respondents (5 from Pahang, 14 from Terengganu, and 7 from Kelantan). This collaborative approach ensured the questionnaire was tailored to the unique needs of artisanal fishers and fostered trust and cooperation. The rigorous testing process resulted in a comprehensive and reliable tool for gathering essential data. To reduce bias, the study selected artisanal fishers randomly at both public and private jetties in each state. Visual aids were used to clarify questions, and each fisher's interview lasted between 45 and 60 minutes. Data collection took place from October 2023 to February 2024.

To determine the profit fishers make from fishing activities in a given month, the study used budgetary analysis based on the data (*i.e.*, revenue and cost) obtained from the interviewees. According to Kumar and Ganguly (2020), budgetary analysis is practicable for calculating profit based on the total revenue and total cost of each production practice. The total revenue, or total yield, is determined by multiplying the price per kilogram (*P*) by the weight in kilograms of each species (*Q*) (see equation 1). The total cost is calculated by adding the fixed costs (FC) and variable costs (VC) (see equation 2). Fixed costs cover the initial costs for the fishing boat and the gear required to conduct fishing operations. Variable costs include the costs of wages (foremen and crew), boat maintenance, fuel, meals, ice supplies, and other operational expenses required on a fishing trip. Then, profit is calculated by subtracting the total cost (TC) from the total revenue (TR) (see equation 3):

$$Total\ Revenue\ (MYR) = P \times Q \quad (1)$$

$$Total\ cost\ (MYR) = FC + VC \quad (2)$$

$$Profit\ (MYR) = TR - TC \quad (3)$$

After profit had been determined, the study used one-way ANOVA to find any significant differences in income among those using different types of fishing gear. Previous researchers, including Gebremedhin *et al.* (2013), have also applied this method to compare the income differences between fishers using modern and traditional boats. Additionally, a post-hoc test was used to identify specific significant differences between pairs of group means to obtain more detailed insights into the income disparities among artisanal fishers. Before conducting the one-way ANOVA, the study performed a normality test to ensure the one-way ANOVA assumptions were fulfilled.

Results

Demographic analysis

Table 2 shows that the demographic profiles of artisanal fishers in the ECPM vary across different fishing gear categories, namely, gillnet, hook and line, and trap. The majority of fishers were between 51 and 60 years old, and among them, 45 used gillnets, 25 employed hooks and lines, and 19 utilized traps. Next was the 41-50 age group with 51 gillnet users, 13 hook and line users, and 11 trap users. The youngest age group of under 30 years old was the least represented with only 3 gillnet users, 8 hook and line users, and no trap users. The fishing industry was male-dominated, with 251 male fishers and only one female fisherman, who used hook and line for fishing. The Malays formed the vast majority of fishers (260), and only two individuals from other ethnic backgrounds engaged in fishing, with one using gillnets and another using hook and line. Similarly, Muslims dominated artisanal fishing (260), and only one Christian (using hook and line) and one individual from another religion (using gillnet) were involved in the industry.

Educational attainment varied, with most fishers having completed the lower secondary school examination known as Penilaian Menengah Rendah (PMR, 72 individuals), or attained Sijil Pelajaran Malaysia (SPM) translated as Malaysian Certificate of Education (72 individuals). A smaller number attained only the primary school-level certificate known as Ujian Penilaian Sekolah Rendah (UPSR, 74 individuals), whereas 24 fishers did not receive any formal education. A minority of 20 individuals completed the high-school level certificate known as Sijil Tinggi Pelajaran Malaysia (STPM) or diploma-level education. Most of the fishers were married (224), 31 were single, and 7 were either divorced or widowed. Fishing experience levels differed across the different fishing gear categories. Relatively few fishers (21 individuals) were the most experienced with over 41 years of experience, and most of the fishers (75) had 21–30 years of experience. The remaining 74, 63, and 29 fishers had 31–40 years, 11–20 years, and less than 10 years of experience, respectively.

Table 2: Demographic Analysis of Artisanal Fishers by Fishing Gear Type on the ECPM.

Demographic characteristic		**Gillnet**	**Hook and Line**	**Trap**	**Total**	
		n	**n**	**n**	**n**	**%**
Age	< 30	3	8	0	11	4.20
	31-40	23	10	7	40	15.27
	41-50	51	13	11	75	28.63
	51-60	45	25	19	89	33.97
	>61	33	4	10	47	17.94
Gender	Male	155	59	47	261	99.62
	Female	0	1	0	1	0.38
Race	Malay	154	59	47	260	99.24
	Other	1	1	0	2	0.76
Religion	Muslim	154	59	47	260	99.24
	Christian	0	1	0	1	0.38
	Other	1	0	0	1	0.38
Education	None	12	5	7	24	9.16
	UPSR	50	7	17	74	28.24
	PMR	45	17	10	72	27.48
	SPM	39	23	10	72	27.48
	STPM/Diploma	9	8	3	20	7.63
Marital	Single	15	12	4	31	11.83
	Married	134	47	43	224	85.50
	Divorced/widow	6	1	0	7	2.67
Experience	<10	11	18	0	29	11.07
	11-20	40	16	7	63	24.05
	21-30	47	15	13	75	28.63
	31-40	46	8	20	74	28.24
	>41	11	3	7	21	8.02
Note:		***n*=155**	***n*=60**	***n*=47**	***n*=262**	

Budgetary analysis

Table 3 presents the monthly average costs, revenues, and profits associated with three common types of fishing gear in Malaysia. It reveals significant variations in economic performance among the three groups. Trap fishing yielded the highest average monthly profit of RM13,087.94 (USD3,065.09), indicating strong economic returns likely due to efficient catch rates or high market values of the species caught. Gillnet operations followed with a moderate profit of RM7,332.62 (USD1,717.24), offering a favorable balance between cost and return, making it a viable option for many small-scale fishers. Hook-and-line fishing yielded the lowest profit of RM3,301.15 (USD773.10) despite incurring relatively high operational costs. However, when sustainability is considered, hook and line stand out as the most environmentally responsible method, being highly selective and causing minimal bycatch or habitat disruption. Trap fishing, while profitable, requires careful regulation to prevent overexploitation and habitat damage, whereas gillnets, though effective, are associated with higher ecological risks such as bycatch and ghost fishing. These findings suggest that while economic viability is crucial, integrating sustainable practices into gear selection and fisheries management is essential for ensuring the long-term resource availability and resilience of Malaysia's fisheries sector.

Table 3: Monthly average total cost, revenue, and profit by type of fishing gear.

Fishing gear	Average total cost		Average total revenue		Average total profit	
	(RM)	(USD)	(RM)	(USD)	(RM)	(USD)
Gillnet	9,942.20	2,328.38	17,274.82	4,045.63	7,332.62	1,717.24
Hook and line	15,406.63	5,950.03	18,707.78	4,381.21	3,301.15	773.10
Trap	12,380.36	2,899.38	25,468.30	5,964.47	13,087.94	3,065.09

Note: Exchange rate: USD1 = RM4.27 (8 May 2025)

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Table 4 shows the normality test results for the one-way ANOVA conducted in this study. It is important to determine whether data is normally distributed or not. If a normality test shows p-values>0.05, it means the data is normally distributed.

Table 4: Normality test results.

Fishing gear	Skewness Statistic		Kurtosis Statistic		Kolmogorov-Smirnov Statistic	
	Statistics	Sig.	Statistics	Sig.	Statistics	Sig.
Gillnet	0.47	0.19	-0.11	0.35	0.06	0.07
Hook and Line	0.64	0.31	-0.04	0.61	0.102	0.20
Trap	0.69	0.35	0.21	0.68	0.11	0.20

The one-way ANOVA test was conducted on the assumption that income had a normal distribution. As shown in Table 5, the types of fishing gear used resulted in significant differences in income. According to MacFarland and Yates (2020), statistical significance applies if the p-value is smaller than the chosen significance level. In this case, the test resulted in a *p*-value of less than 0.05, confirming that the income of artisanal fishers differs depending on the type of fishing gear used.

Additionally, a post-hoc test was performed to determine which specific groups had significant differences. The results presented in Table 6 show that fishers using gillnet and fishers using hook and line did not differ significantly in income. However, significant differences were found between hook and line and trap fishing (*p*-value=0.017) and between trap and gillnet fishing (*p*-value=0.037).

Table 5: One-Way ANOVA of income by different types of fishing gear.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	680331469.5	2	340165734.8	4.163	0.016
Within Groups	23775983644	291	81704411.15		
Total	24456315114	293			

Table 6: Differences in average income between different types of fishing gear.

Fishing Gear	Gillnet	Hook and Line	Trap
	Mean Difference	Mean Difference	Mean Difference
Gillnet	-	1,212.12 [1,341.14]	3,647.55* [1,474.90]
Hook and Line	1,212.12 [1,341.14]	-	4,859.67* [1,760.72]
Trap	3,647.55* [1474.90]	4,859.67* [1,760.72]	-

Note: * and ** refer to significance levels of 1% and 5%, respectively. […] refers to the value of standard error.

Discussion

The significant income differences among artisanal fishers using gillnets, hook and line, and traps can be attributed to several key factors, including target species, fishing efficiency, and operating costs. Each fishing method targets different species, which can vary significantly in market value (Olsen *et al.*, 2021). For instance, gillnets primarily capture pelagic species like round scad, which tend to have lower market prices than demersal species such as Japanese threadfin bream or high-value crustaceans commonly caught in traps. Also, hook-and-line fishing usually targets species with lower or more variable market values, leading to lower overall income despite the precision and selectivity of this method (Sogn-Grundvag *et al.*, 2020).

In contrast, trap fishing often yields species like groupers and snappers, which command higher prices due to their quality and strong demand in the fresh seafood market (Cramer and Kittinger, 2021). This method is also more efficient and selective in capturing high-value species (Vadziutsina and Riera, 2020). Since traps can be left in the water for extended periods (Nissa *et al.*, 2021), they can capture fish continuously without requiring constant manual effort. As a result, trap fishing often yields higher catches of economically valuable species, leading to greater income.

Additionally, operating costs differ among fishers using gillnet, hook and line, and trap fishing. While trap fishing may require a higher initial investment for purchasing and maintaining traps, its long-term operational costs tend to be lower compared to gillnet and hook-and-line fishing (Rochmat *et al.*, 2023). In contrast, gillnet and hook-and-line fishing demand more fuel for active fishing and require greater manpower for net deployment and retrieval. Lower operational costs, combined with higher-value catches, allow trap fishers to attain better profit margins.

Fishers using gillnets and hook and line methods may not earn significantly different incomes due to the various factors that equalize their economic returns. Both techniques target similar species, such as mackerel, tuna, and other pelagic fish, which have comparable market prices (Montgomerie, 2022). Since the species caught are generally the same, sales revenues are similar regardless of the fishing method employed. Although hook-and-line fishing is considered more labor-intensive, it can sometimes achieve comparable catch levels to gillnet fishing, particularly for high-demand species like squid and mackerel. This balance in catch efficiency helps maintain similar income levels between the two methods.

Furthermore, under certain conditions, such as peak season when fish are plentiful, fishers using hook and line can be just as productive as those employing gillnets (Marques *et al.*, 2021). Both fishing methods are generally sustainable for artisanal fisheries as they enable targeted fishing and help minimize bycatch (Scott *et al.*, 2022). This selectivity ensures that fishers can sustain their income without causing significant harm to fish populations. While hook-and-line fishing offers a more selective approach, gillnets provide efficiency for specific species, ultimately contributing to similar income levels between fishers using either method (Berninsone *et al.*, 2020).

These findings are in line with policies at national and international levels. For example, Malaysia's National Agrofood Policy 2.0 (NAP 2.0) emphasizes the modernization and sustainability of the fisheries sector, and this study's findings can help guide the allocation of subsidies and investments toward fishing practices that balance profitability with environmental stewardship (Ministry of Agriculture and Food Security (MAFS, 2021). For instance, targeted subsidies or incentive schemes could be introduced to support fishers who adopt sustainable practices such as hook and line, despite its lower immediate profit margin. Moreover, training programs under the Fisheries Development Authority of Malaysia (LKIM) can help artisanal and small-scale fishers improve efficiency, safety, and post-harvest handling, potentially increasing returns without compromising sustainability.

At the international level, these strategies align with the Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries and Sustainable Development Goal (SDG) 14, which promotes the conservation and sustainable use of marine resources (United Nation, 2015; FAO 2021). Encouraging sustainable gear use through policy incentives not only protects marine biodiversity but also ensures long-term income stability for coastal communities.

Thus, linking economic data with broader development goals enables more effective and inclusive fisheries policies that support both people and the planet.

Conclusion

This study assessed the impact of different fishing gear (gillnets, hook and line, and traps) on the income of artisanal fishers on the East Coast of Peninsular Malaysia. The results reveal that while gillnets and hook and line generate relatively similar earnings, trap fishing consistently yields higher income due to its ability to target high-value species and lower long-term operational costs. These findings underscore the importance of collective action and knowledge-sharing among fishers, such as forming cooperatives to access bulk discounts, secure better market prices, and share resources like advanced equipment. Experienced fishers can mentor others in identifying productive fishing grounds, understanding fish behavior, and applying efficient techniques, thus fostering a collaborative culture. Community-based resource management can further empower fishing communities to prevent overfishing and enhance social cohesion. For policymakers, the study provides a foundation for developing evidence-based and equitable fisheries policies, including regulations on mesh size, fishing depths, and seasonal restrictions. Promoting both formal and informal education for fishers such as training in fisheries management and technology can enhance productivity and resource stewardship. Regular monitoring of catch composition, fishing activities, and income levels is essential for policy refinement. Fishers are encouraged to adopt emerging technologies, such as artificial intelligence, remote sensing, and advanced gear, to improve efficiency and sustainability. Exploring alternative livelihoods, including aquaculture and value-added fish processing, can diversify income sources.

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Conflicts of interest

The authors declare no conflicts of interest.

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