Financial feasibility of hand line fisheries and determination of tuna production in Ambon Island

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Abstract. The potential availability of fish resources can be utilized in various economic activities to improve the welfare of coastal communities. The utilization of tuna by using hand line is still carried out by small and medium scale fisheries with some limitations, such as technical production, costs and management skills. The purpose of this study was to describe the technical profile of tuna fishery production in Ambon Island, specifically in Negeri Tial and Negeri Laha; analyze the absolute profit level of tuna fishermen; analyze hand line fisheries business feasibility; and determine the efficient fishing input. Negeri Tial and Laha are the centers of handline fisheries in Ambon Island. This study was conducted by survey. Primary data collection through empirically constructed questionnaires and secondary data obtained from several related agencies. Samples were taken purposively, so that the number of samples in each Negeri was 20 units. A qualitative method approach is used to describe the technicalities of tuna fisheries production, while for other purposes a quantitative approach is used. The results showed that in increasing production, tuna fishermen in Tial and Laha used relatively the same type of hand line and fishing vessel size, but the use of artificial bait in Laha was more varied. Both research objects gain advantages and are feasible to be developed. Fishing input that is efficient in increasing production is the experience of fishermen and the frequency of fishing. Based on the research results, hand line tuna fisheries in Negeri Tial and Laha can be developed to improve the welfare of business actors.

1. Introduction
The estimated fishery potential in Maluku waters reaches 4,669,390 tons [1], which is distributed to the Fisheries Management Area (FMA) 714 covering the Banda Sea and its surroundings, FMA 715 Seram Sea and Tomini Bay, and FMA 718 Arafura Sea and the East Timor Sea. The utilization of small and large pelagic species (excluding tuna and skipjack) in FMA 714 and FMA 715 is fully exploited (> 0.5).

Tuna (Thunnus sp) is one of Maluku's leading commodities, with production in 2018 of 25,116 tons. This figure is lower than the 2017 production which reached 66,064 tons [2]. The contribution of Maluku tuna production comes from small-scale fishermen who use fishing fleets under 5 GT.

Small-scale hand line fisheries are generally unstable and relatively unsustainable in the long term. This is due to the limited availability of tuna resources, remote fishing grounds that affect the high cost of production, insufficient capacity of business actors, limited support for facilities and infrastructure and inadequate management of fishery products. Business uncertainty is a problem faced by fishermen, because fishing activities are very dependent on the fishing season and climate as well as government policies that have not provided certainty for sustainable business [3].

Management of small-scale fisheries is inefficient because the agribusiness subsystem, which is the chain of fisheries business from upstream to downstream, has not been managed effectively [4]. So far, business actors only use personal experience in managing their business, and this is a phenomenon of small-scale fisheries in developing their business [5].
Efficiency is a dimension of the ability to manage or utilize production assets or inputs [6]. This research used technical efficiency, which is a reflection of a business ability to maximize output with certain inputs [7]. Limited cost resources are important for business actors to allocate production factors optimally. Capture fisheries production fluctuations, on the other hand, high input costs can result in businesses experiencing losses, even collapsing. Thus, the rationality of fishermen in using inputs is important to evaluate the development of hand line fisheries. The research objectives were to describe the technical profile of tuna fishery production in Ambo Island i.e., Negeri Tial and Laha, analyze the absolute profit level of tuna fishermen, analyze business feasibility, and determine efficient fishing input.

2. Methodology

2.1. Field work
The survey was conducted on Ambon Island, specifically in Negeri Tial and Negeri Laha (Figure1), which are the centers of hand line fisheries, from July to September 2019.

![Figure 1. Research location](image)

2.2. Data collection and sampling techniques
This study used a survey. The data collected is primary data, which is obtained through interviews with questionnaires, and secondary data from several data source authorities. The number of hand line population in the research object, Negeri Tial as many as 60 units and Negeri Laha 40 units. Samples were drawn using purposive sampling technique, with the following considerations: business continuity, business activeness during the research and having justified data. Thus, the number of samples for the two research objects, each of 20 units.

2.3. Data analysis
Descriptive qualitative method is used to describe the technical of hand line fishery production, while the analysis of the level of business profit, business feasibility, and input efficiency uses quantitative methods. The procedure for using analysis tools, as follows:
1. Analysis of the level of business profits through the income statement approach, based on the formula:
   \[ \pi = TR - TC \]
   \[ TR = Q \cdot Pq \]
   \[ TC = TFC + TVC \]
Assessment Criteria: \( TR > TC \) business profitable, worth to develop  
\( TR < TC \) business unprofitable, not worth to develop  
\( TR = TC \) business break even  

2. Analysis of financial ratios using the Time Value of Money Method:  

a. Analysis of the revenue-cost ratio, as follows:

\[
\frac{R}{C} = \frac{TR}{TFC + TVC}
\]

Assessment Criteria: \( \frac{R}{C} > 1 \) business profitable, worth to develop  
\( \frac{R}{C} < 1 \) business unprofitable, not worth to develop  
\( \frac{R}{C} = 1 \) business break even  

b. Analysis of return on investment as follows:

\[
ROI = \frac{\text{Profit Earned}}{\text{Investment}} \times 100\%
\]

Assessment Criteria: The greater the ROI value, the greater the ability of the business to return the initial capital, so that the business is feasible to develop, and vice versa.  

3. Analysis of fishing input efficiency, using the Cobb-Douglas Production Function approach:

\[
y = ax_1^{b_1}x_2^{b_2} \cdots x_n^{b_n} \cdots x_i^{b_i} e^u
\]

The equation is converted to multiple regression formula, as follows:

\[
y = a + b_1 + b_2 + \cdots b_n + b + v
\]

To simplify the estimation, the multiple linear form is changed by adding the logarithm (log) to all variables and the equation above becomes:

\[
\log y = a + b_1 \log x_1 + b_2 \log x_2 + \cdots + b_n \log x_n + v
\]

where \( y \) = production; \( x_1 \) = cost of fishing operation; \( x_2 \) = fishermen’s experience at sea; \( x_3 \) = catch frequency; and \( x_4 \) = non-formal education.  

3. Result and Discussion  

3.1. Overview of technical of hand line fishery production  

Catching tuna in the two research locations uses a very simple hand line, consisting of: rollers, ropes, hooks and bait. The boat is made of fiberglass and is 7-9 m long, 1 m wide and 0.80 m high. Boat capacity <5 GT, 15 PK outboard machine. In fishing operations, natural bait (pieces of fish meat or whole fish) or artificial bait (string, chicken feathers or goat hair) is placed on the hook. Natural types of bait are used such as squid or flying fish, while artificial bait is made to resemble tuna fish (Euthynus sp) or parang-parang fish (Chirocentrus dorab). During the observation, fishermen in Negeri Laha use a fishing aid, which is called a death ring. If the weight of the tuna caught is > 30 kg, then this tool is used to speed up the towing of the catch onto the boat.
3.2. Catching frequency and production

Both Laha and Tial tuna fishermen generally have the same fishing ground, i.e., Banda Sea and around the Nusalaut waters. According to [8], Banda Sea and its surroundings is a potential area for tuna fishing using hand lines. Observations for 3 (three) months on each research location indicate that the number of catching frequencies is relatively the same, but tuna production of Laha fishermen is higher than production of Tial fishermen, with a difference of 19.6% (Figure 2). This is probably because Laha tuna fishermen use more varied of artificial bait.

![Figure 2. Catching frequency and production](image)

3.3. Cost structure

3.3.1. Permanent working capital. The average total of investment value of hand line unit in Negeri Tial is Rp35,761,050 while in Negeri Laha the amount is Rp33,485,470 or different 6.36%. Investments in machinery, ships/boats, fishing equipment vary in value (Figure 3). In Laha, the use of additional equipment is only a styrofoam box, while in Tial, compass, styrofoam box, knife and hook. The difference in the amount of capital goods also affects the investment value.

![Figure 3. Average investment value of hand line fisheries](image)
3.3.2. Variable cost. For 3 months, tuna fishermen in Laha spent an average variable cost (AVC) of Rp10,190,488.57, while in Tial for 4 months (October - December 2018 and January 2019), the amount of Rp12,159,496.75 (Figure 4). The largest variable cost in hand line fisheries in Laha is found in the fuel expenditure component (including gasoline and lubricant) by 53% and the lowest in artificial bait by 8%. The same thing also happened in Tial, the largest component of fuel was 55% and the lowest was the purchase of round stones at 5% used to lower the line during fishing operations.

![Figure 4. Average Variable Cost](image)

3.3.3. Fixed cost. Fixed costs are not significant with changes in the level of production and expenditure in units per year. The calculation of fixed costs in this study is adjusted to the time of observation at the research location. The value of fixed costs is shown in Figure 5.

![Figure 5. Average Fixed Cost](image)

3.3.4. Profit and revenue analysis. The average income and profit in the two research objects are different, due to differences in production, prices, and even expenditures. Laha fishermen received
revenue and profit of Rp82,180,975/4 months and Rp70,128,551/4 months, respectively, while in Tial it was Rp45,111,530/4 months and Rp31,199,151/4 months (Table 1).

Table 1. Average revenue and profit of hand line fishery business

| Location | Production (Kg/unit) | Price (Rp/kg) | Revenue (Rp/unit) | Expenditure (Rp/unit) | Profit (Rp/unit) |
|----------|----------------------|---------------|-------------------|-----------------------|-----------------|
| Laha     | 966.84               | 85,000        | 82,180,975        | 12,052,423            | 70,128,551      |
| Tial     | 777.79               | 58,000        | 45,111,530        | 13,912,379            | 31,199,151      |

The difference in profit between Negeri Laha and Tial handline fishermen is 55.5%. To produce 1 kg of tuna, fishermen Laha spend Rp10,540, while the Tial fishermen amounted to Rp15,633. Financially, business at both research locations was very profitable (TR > TC).

3.4. Financial feasibility analysis

The benefit of financial feasibility analysis is as information for business actors / fishermen to make decisions on developing hand line fisheries. The analysis approach uses financial ratios, Revenue Cost Ratio (R / C), Investment Benefit Ratio (PP) and Profit Investment Ratio (ROI). The analysis results are shown in Table 2.

Table 2. The results of financial analysis of the hand line fishery business

| Location | R/C   | PP   | ROI (%) |
|----------|-------|------|---------|
| Laha     | 6.88  | 0.50 | 215.08  |
| Tial     | 3.73  | 1.40 | 96.75   |

Based on Table 2, R / C is 6.88, which means that to obtain revenue of Rp. 1 requires an expenditure of Rp. 6.88. In accordance with the provisions of the R / C index> 1, the business is profitable and feasible to develop. The payback period for hand line fishery business in Negeri Laha is 0.50 years or 6 months, while in Tial is 1.5 years. It is estimated that the age of hand line business is up to 10 years, so the business is feasible to develop. The highest ROI index is found in the hand line fishery in Laha compared to Tial. It is indicated that the businesses in the two research objects get a high enough profit compared to the initial capital provided.

3.5. Analysis of the determination of catch production

The results of analysis of Cobb-Douglas Production Function model using multiple regression techniques with SPSS analysis tools are shown in Table 3.

Table 3. Regression Coefficient

| Independent Variable | Estimation Parameters | Laha | Tial |
|----------------------|-----------------------|------|------|
| Log Ø                | Constant              | 12.557 | 4.138 |
| Log x1               | Cost of catching      | -0.498 | 0.033 |
| Log x2               | Fisherman experience  | 0.108  | 0.703 |
| Log x3               | Catching frequency    | 0.487  | 0.204 |
| Log x4               | Non-formal education  | 0.169  | 0.053 |

Based on the regression coefficient estimates, the fishing production of tuna in Laha is determined by the fishermen experience variable (x2) and the catch frequency (x3). The same condition also
happened to Tial fishermen. The effect of input on output in Laha can be explained as follows, a 1% increase in fishermen fishing experience can increase catch production by 10.8% and an increase in catch frequency by 1% will increase production by 48.7%. In Tial, a 1% increase in fishermen fishing experience will increase tuna production by 70.3% and a 1% increase in catch frequency can increase tuna production by 20.4%.

4. Conclusion
1. Hand-line fishermen in Negeri Laha are more varied in using bait compared to Tial fishermen, while the size of fishing boats is relatively the same.
2. Based on the income statement and financial ratio model, tuna fisheries business in the two research locations is profitable and feasible to develop.
3. Fishermen's fishing experience and fishing frequency are efficient variables and also determine the increase in tuna production.

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