International Conference on Engineering Design and Environmental Sustainability (ICEDES) 2025
ISSN: 3031-7320
Website: https://ic.upstegal.ac.id/index.php/icedes

PRODUCTION CORRELATION AND PRODUCTION FACTORS IN PURSE SEINE FISHING BASED IN TPI TEGAL CITY HARBOR

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ABSTRACT *Purse seine fishing gear is very effective for catching small pelagic fish operated by circling schools of fish with fishing aids (FADs and lights). Efficiency as one of the performance indicators of the capture fisheries sector, production factors need to be optimized to prevent waste or inappropriate use of production factors. The purpose of this study is to determine the relationship between production and production factors in purse seine fishing unit based in TPI Pelabuhan and analyze production factors that significantly influence.*
The method used in this research is case study method. Cobb-Douglas data analysis in the form of multiple linear regression, random sampling technique of data collection as many as 16 Purse Seine vessel questionnaires. This research was conducted on October 1-11 2024.
Based on the research conducted, the relationship between production factors contributes positively and negatively to the increase in production. Production factors that have a significant influence on output are Ship Size (X1) Net Length (X3) and Total Fuel (X5). The calculation of the coefficient of determination shows the relationship of the closeness of each production factor to fish catch. The amount of fuel factor has the greatest influence with a contribution of 39.5%.

Keywords: *Purse seine, production factors, Tegal City Port TPI.*

INTRODUCTION

The coordinates of Tegal City are 109°08' - 109°10' East Longitude and 6°50' - 6°53' South Latitude with an area of approximately 39.68 km² or 3,968 hectares (Marine and Fisheries, Agriculture and Food Service of Tegal City 2017). Tegal Maritime City has a strategic role in the national economic sector, especially for coastal communities that depend on marine products as the main source of income. Tegal city is supported by three main marketing facilities, namely Fish auction site Pelabuhan, Fish auction site Tegalsari, and Fish auction site Muareja (Alamsyah, 2023). Fish auction site Pelabuhan or Tegal East Port, also known as Pelindo Port Tegal, is an important place for fishermen to catch fish, especially using Purse Seine fishing gear. Purse seine gear is one of the most widely used methods in catching small pelagic fish, based on information from the Port Fish auction site consisting of: swallow (Decapterus spp.), mackerel (Rastrelliger kanagurta), mackerel (Selar crumenophthalmus), tembang or jui (Sardinella spp.), lemuru or siro (Amblygaster sirm), mackerel (Scoberomorus sp), cob (Auxis sp), pomfret (Formio niger). According to the Minister of Maritime Affairs and Fisheries Regulation No. 79/2016, the Java Sea, included in WPP-NRI 712, is the main location for abundant small pelagic fishing.

Purse seine is effective for catching various types of fish simultaneously with the support of additional devices such as FADs and lights. According to Hakim *et al.*, (2018), fishing activities are carried out to achieve catches that are in accordance with predetermined targets. Yogatama (2020), The

production function reflects the maximum level of output that can be obtained from the use of a given combination of inputs. Efficient management of production factors is the key to achieving optimal production outcomes. According to Wijayanti *et al*., (2020), efficiency is intended to reduce the use of production factors that are not optimal, which can have an impact on not achieving the desired fishing business income. Knowing the production factors is very important to estimate future production, thus it can be known the variables that have a significant influence on production (Triharyuni and Hartati 2014).

The successful use of Purse Seine is influenced by production factors such as ship labor, fishing gear, fuel, and capital, each factor has a crucial role in determining the amount and quality of the catch (Pratama *et al.*, 2016). According to Kirana (2024), production efficiency reflects the extent to which a company or production unit can optimally utilize resources to produce goods and services. The main goal is to minimize waste of raw materials, labor, and time. Overall production efficiency seeks to achieve optimal results at minimal cost.

Over time, Tegal City faced challenges such as falling prices and rising fuel costs that affected the economic activities of fishermen. Nisa and Auliatun (2019) stated that overfishing in Tegal City waters occurred due to the increase in the number of fishermen, resulting in a decrease in production levels. Based on this background, it is important to understand more deeply about how the relationship between production and production factors at the Fish auction site of Tegal City Port for Purse Seine fishing units. Knowing how the overall input factors affect the catch. The understanding gained is expected to give positive contribution for the manager in improving efficiency, fisheries productivity, local economic growth, and fishermen's welfare.

METHOD

This research was conducted at Tegal City Port Fish auction site, from October 1 to 11, 2024. Data collection consisted of primary and secondary data, primary data was collected from questionnaires, interviews, observations. The data collection method used is a case study with the number of samples used in this study as many as 16 Purse Seine vessels out of 180 purse seine vessels that have been determined based on the random sampling method. Data collected for Purse Seine vessels in the form of data: ship size, engine power, net length, number of crew, fuel, length of operation and fishermen skills. Secondary data in this study were data collected and analyzed from agencies and institutions such as PPN tegalsari tegal city, Fish auction site Tegal City Port, in the form of annual report data of production, the development of the number of fishing gear. Data analysis used Cobb-Douglas in the form of multiple linear regression with classical assumption test: normality test, heterocedation test, multiconelerity test. Pearson correlation test, hypothesis making: F test, coefficient of determination R2 and coefficient of determination analysis.

RESULTS AND DISCUSSION

Tegal city has three main locations for fish auctions, namely Fish Auction Place Pelabuhan, Fish Auction Place Tegalsari, and Fish Auction Place Muarareja. In 2023, the number of vessels in Tegalsari Perikanan Nusantara Port was recorded at 3,177 units, and the number of crew members registered with BPJS was 51,162. Tegalsari Perikanan Nusantara Port uses a variety of fishing gear, including cantrang or JTB, gill net, bandong or bubu, small pelagic Purse Seine, fixed gill net, bouke ami, squid fishing rod, carrier, and vessel fall net.

Fish Auction Place Pelabuhan is one of the fish auction sites in Tegal City, located in the Pelindo Regional three port area, with an area of +/- 9,000 m2. As a place to dock vessels, such as Purse Seine, Mini Purse seine and Gillnet vessels. Purse seine is one of the effective fishing gear to catch various types of pelagic fish, such as Layang, Bawal, Mackerel, Selar, Tembang, Tongkol, Lemuru, Tenggiri, and Squid.

The Fish Auction Place (TPI), has functions and objectives as an economic improvement through the enhancement of the fishing industry, a means of marketing fishery products, ensuring they receive the best price for their catch and trying to attract more potential buyers (price stability), as local revenue and statistical data collection in its regulatory planning efforts. The port itself functions as a center for loading and unloading goods, a logistics distribution hub, and a crucial international trade gateway, facilitating the storage and holding of goods, connecting land and sea. Ports are gateways, interfaces, and links in the supply chain, becoming industrial entities that drive business growth, meeting places for various interests, and providing supporting facilities for the distribution of production and the movement of people.

The most dominant catches or the main catches are Layang and Tongkol fish. Layang fish (Decapterus spp) is a small pelagic fish that lives in groups and is the main catch of fishermen. This fish actively follows the current and gathers in plankton-rich waters, found on the coast and high seas. It is slender, flat, with a silvery color, and 10-25 cm long. The catch of kite fish is auctioned at the fish auction with a price of Rp.8,000 - Rp.14,000 per kg. Kite fish production in January 2024 reached 586,022 kg, and experienced significant fluctuations in May around 91,868 kg (Marine and fisheries, Agriculture and Food Service of Tegal City, 2024).

Tongkol (Euthynnus affinis) is the most dominant catch or the most important catch. As the main catch, Tongkol is a pelagic fish species that has a torpedo-shaped, slender, and sturdy body, allowing it to swim quickly. Tongkol has a blue-black color on its upper body, while its underside is shiny gray. It can reach a length of 30-40 cm and sells for between Rp 11,000 and Rp 16,000 per kilogram (Marine and fisheries, Agriculture and Food Service of Tegal City, 2024).

Fishermen's catches are auctioned at Tegal City Port TPI using pure auction and borong auction system. Pure fish auction is a fish trading system conducted at fish auction site (TPI) with open auction method, fishermen's catches are sold to buyers or bidders through transparent bargaining process and directly in public. Borong fish auction is a fish trading system where fishermen's catches are sold to

buyers (bidders) in large quantities through an auction process. The following is information on the production of capture fisheries at the Tegal City Port TPI during the period 2019 to 2023 in Table 1:

Table 1. Production Potential of Tegal City Port TPI

No	Year	Production (kg)	Raman (Rp)	Retribution (Rp)
1	2019	13.407.297	162.152.491.000	4.507.839.249,80
2	2020	12.901.938	177.414.073.000	4.932.111.229,40
3	2021	11.306.267	185.884.887.000	5.162.599.858,60
4	2022	9.310.769	159.959.853.000	4.446.883.913,40
5	2023	11.342.231	159.540.260.000	4.435.219.228,00

Source: Tegal City Port TPI, (2024)

The Department of Marine Affairs and Fisheries, Agriculture and Food of Tegal City attempted to increase production, retribution, and quality of fishery products through several strategic steps. These efforts included: the arrival of ships and fish from outside the region to be auctioned at the Tegal City Fish Auction Site (TPI), as well as an increase in the proactive collection of ship documents (pick-up ball) to ensure orderly administration in recording ship arrivals. Provide recommendations for subsidized diesel fuel services and harmonize coordination with various related parties such as Pelindo Regional three, Port Police, PSDKP Satker, PPN Tegalsari, KSOP, and other stakeholders. Approaching ship owners from outside the region is also part of the improvement strategy.

Mini Purse Seine gear shows a consistent decline in numbers from year to year, with fishermen switching to gross tone Purse Seines ranging in size from 50 - 160 GT, as they produce higher productivity. The main advantage of Purse Seine is its potential to catch large quantities of fish, which can bring significant profits. The following table 2 shows the development of Purse Seine fishing gear:

Table 2: Development of Purse Seine Fishing Gear

No	Year	*Purse Seine*	*Purse Seine* Mini
1	2019	149	256
2	2020	150	223
3	2021	165	126
4	2022	141	69
5	2023	180	54

Source: Tegal City Port TPI, (2024)

According to Henantyo *et al.*, (2016), Purse Seine offers higher productivity than other fishing gears, but its disadvantage lies in the need for labor. The Purse Seine size for daytime fishing is longer than that used at night. Purse seine is a fishing gear designed to effectively catch schooling fish in shallow waters. It is categorized as active because its use involves obstructing, confining, and restricting fish movement space, so that fish cannot escape. The use of Purse Seine gear involves two main stages,

namely setting and hauling, the success of both of which depend on a number of factors, including the speed at which the net is coiled, the sinking of the sinker, and the pulling of the collar rope.

Purse seine is strongly influenced by these factors, the operation of this gear is similar to the general light fishing technique, which uses lights to collect fish that are clustered. Fish are directed to the bangkra lamp, then, the vessel moves around the bangkra while lowering the fishing gear. Next, the bottom of the net is pulled so that the fish are trapped inside (Siahaan *et al.*, 2021). Purse seine vessels are characterized by many lights mounted on the top, which serve to attract fish, especially at night. With this strategy, fishermen can significantly increase their catch.

The success of a fishing operation is greatly influenced by the design and manufacture of the fishing gear used. Proper technical calculations are required to produce effective and efficient fishing gear. Good fishing gear is a combination of various components that are carefully designed using techniques and calculations that have been equipped. The more effective the fishing gear used by fishermen, the greater the catch that can be achieved (Putra and Khikmawati, 2023).

The main components of the Purse Seine net fishing gear are the net body and rigging. The net is divided into three main parts, namely the main part, wings, and pockets, which are equipped with various ropes such as buoy ropes, upper ris ropes, lower ris ropes, weight ropes, collar ropes, and slambar ropes. The Purse Seine is equipped with floats, weights, and rings. The length and width of the trawl ring determine its design, with the length being measured where the wingtip is to the other wingtip, and the width being the distance between the upper ris rope and the lower ris rope. Inverted trapezoidal Purse Seine rings have a width or height measured at the center or at the pocket forming area (Putra and Khikmawati, 2023).

The process of using Purse Seine gear begins with a search for fish using sonar or echo sounder. The location is found, the ship moves around the school while lowering the net in a circular manner (setting), the rectangular net is lowered with a float on the upper side and a weight on the lower side, so that the net can sink optimally. The net is set well around the schools of fish, the bottom of the net is pulled up with a collar rope, forming a pocket that holds the fish inside. Next, (hauling) the net is pulled onto the ship using hydraulic tools such as power blocks, until the fish are collected in the net to be lifted onto the ship.

The next stage of fish handling on board involves washing, sorting according to the type of fish, the size of the fish, the next stage is freezing using a freezer with a temperature of around -20°C, then packaging, and storing the fish in the hold.

a) Unloading the Catch

b) ransportation of Fishing Products

c) Fish weighing

d) Fish auction

Figure 1: Fish marketing

Musim puncak penangkapan ikan terjadi pada bulan agustus hingga bulan desember sedangkan musim paceklik penangkapan terjadi pada bulan januari hingga maret. Kapal dan Mesin Kapal purse seine frezzer memiliki ukuran GT kisaran 50 - 160 GT daerah penangkan di Laut Jawa, Selat Makassar, Selat Sulawesi, perairan Bawean, perairan Karimunjawa, perairan Kalimantan, dan Laut Natuna. Lama operasi penangkapan armada purse seine sekitar 3-4 bulan dengan jumlah bahan bakar sekitar 30 -35 ton. Daya mesin 300 – 600 PK daya mesin kapal digunakan untuk penggerak kapal, pembangkit listrik dan sebagai mesin induk. Panjang jaring untuk melingkari kawanan ikan, sehingga membentuk seperti mangkuk atau kantong dengan ukuran sekitar 350 – 600 meter, Jaring terbuat dari polyethilene (PE), dengan ukuran 0,394 – 0,787 inci mata jaring. Jumlah anak buah kapal sekitar 30-35 ABK.

Efficient management of production factors is key to achieving optimal production results.

Efficiency is intended to reduce the use of non-optimal production factors, which can have an impact on not achieving the desired fishing business income. Efficiency acts as a performance benchmark in the capture fisheries sector, with the need to optimize production factors so that fishing units run effectively and produce catches in accordance with resource capacity (Wijayanti *et al.*, 2020).

The results of questionnaire data collection on 16 Purse Seine vessels in Tegal City Port Tpi. The data were analyzed in the form of Cobb-Douglas production function equation of multiple linear regression, the first step of classical assumption test is a procedure that must be met so that multiple linear regression can be applied correctly, so that the resulting estimates become unbiased and efficient. The classical assumption test consists of: normality test, heterocedation test, multiconelerity test. Pearson correlation test, hypothesis making: F test, coefficient of determination R2 and coefficient of determination analysis. Data analysis for the Cobb-Douglas production function equation using multiple linear regression with the SPSS version 25 application, can be made the following production relationship equation and production factors:

$$Y = 236.891 + 0{,}695\ x_1 + 0{,}075\ x_2 - 0{,}181\ x_3 - 1.527\ x_4 + 2.285\ x_5 + 0.521\ x_6 + 17.813\ x_7.$$

Unknown:

Y : Related Variable (Quantity of production)

b0, b1,...,b7: Regression coefficient

X1: Ship size (GT)

X2: Engine power (PK)

X3: Net length (Meter)

X4: Number of crew (Person)

X5: Total fuel (Ton)

X6: Length of operation (Days)

X7: Fisherman Skills (Fisherman skill score (1: very low, 2: low, 3: medium, 4: high, 5: very high, 6: professional))

From the results of multiple linear regression analysis, several main points can be concluded as follows:

1. Ship Size

The regression coefficient of 0.695 indicates that each additional 1 GT size increases production by 0.695 tons per trip. This indicates that the technical design of the vessel plays an important role in operational efficiency and fishing capacity. Vessels with larger size can carry larger fishing gear and catch more. Based on the p-value (0.024), the size of the ship has a statistically significant effect on production. Ariefandi and Isdianto's (2023) research supports these findings, stating that a larger catch storage space capacity on vessels with higher tonnage grose affects the volume of catch.

2. Engine Power

The regression coefficient of 0.075 has a positive impact, an increase in engine power by 1 PK will increase production by 0.075 tons. The speed of the ship in pursuing schools of fish is influenced by the engine power capacity, especially when operating the net. according to Imanda *et al.*, (2016), the speed of the ship in pursuing moving schools of fish is determined by engine power, and ships that have higher speed can compete with the speed of the fish.

The p-value (0.103) indicates that this effect is not statistically significant due to several external factors such as weather, season, and fishing location. according to Damayanti (2021), the use of more powerful engines in fishing needs to be accompanied by a good understanding of fish stocks and conditions of the fishing area, in order to minimize losses and ensure the safety of fishermen.

3. Net length

The net length coefficient of 0.181 has a negative effect, adding 1 meter of net length will increase production by 0.181 tons. The net is made of polyethilene (PE), with a mesh size of 0.394 - 0.787 inches. The use of nets that are too long can result in difficulties in operating and managing nets at sea, thus reducing the effectiveness of fishing. In accordance with the opinion of Imanda *et al.*, (2016), which states that the net looping process in Purse Seine fishing gear takes longer as the length of the net increases, which also requires a machine with greater power to balance the speed of the fish.

At a p-value of (0.020), the effect of net length is statistically significant. The results of observations and interviews using an effective net tailored to the characteristics of tareget fish and water conditions, can increase the catch optimally. According to Zakaria *et al.*, (2017), the more effective the fishing gear used by fishermen, the higher the success rate in obtaining optimal catches.

4. Number of crew

The coefficient of the number of crew members 1.527 has a negative effect, adding crew members will increase production by 1.527 tons. The addition of crew members will reduce production if it is not balanced with increased efficiency, causing ineffective use of labor which will only increase operational costs, waste from an economic point of view. The crew must be over 17 years old, crew members with more experience and training usually have superior abilities and understanding in fishing techniques, so the opportunity to increase catches is greater.

The P-value of 0.457 indicates that the effect of crew size is not statistically significant. Research by Pratama *et al.*, (2016) stated that the lack of optimal quality of crew work will have an impact on the time to do the work will be longer, so that the results of a job become less optimal.

5. Total fuel

The fuel coefficient of 2.285 has a positive effect, each additional 1 ton of fuel will increase production by 2.285 tons. The type of fuel used by fishermen is diesel. The more fuel the number of days of operation will increase the ship can operate longer and reach a wider fishing area.

The p-value is 0.039 which indicates that the effect of the amount of fuel is statistically significant. The more fuel used, the stronger the ship's engine so that the ship can move faster in circling the net and chasing fish that are clustered. In accordance with Zakaria *et al.*, (2017), the use of more fuel

indicates a longer fishing ground distance.

6. Length of operation

The operating duration coefficient of 0.521 has a positive effect, each additional operating duration of one day will contribute to an increase in production by 0.521 tons. Increasing the duration of the ship's operational days will increase the number of fishing days, so that it can produce more catches and expand the fishing area. The use of technological tools such as ecosonders will accelerate the fishing ground. Purse seine vessels operating in Tegal City Harbor generally fish in Kalimantan, Makassar, and Java Sea waters, with a duration of operation of around 3 to 4 months. According to Dewi *et al.*, (2020), that the duration of fishing affects fish catches, the longer the fishing time, the greater the amount of fish that can be obtained by fishermen.

The p-value is 0.278 which indicates that the effect of length of operation is not significant on production. The results of observations and interviews that the longer the operating day, the more operational costs incurred and ship supplies with this need for effective operational management. This is in accordance with Dimas and I Ketut (2018), the decreasing availability of fish in the sea makes it difficult for fishermen to get the maximum catch, even though the time spent at sea is increasing.

7. Fisherman Skills

The coefficient value of Fisherman Skills 17.813 has a positive effect, if the increase in fisherman skills will increase production by 17.813 tons. The higher the fishermen's competence, the higher the catch obtained. A supportive work environment also contributes to improving fishermen's performance. In accordance with Sabrawijaya (2020), skill is a special proficiency or expertise that a person has. Mastering more efficient fishing techniques, such as selective use of fishing gear and responsible fishing practices, can yield more fish.

The p-value is 0.085 which indicates that the effect of fisher skills is not statistically significant on production yield. The results of observations and interviews that the skill factor of fishermen is also influenced by the weather, and the fishing season. In accordance with Choirunnisa *et al.,* (2022), the impact of climate change is felt in many aspects of life, one of which is seasonal shifts that affect capture fisheries, which are highly dependent on the availability of marine resources. High wind strength and large waves prevent fishermen from catching fish, resulting in a decrease in fishing production.

F Test Results And Coefficient Of Determination

Based on the results of data analysis using the F test, the FHitung value obtained is 6,752, the FTabel value with a confidence level of 95% is 3.37. FHitung value is greater than the FTabel value, then the hypothesis (H1) is accepted, that the independent variables together have a significant influence on the dependent variable, namely fish catch using Purse Seine fishing gear. Conversely, the null hypothesis (Ho) is rejected, indicating that the production factors used in fishing activities have a real influence on changes in the production yield obtained by fishing units using the Purse Seine gear method.

The value of the coefficient of determination (R^2) which shows the extent to which the independent variable is able to explain the variation that occurs in the dependent variable. the value of

the coefficient of determination (R^2) is 0.925 or 92.5%. This indicates that the production variable, which in the case of this vessel includes various factors such as size, engine power, net length, number of crew members, amount of fuel oil, length of operating time, and fishermen's skills, has a contribution of 92.5% to the fish production obtained. Meanwhile, about 7.5% is influenced by other factors not included in this analysis, such as weather conditions (climate), fishing season, and other environmental factors that can affect the amount of catch.

The Magnitude Of The Correlation Between Production Factors And Production Factors

Sugiyono (2016) explains that in correlation analysis there is a coefficient of determination, which is the square of the correlation coefficient (r^2). The coefficient of determination is used to measure the extent of the influence between the two variables studied. The calculation of the coefficient of determination (Kd) is carried out assuming that other factors not analyzed are considered constant (ceteris paribus).

The coefficient of determination has a total percentage of 100%. The coefficient of determination does not reach 100%, so the rest reflects the influence of other factors that affect the variable being analyzed.

Kd= r2x 100%

In detail, the magnitude of the influence of production factors on Purse Seine fisheries is presented in Table 3.

Table 3. Coefficient of Determination of the Relationship between Production and Production Factors

NO	Variables	Coefficient of Determination (R)
1	Ship Size X_1	0,19 %
2	Engine Power X_2	10,4 %
3	Net length X_3	20,5 %
4	Number of crew X_4	14,5 %
5	Total fuel X_5	39,5 %
6	Length of operation X_6	25,3 %
7.	Fisherman Skills X_7	12,1 %

Source: SPSS data processing results, (2024)

Factors affecting fisheries production varied in their contribution. The amount of fuel has the greatest influence (39.5%), followed by length of operation (25.3%), net length (20.5%), number of crew (14.5%), fishermen's skills (12.1%), engine power (10.4%), and vessel size which contributes the least (0.19%). The factors mentioned above fall under the category of internal factors, which are elements that originate from within the fishing business and can be controlled by the vessel owner. External factors or other factors that are not taken into account are elements that come from outside the fishing business and cannot be controlled by fishermen such as weather, fishing season, ecosystem damage, and government policies.

CONCLUSION

In conclusion, this study has shown that purse seine fishing gear, especially when combined with fishing aids like FADs and lights, plays a significant role in enhancing the capture of small pelagic fish. The analysis of production factors in the purse seine fishing unit, based in TPI Pelabuhan, reveals that optimizing these factors is crucial to improving efficiency and avoiding waste in the fishing sector. The research indicates a positive and negative relationship between production factors and fish catch, with key factors such as ship size, net length, and total fuel consumption significantly influencing output. Among these, fuel usage has the largest impact, contributing 39.5% to the overall fish catch. This finding emphasizes the importance of managing fuel consumption to maximize production while minimizing unnecessary costs, thereby supporting sustainable fishing practices.X5.

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