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Determinants of Catch And Catch Per Unit Effort of Motorboat and Outboard Motorboat Fishers in Bulukumba Regency

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Abstract. Motor and outboard boats are the main means by which fishersmen exploit the fisheries resources in these waters. The success of the catch and the efficiency of the fishermen's efforts are strongly influenced by various factors related to the characteristics of the boat, the fishing gear and the condition of the aquatic environment. This study aims to analyse the determinants of catch and catch per unit effort of motorboat and outboard motorboat fishers in bulukumba regency. Data collection techniques used were observation, interview and documentation. The number of samples was 81 modern fishermen (juragan fishermen) of motorboats out of 407 population using the Slovin formula method and 81 outboard motorboat fishermen out of 81 population using the area proportional random sampling method. Data analysis techniques used are statistical tests, classical assumptions tests using SPSS 25 and CPUE analysis. The study found that the length of fishing (X1), volume of diesel (X2), age of fishermen (X4), and fishing experience (X6) had a positive impact on the production of motorboat fishermen's catch (Y1) when examined independently. On the other hand, the number of labour (X3) and formal education of fishermen (X5) were negatively correlated with catch production. The duration of sea time (X7) and the power of the outboard engine (X8) have a positive impact, whereas the volume of petrol (X9), age of fishermen (X10), formal education of fishermen (X11), sea experience (X12), and number of fishing gear used (X13) have a negative impact on the catch rate of outboard motorboat fishermen (Y2). Based on the CPUE (Catch per Unit Effort) value, there has been a fluctuation of motorboat and outboard motorboat fishermen from 2017 to 2021. The average value per year, from 2017 to 2021, was 389.9914kg/trip for motorboat fishermen and 46.66028kg/trip for outboard motorboats. It is recommended to increase the number of fishing gear, particularly trawl gear, and transportation facilities in fishing. Fishers should be incentivised to utilise fishing equipment that is appropriate for the specific kind of fish and local aquatic environments in order to enhance catches and reduce negative impacts on fishing resources.

Keywords: Catch production of motorboat, Outboard motorboard fishermen, CPUE.

1 Introduction

Traditional fishers are fishers who conduct fishing business on a small scale. They are mostly found in coastal areas. Artisanal fishermen are one of the important sources of income for coastal communities in developing countries. Artisanal fishermen are one of the main sources of income for coastal communities in developing countries [1], [2]. In Indonesia, traditional fishermen generally use simple fishing gear and use outboard motorised boats with various capacities. Traditional fishermen in Indonesia generally use boats measuring 5-24 PK, while for the type of motorboat 24-350 GT (gross tonnage).

Fishermen are one of the community groups that rely heavily on fish catches as the main source of livelihood. Bulukumba Regency, as one of the coastal areas in Indonesia, has considerable fisheries potential. The importance of understanding the factors that influence fishermen's catch is key to improving the sustainability of the fisheries sector in this region. One important aspect in analysing fishermen's catch is to understand the determinants of catch and catch per unit of effort [20]. Fishing effort is conducted using motorboats and outboard motorboats, each of which has its own characteristics and advantages. Therefore, this research will focus on analysing the determinants of catch and catch per unit effort of motorboat and outboard motorboat fishermen in Bulukumba Regency.In this study, the determinants of catch refer to factors that significantly affect the number and type of fish caught by fishermen. Meanwhile, catch per unit effort reflects the efficiency and productivity of fishermen in using their fishing gear. An in-depth understanding of these two aspects can provide a more comprehensive picture of the dynamics of fisheries in Bulukumba Regency.

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This research needs to increase the number of fishing gears, especially trawl gear types, as well as transport equipment in fishing. Encourage fishers to use appropriate and effective fishing gear, which is suitable for the type of fish being caught and the local aquatic ecosystem [4], [5]. Proper gear selection can help increase catches and reduce negative impacts on fisheries resources. Utilise available technology and information, such as the use of modern navigation tools, satellite monitoring, and information on water conditions and fish migration patterns. This can help fishers make smarter decisions about when and where to fish. It also encourages fishers to diversify their sources of income beyond fishing.

2 Materials and Methods

2.1 Materials

2.1.1 Modern Fishers Using Motorised Boats

To analyze the estimation of fishers' Catch using motorboats, a multiple regression analysis model is used with the following model [6].

$$QHTNMTR = \beta_8 LMT\ \beta_9 QSLR\ \beta_{10} QTKR\ \beta_{11} QUmur\ \beta_{12} QPENDN\ \beta_{13} PNGLM \quad \text{(I.1)}$$

The equation (1.I) uses the double log or natural logarithm (Ln) mathematical equation as follows [7] :

$$LnQHTNMTR = Ln\beta_8 + \beta_9 LnLMT + \beta_{10} LnSLR + \beta_{11} LnQTKR + \beta_{12} LnQUmur + \beta_{13} QPENDN + \beta_{14} QPNGMLT + e_2 \quad \text{(I.2)}$$

Where :

QHTNMTR	:	Fishers' Catch Productions Motorboat	(Kg)
β_8	:	Intercept/Konstanta	
β_9, β_{10}, β_{11}, β_{12}, $\beta_{13,...}$	:	Coefisien Regresion	(Independent variable)
Ln	:	Logarithms Naturally	
LMT	:	Sea time	(Hours)
SLR	:	Diesel value	(Litres)
QTKR	:	Total Labor	(Life)
QUMUR	:	Age of fishers	(Year)
QPEND	:	Fishers' formal education	(Year)
PNGMLT	:	Sea experience	(Year)
e	:	Disturbance error	(Disturbance error)

2.1.2 Tradisional (Small Scale) Fishers Using Outboard Motors

To estimate the catch of fishers on outboard motors, a double regression model was used with the following model :

$$QHTNMTP = \beta_0\ \beta_1 LMT\ \beta_2 PWRM\ \beta_3 QBNSN\ \beta_4 QUN\ \beta_5 PENDN\ \beta_6 PNGMLT\ \beta_7 QALTKP \quad \text{(I.3)}$$

The double log or natural logarithm (Ln) mathematical equation is used to facilitate the calculation of the equation model (1.3) as follows :

$$LnQHTNMTP = Ln\beta_0 + \beta_1 LnLMT + \beta_2 LnPWRM + \beta_3 LnQBNSN + \beta_4 LnQUN + \beta_5 QPENDN + \beta_6 PNGMLT + \beta_7 QALTKP + e_1 \quad \text{(I.4)}$$

QHTNMTP	:	Fishers' Catch Production Outboard Motor	(Kg)
β_0	:	Intercept/Konstanta	
β_1, β_2, β_3, β_4, $\beta_{5,...}$	:	Coefisien Regresion	(Dependent Variable)
Ln	:	Logarithms Naturally	
LMT	:	Sea time	(Jam)
PWRM	:	Outboard engine power	(PK)

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QBNSN	:	Gasoline value	(Liter)
QUN	:	Age of fishers	(Tahun)
QPENDN	:	Fishers' formal education	(Tahun)
PNGMLT	:	Sea experience	(Tahun)
QALTKP		Total Fishing Tools	(Unit)
e	:	Disturbance error	(Disturbance error)

2.1.3 Analyse catch per unit effort (CPUE)

Pitcher et, al, (2019) Fishery productivity is a measure that describes the effectiveness or success of fishing effort in producing maximum catches while maintaining the sustainability of fishery resources. Catch per unit effort theory typically measures how many fish are caught with a given amount of effort, or fishing effort. This fishing effort can be measured in different ways, such as the number of fishing hours, the number of nets used or the number of fishermen involved.

To make it easier to analyse fishery productivity or catch per unit effort (CPUE). The data were calculated using Schaefer's (1954) analytical model as follows [8]:

$$CPUE = \frac{catch\ (ton)}{effort\ (trip)} \qquad \text{(I.5)}$$

CPUE : Fishers' Catch Productivity
Catch : Catch Production (Ton)
Effort : Sea Time (Trip).

3. Methods

The research aims to identify the determinants that affect the catch and catch per unit effort of motorboat and outboard motorboat fishers in Bulukumba Regency. Specifically, the study focuses on the impact of variables including the duration of fishing trips, diesel and gasoline volume, crew size, age and educational attainment of fishermen, fishing experience, outboard engine horsepower, and fishing gear count on the fishing outcomes. The research participants are fishermen who use motorboats (juragan fishermen) and outboard motorboats, also referred to as traditional fishermen. The study was carried out in Ujung Bulu District, Bulukumba Regency, and the sample consists of 407 fishermen who reside in four villages, namely Bentengnge, Kasimpureng, Terang-Terang, and Bintarore in Ujung Bulu sub-district. The population for motorboats is based on census data comprising 81 respondents, with the population being equivalent to the sample. Likewise, there are 81 respondents for outboard motorboat fishermen.

3.1 Testing Parameters

a. Classical Assumption Test and Multiple Linear Test
b. Analysis Catch Per Unit Effort

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3.2 Experiment Design and Construction

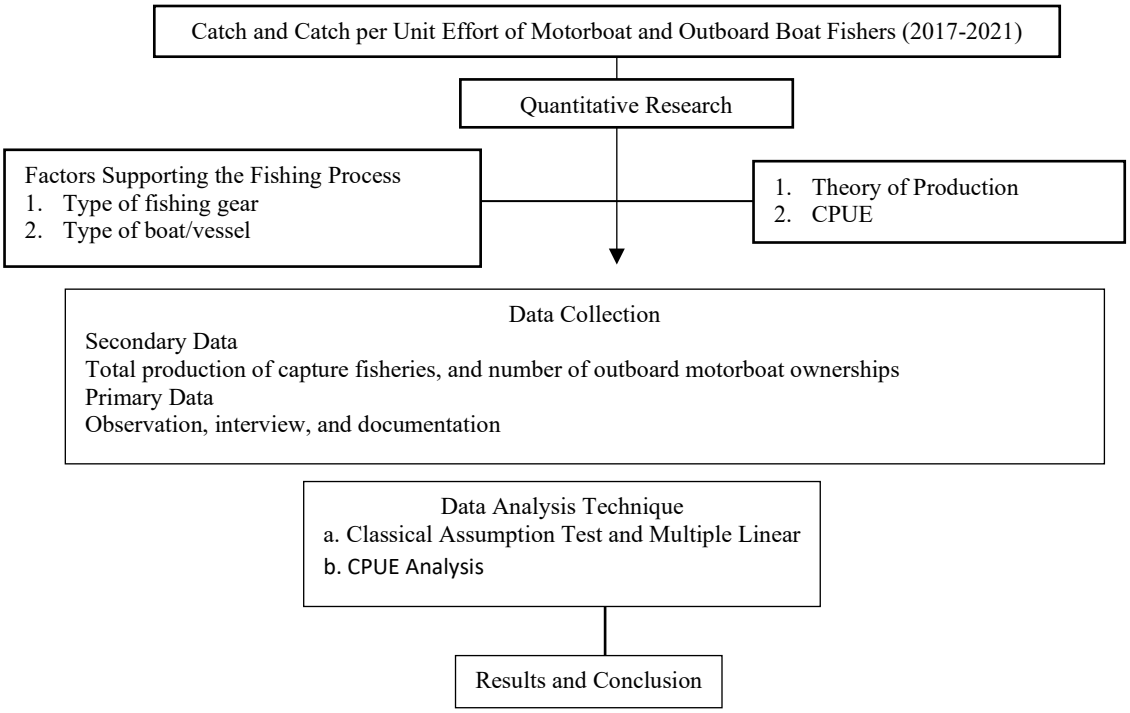

Figure 1. Research Design

4 Results and Discussion

4.1 Catch Production of Motorboat and Outboard Motorboat Fishers

Table 4.1 Regression Analysis Results of Catch Production of Outboard Motorboat (Y1) and Motorboat (Y2)

Variabel Independen	Outboard Motorboat			Motorboat		
	Koef (β)	t Value	Sig.	Koef (β)	t Value	Sig.
Sea Time	1,351	4,165	***0,000	-4,896	-4,768	***0,000
Outboard engine power	-0,563	-1,953	**0,055	-	-	-
Gasoline value	0,630	1,326	ns0,189	-	-	-
Diesel value	-	-	-	0,165	3,230	***0,002
Age of fishers	-0,080	-0,494	ns0,623	-1,399	-2,130	***0,037
Total Labor	-	-	-	-6,229	-1,058	ns0,293
Fishers' formal education	0,031	0,019	ns0,623	3,150	0,387	ns0,700
Sea experience	0,122	0,643	ns0,522	2,880	4,569	***0,000
Total Fishing Tools	0,212	1,331	ns0,187	-	-	-
Intersep/Konstanta		0,054			127,981	
F value		4,338			9,489	
Adjusted R^2		0,226			0,389	
Sample (n)		81			81	

Source : Output SPSS 25. Data Processed 2022

Where :

*** = Significant error rate 1 % (0,01), or confidence level 99 %
** = Significant error rate 5 % (0,05), or confidence level 95 %
* = Significant error rate 10 % (0,10), or confidence level 90 %
ns = insignificant

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Based on the regression analysis results in table 3.1, the regression equation is as follows :

$$LnQHTNMTR = 127,981 - 4,896\ LnLMT + 0,165\ LnQSLR - 6,229\ LnQTKR - 1,399\ LnQUmur + 3,150\ QPENDN + 2,880\ QPNGMLT + e\ 63,74923 \quad (I.6)$$

$$LnQHTNMTP = 0,054 - 1,351\ LnLMT - 0,563\ LnPWRM + 0,630\ LnQBNSN - 0,080\ LnQUN - 0,031\ QPENDN + 0,122\ PNGMLT + 0,212\ QALTKP + e\ 12,20102 \quad (I.7)$$

Related to the production of catches in previous studies, the results of research by Miftachul Munir, 2022 on factors affecting the production of fishermen in Kradenan Village, Palang District, Tuban Regency are positively influenced by the variables of capital, expertise, length of time at sea and weather.

The variable sea time in Ujung Bulu Sub-district, Bulukumba Regency has a positive effect [9], [10] of 0.000 for motor boat and motor boat fishermen and 0.000 for catch production in Ujung Bulu Sub-district, Bulukumba Regency. The positive effect means that fishermen who spend more time at sea have a greater chance of reaching fishing grounds further away from the coast [11]. These areas have larger fish populations or more diverse fish species, which can contribute to increased catch production. This positive effect can also occur if fishermen who have access to better and more sophisticated motorised or outboard boats can reach further and more efficient fishing grounds.

The power of the outboard engine has a positive impact on the catch production of outboard motorboat fishermen, with an effect size of 0.055. This effect arises because a larger engine size yields a greater capacity for pertalite fuel, enabling fishermen to explore longer distances. The use of pertalite fuel is more prevalent than diesel fuel among fishermen. This is consistent with Jabri et al.'s (2013) research in Oman [12], which found that the power of the engine has an impact on the income of small-scale fishermen. A higher engine power enables the fishers to access catch areas that are farther away and contain a higher potential catch [13].

The quantity of diesel used has a positive impact on the catch production of motorboat fishermen at a rate of 0.002. If the fishermen are able to sell their catch at a good price, an increase in petrol usage can generate greater income for them. Furthermore, a higher volume of gasoline enables fishermen to travel further to fish-rich waters, thus enhancing their catch.

A negative effect of 0.189 occurs on outboard motorboats when there is an increase in the amount of gasoline used. The mentioned negative effect can be attributed to fishing grounds being farther away, leading to amplified operational expenses. Additionally, larger and more powerful engines result in higher operational expenses, comprising elevated fuel consumption and boat maintenance costs. An appropriate solution is to enhance efficient fishing techniques, for instance by selecting more strategic fishing sites grounded on data about fish movements. Doing so can lessen both the time and expense incurred on travelling [14].

The age of fishermen has a positive impact on the catch production of motorboat fishermen, measured at 0.037. This constructive impact arises from the abundance of experience that older fishermen have, particularly in terms of managing motorboats, navigating the sea, and catching fish. Besides, the interactions and networks among fishing industry members further contribute to this effect. This resource can provide up-to-date information on sea conditions, fish prices, and opportunities to collaborate with other fishermen and industry stakeholders. Additionally, the age variable of outboard motorboat fishermen has a negative effect of 0.623, signifying declining productivity with increasing age. Furthermore, it is widely acknowledged that the employment of labour on outboard motorboats is comparatively limited compared to other types of motorboat. Under field conditions, individuals over 60 years of age who are productive can still go to sea, even though physical productivity may decrease with age. However, this can vary for each individual and is dependent on their general health, fitness, and lifestyle. When it comes to changing culture and outlook, older fishermen find it somewhat difficult to alter fishing techniques that have become entrenched in their culture and tradition. Older fishermen experience challenges when it comes to obtaining new training, technology, and information. This issue can be tackled by improving access to education and training resources. Offering ongoing training and education to fishers in contemporary fishing techniques, marine resource management, technology usage, and sustainable practices can aid elderly fishers in adapting to the latest developments in the fisheries industry [15].

The provision of formal education to fishermen has a negative impact on the catch production of motorboat and outboard motorboat fishermen, where the coefficients are 0.700 and 0.985 respectively. This negative influence results from the fact that, generally, the community acquires knowledge of fishing from their parents, which constitutes the traditional body of knowledge for their profession. These findings corroborate those of A. Rahim, D.RD. Hastuti, et al. (2018) in Nelayan Indah Village, Medan Labuhan District, Medan City [16], [17]. It should be noted that fishermen with lower levels of formal education are potentially exposed to fewer modern techniques associated with more effective and sustainable fisheries practices, which could adversely impact catch productivity.

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Fishing experience has a negative effect on the catch production of outboard motorboat fishermen and motorboat fishermen [18], with coefficients of -0.610 and -0.298 respectively. This unfavourable scenario results from the tendency of experienced fishermen to catch excessive amounts of fish over time and lead to overfishing and a decline in fish stocks, thus reducing catch production. Moreover, experienced fishermen are reluctant to embrace new, sustainable practices or modern technology that could boost production. This impediment has a limiting impact on the development of more effective methods to enhance catch production.

The use of excessive fishing gear negatively impacts the catch production of outboard motorboat fishermen by 0.187. This adverse effect arises due to overfishing resulting from the utilization of a significant amount of fishing gear in a single water area. Overfishing jeopardises the survival of fish populations, resulting in a decline in fish stocks. This adverse effect arises due to overfishing resulting from the utilization of a significant amount of fishing gear in a single water area. This adverse effect arises due to overfishing resulting from the utilization of a significant amount of fishing gear in a single water area. Moreover, extensive usage of fishing gear triggers unwanted fish capture, also known as bycatch. This may involve unintended catch of non-target species, such as protected or endangered marine animals, that can become entangled in nets and trawls.

The total labour force has a negative impact on the production of motorboat fishing. Its effect is -0.293, as high labour requirement increases costs pertaining to salaries, incentives, and crew member benefits. This results in higher operational costs, reducing net profits. Overabundance of workforce on motor vessels may adversely affect productivity by giving rise to role and task conflicts, lack of coordination, and decreased efficiency.This can diminish the overall efficiency of the motor vessel and the quality of service or production offered.

4.2 Catch per Unit Effort Analysis

4.2.1 Motorboat Fishers

Table 3.2 The Results Of The Estimation Of The Production Of Fishing Effort And CPUE Of 4 Villages (Bentengnge, Kasimpureng, Terang-Terang, And Bintarore) In Ujung Bulu Sub-District, Bulukumba District

Year	Average Production (kg)	Production (kg)	Effort (trip)	CPUE (kg/trip)
2017	1235.625	9885	216	45.76388889
2018	1313.75	10510	195	53.8974359
2019	1578.125	12626	196	64.41836735
2020	1143.125	9145	269	33.99628253
2021	1074.375	8595	244	35.22540984
Total	6345	50761	1120	233.3014
Average				46.66028

Source : Data Primer, (2022)

Based on the Effort and CPUE Relationship Graph of fishermen from 4 villages in the Ujung Bulu sub-district between 2017 and 2021, a linear equation is derived: Y = -0.3542x + -128.25 with an R2 of 0.8274. This equation illustrates that :

a. The equation y = -0.3542x + -128.25 with an R2 value of 0.8274 demonstrates that the constant (a) of -128.25 indicates the potential available in nature to be -128.25 kg/trip when no effort is exerted. The regression coefficient (b) of -0.3542 denotes a negative relationship between production and effort, indicating that each reduction of 1 trip's effort leads to an increase in CPUE of -0.3542 kg/trip, and vice versa.
b. The R2 coefficient of determination is 0.8274, equivalent to 82.74%. This signifies that the fluctuation or changes in CPUE by 82.74% are due to the variation of effort values and the remaining 17.26% is attributable to other factors not outlined in this research.

The CPUE value in Table 3.2 varies between 2017 and 2021. The maximum CPUE value of 64 kg/trip occurred in 2019, while the minimum of 33 kg/trip was observed in 2020. Changes to fishing gear and effort resulted in the fluctuations in CPUE values during this period. Furthermore, in 2020, the CPUE value declined from 64 kg/trip to 33 kg/trip due to excessive fishing efforts in the previous year. If fish resources are not appropriately managed and regulated, this can result in overfishing, leading to a decrease in fish stocks and catch per unit of effort (CPUE). The outbreak of Covid-19 has significantly affected several economic sectors, including the fishing industry. The imposition of movement restrictions and supply chain disruptions have adversely impacted fishers and fishing activities. Fishers may be constrained by travel restrictions, limited access to markets and interruptions in catch distribution, which have caused a decrease in the fishing efforts.

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4.2.2 Outboard Motorboat Fishers

Table 3.3 Results of Catch Effort Production and CPUE Calculation of 4 Villages (Bentengnge, Kasimpureng, Terang-Terang, and Bintarore) in Ujung Bulu Sub-district, Bulukumba Regency

Year	Average Production (kg)	Effort (trip)	CPUE (kg/trip)
2017	545,416	397	471,208
2018	492,916	250	371,458
2019	469,166	190	329,583
2020	577,5	207	392,25
2021	577,916	193	385,458
Average	532,5828	247,4	389,9914
Total	2662,914	1237	1949,957
Intercep (a)	261,49		
Slope (b)	0,5194		

Source : Data Primer, (2022)

Another case of Catch per Unit Effort (CPUE) for outboard motorboat fishermen is presented in Table 3.3, wherein the average production in 2017 was 545.416kg, and the CPUE value was 471.208kg. This indicates that an increase in effort along with an increase in CPUE could lead to overfishing or higher productivity. However, our analysis of previous years shows that the CPUE value of outboard motorboat fishermen has decreased annually. In 2019, there was a significant drop in catch, due to a reported disease outbreak. This led to restricted market access, disruptions in the supply chain, and closures of both local and international markets, which made selling fish problematic for fishers. As a result, fishermen may be less motivated to go to sea, or there may be lower demand for their catch, which could negatively impact the catch per business unit. Furthermore, any disruptions to the provision of fuel, equipment, and logistical support can also impact the fishing effort and catch of fishers.

5 Conclusion

Based on the analysis that has been conducted, the variables affecting the catch production of motorboat fishermen, outboard motorboats and Catch Per Unit Effort (CPUE) can be summarised as follows :

a. The variable of sea time (X1), volume diesel (X2), age of fishermen (X4), and experience at sea (X6) are variables that positively affect the catch production of motorboat fishermen. Similarly, the length of fishing (X7) and outboard engine power (X2) are variables that positively affect the catch production of outboard motorboat fishermen (Y2). It is important to note the significant impact these variables have on catch production.
b. The variable of total labour (X3), fisher formal education (X5) has a negative effect on the catch production of motorboat fishermen (Y1), as well as the variable of gasoline volume (X9), fisher's age (X10), fisher's formal education (X11), fishing experience (X12), total fishing gear (X13) negatively affect the catch production of outboard motorboat fishermen (Y2).
c. The primary hurdle in enhancing the well-being and longevity of the fishing industry is to achieve a balance between the favourable and negative impacts of each factor.
d. Opportunity: Utilise the positive influence of several variables, including the length of time spent at sea, diesel volume, age, fishing experience, and outboard engine power, to increase catch production for motorboat and outboard boat fishers. By optimising the impact of each variable, fishers can devise more productive fishing methods, such as identifying more lucrative fishing locations and pursuing fishing during the season with the highest yields.
e. Solution: Provide education and training to fishermen to enhance their comprehension of the factors that impact their catch, including diesel volume, age, education, and experience. This will enable them to detect patterns in fisheries production and take appropriate countermeasures. Provide advanced fisheries technology aid to fishermen to assist them in optimising the beneficial effects of engine power and gear size. Technologies like GPS, state-of-the-art weather sensors, and highly efficient fishing gear facilitate the search for prime fishing locations and ultimately boost catch quantities. Additionally, it is essential to monitor fishery activity and catch rates regularly to determine the influence of diverse variables. These findings furnish valuable data to assess the efficacy of fishing management methods and make any required alterations.

f. Using the CPUE (Catch per Unit Effort) data, motorised boat and outboard motor boat fishermen experienced fluctuations between 2017 and 2021, with an average value of 389.9914kg/trip for motorised boat fishermen and 46.66028 kg/trip for outboard motorboats during this period.

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