Utilization of vessel multi aid (VMA) as a smart fishing technology for small scale fisheries

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Abstract. Fishing businesses in Indonesia are generally small-scale fishing fisheries, which is highly dependent on season and weather conditions. In the Palabuhan Ratu, the area of West Java, the capture fisheries mostly operate a fishing boat under 10 GT. Various techniques to increase the success of fishing efforts in Pelabuhan Ratu have been carried out, one of them is by testing the use of vessel multi aid (VMA). The study aimed to examine the effectiveness of fishing aids in increasing the catch of fishermen by using the VMA on several fishing vessels in Pelabuhan Ratu. The experiment was conducted from September to November 2019 on ten payang fishing vessels with a capacity of 2GT - 5 GT, using YUKOM VMA. YUKOM VMA is a fishing aid using radio waves and has features: fishing area information, weather condition information, SOS, which can be used during emergencies and e-logbook for recording catches. The results showed that the average fish catch per trip tended to increase by 58.08% per trip. This suggests that the use of fishing aids technology in the form of VMA in small-scale fishing efforts may be an effective way of increasing the catch.

1. Introduction

The resource development of capture fisheries enterprises in the Sukabumi Regency is faced with problems: high potential but declining productivity. Based on research was done by Wardono [1] that the productivity of fishermen and small fishing vessel tend to always decrease each year. The trend is inversely proportional to the productivity of the large fishing vessel, which always rises. This condition is pressuring the role of small-scale fisheries from whose share of production is less than 5% in 2013. The number of ships and fishermen in the small fishing vessel is much greater than the large fishing vessel. With a very small share, the role of small-scale fishermen in Palabuhanratu gradually gets smaller and increasingly marginalized. This will have an impact on efforts to improve the welfare of small fishermen. Furthermore, this condition can threaten the sustainability of small-scale fishing businesses.

Efforts can be made to improve the living standards or fishermen's income by increasing their catch production. One way to do this is to work towards productive fishing units, i.e., high in quantity and catch
values as well as fishing technology vessel multi aid that is suitable for their fishing objectives [2]. In addition, the fishing units must be efficient and make use of technologies that are suitable for the local conditions and, at the same time, do not damage the fisheries resources' sustainability [1].

The use of smart fishing tools such as Vessel Multi Aid (VMA) is one of the efforts to increase fishing productivity. The use of these tools is expected to increase fishing efficiencies technically and economically for the user. The introduction of this tool to the fishing community in Palabuhanratu is expected to be a solution to increase the fishermen's productivity and welfare in Palabuhanratu. Therefore it is necessary to introduce new technologies like VMA fishing aids and evaluate the extent to which these tools can increase the productivity of small-scale fishermen in Palabuhanratu, West Java.

2. Method

2.1. Data collection

The method used in this study is the survey method. It is a quantitative and qualitative research using structured and systematic questions towards respondents [3]. It is used to determine the technical and economic efficiency level of fishing activities using VMA in Palabuhanratu, West Java. The data in this study are primary and secondary data. Primary data consists of technical and economic aspects. The technical aspects are data which are related to the fish-capture unit operation, fishing gear, and fishing ground, whereas the economic aspects are data related to business cost analysis. The details of primary and secondary data to be collected are as follows:

(a) technical aspects: respondent/fishermen information, respondent's readiness of HR, respondent's perception of VMA usage, respondent's obstacles in using the tools.
(b) Vessel, vessel motor, fishing gear operation method, fishing gear size, and number, construction and fishing gear parts, area of operation, the number of fishing operations, number of trips, amount of time was needed to operate fishing gear, and fishing season.

2.2. Productivity

Fishing gear productivity is calculated by CPUE. CPUE is the number of fishermen's Catch Per Unit Effort. Fishing gear productivity is the result of catch with the unit weight per capture effort. Therefore CPUE can be used as a productivity value.

The amount of production and catch effort of each fishing gear is analyzed to calculate productivity. Then, CPUE is calculated using the following formula [4]:

\[
CPUE = \frac{C}{f}
\]

Where:
- CPUE: Catch Per Unit Effort (weight unit/effort unit)
- C: Production (weight unit)
- f: Fishing Effort (effort unit)

Fishing gear with the highest CPUE is stated as the most productive fishing gear in terms of daily productivity.

2.3. Technical efficiency

The technical efficiency of the fishing unit determines the factors that influence fishing gear productivity, such as operational method, fishing gear construction, and fishing ground. It is calculated by data analysis, i.e., production/trip, production/tools setting, vessel production/size, motor power/production, production/fuel production/number of crew members.
Technical efficiency was analyzed by a method called scoring. The values in scoring start from the lowest to the highest. The scoring method is used to calculate variables to be one criterion. The following function formula is used to standardize these values [3,5,6]:

\[ V(X) = \frac{x-x_0}{x_1-x_0} \]  \hspace{1cm} (2)

\[ V(A) = \sum V_i \]  \hspace{1cm} (3)

Where :

For \( i = 1, 2, 3, \ldots, n \) with :

- \( V(x) \) : best function of \( x \) variable
- \( x \) : \( x \) variable
- \( x_1 \) : best value of \( x \) criteria
- \( x_0 \) : worst value of \( x \) criteria
- \( V(A) \) : value function of \( A \) alternative
- \( V(x_i) \) : value function of alternative at \( i \)-criteria

After figuring out the factors that influence fishing gear productivity, the two fishermen groups were compared.

3. Result and analysis

There are two types of \textit{payang} boats, i.e., wooden and fiber. Nearly all \textit{payang} boats whose fishing bases are at PPN Palabuhanratu and PPI Cibangban are wooden boats. Each of them has a dimension of \( 10.9 \times 2.65 \times 1 \text{ m} \). It uses Yamaha 40 PK outboard motors. \textit{Payang} boat does not have a house deck; therefore, the deck area is wide and does not interfere with the \textit{payang}'s setting and hauling processes. Specifically, in PPN Palabuhanratu, there are a few diesel-engined wooden boats that use \textit{payang} fishing gear. In 2013 only one diesel vessel remained using \textit{payang} nets.

\textit{Payang} fishing operations in Palabuhanratu Bay are usually carried out for one day from \( \pm 06.00 \) Western Indonesia Time (WIT) until \( \pm 18.00 \) WIT. However, if the catch is deemed sufficient, \textit{payang} boats may return earlier (at 13.00 WIT the earliest). Conversely, if the catch is deemed insufficient, the boats may return at nighttime (at 22.00 WIT the latest). Some fishermen have been equipped with VMA tools (Table 1).

| No. | Vessel Name | Type | GT | Fishing Gear | Installation Date |
|-----|-------------|------|----|--------------|-------------------|
| 1.  | KM Mandarin | Payang | 5  | Net          | 05/04/2020        |
| 2.  | KM Waafa    | Payang | 5  | Net          | 06/04/2020        |
| 3.  | KM Sri Nabila | Payang  | 5  | Net          | 07/04/2020        |
| 4.  | KM Harum    | Payang | 5  | Net          | 08/04/2020        |
| 5.  | Manis       | Payang | 5  | Net          | 09/04/2020        |
| 6.  | KM Ala Sakti | Congkreng  | 3  | Net & Pole   | 20/07/2019        |
| 7.  | KM Nelayan  | Payang | 5  | Net          | 20/07/2019        |
| 8.  | KM Abah Sakti | Payang | 5  | Net          | 20/07/2019        |
3.1. **Productivity per trip**

Fishermen who use payang fishing gear in Palabuhanratu do one-day fishing activities usually. This means that Payang boats make one fishing trip every day. Payang fishermen (VMA and non-VMA) depart from the fishing base (PPN Palabuhanratu) around 06.00-07.00 WIT and return around 17.00-18.00 WIT. However, the arrival time may vary depending on the catch and distance of the fishing ground. There are six fishing units that were used as research samples; three vessels without VMA and three vessels with VMA. Each ship made six trips, and its production recorded. The following is a figure of the productivity of the fishing unit per trip.

![Figure 1. The productivity of the fish-capture unit per trip.](image)

Figure 1 shows that the productivity of fish-capture units equipped with VMA is greater than the ones without VMA. The average productivity of fishing units without VMA is 220.00 kg/trip, whereas the ones with VMA is 347.78 kg/trip. The use of VMA helps increase payang vessel productivity by 58%. Despite this increase, it is lower than the payang vessels' productivity in Palabuhanratu VAT in 2018 [1]. This is due to the fishing season.

3.2. **Productivity per fishing gear operation**

Besides being affected by the frequency of the trips, production is also affected by the number of times the fishing gear is operated. The more the effort, the greater the chance to get more catches. The effort to operate a fishing gear varies in each unit, depending on fish abundance, fishing gear condition, labor amount, weather conditions, and so on.

Based on field observations, fishing gear operations between the fish-capture units without VMA and the ones with VMA are not much different. Every day, the units without VMA set the fishing gears 4-9 times, whereas the units with VMA set the fishing gears 5-9 times. The following is a figure of productivity between non-VMA and VMA fish-capture units.
Figure 2. Fish-capture unit productivity per fishing gear operation.

When the data is viewed based on the number of fishing gear operations, fishing units with VMA are more productive than those without VMA even though the number of gear operations is relatively the same. This happens because the production per trip values differ in each group. The use of VMA does not have an effect on a lot of payroll fishing operations but can increase productivity per fishing gear operation.

3.3. Productivity per vessel size
Vessels that are commonly used to operate payang fishing gear in Palabuhanratu are made of wood. The dimensions are 12 m long (LOA), 2 m wide (B), and 0.8 m deep (D). Therefore, payang vessels in Palabuhanratu PPN have sizes of approximately 7 GT. In this study, the only fishing units observed were those that used payang fishing gear. Hence there's no difference in vessel sizes between VMA and non-VMA units.
There's no effect of vessel size towards productivity that were identified in this study. This happens due to the relatively same size of all fishing units. However, when viewed from the fish-capture unit productivity per vessel size, the productivity of VMA vessels is higher than non-VMA.

3.4. Productivity per motor power

The vessels that are used to operate payang are outboard motorboats. Payang vessel generally uses an outboard motor that has a power of 40 PK and fueled by gasoline. Just like the vessel sizes, the motor power of payang vessels in Palabuhanratu are the same with one another. Therefore, there is no difference in motor power between units that use VMA and those that do not.

Based on the motor power, the productivity of fish-capture units without VMA is 5.50 kg/PK, while
those with VMA is 8.69 kg/PK. This indicates that the productivity of VMA units is higher than non-VMA. The effect of motor power on the productivity of payang units are not identified in this study. This is due to the similar motor type and power used by each unit [1].

3.5. Productivity per number of a crew member

Payang fishing gear is very dependent on human strength in its operation. After it is set to encircle a group of fish, it is then hauled onto the vessel using the force of human hands. The number of crew members in the two groups ranged from 10-12 people. In addition to being affected by the number of workers, the workers' skills also affect the number of catches. Without qualified human resources, a sophisticated tool will still result in low productivity.

The productivity of non-VMA vessels is 20.10 kg/person, while VMA vessels are 31.33 kg/person. This means that the productivity of fish-capture units equipped with VMA is greater than those without VMA. Similar to the factors of vessel size and motor power, no further analysis can be provided for this parameter (number of workers). This is due to the similar number of crews in each fishing unit. However, because the catch in VMA units is greater, it can be deduced that based on the number of crew members, the productivity of VMA vessels is higher than non-VMA.

![Figure 5. The productivity of fishing units per number of a crew member](image)

3.6. Technical efficiency analysis

After analyzing each production factor, an overall analysis is done to get the best alternative. The following data is a productivity recapitulation of all the factors discussed earlier.

| Productivity                              | Fish-capture Unit |
|-------------------------------------------|-------------------|
|                                           | Non-VMA | VMA   |
| Per Trip (kg/trip)                        | 220.00   | 347.78|
| Per Fishing Gear Operation (kg/setting)   | 28.39    | 48.37 |
| Per Vessel Size (kg/GT)                   | 31.43    | 49.68 |
Payang vessels productivity in PPN Palabuhanratu are 652.19 kg/trip; 0.0021 kg/liter; 43.47 kg/person; 90.30 kg/GT [7]. The payang vessel productivity in this research is smaller than previous studies. This indicates that pelagic fishing in the waters of Palabuhanratu and its surroundings has been saturated and tends to be unprofitable.

Besides being affected by technical factors, productivity is also affected by the availability of fish stocks at sea. Based on a study by the Marine Fisheries Research Institute that the utilization of small and large pelagic fish in WPP-RI 573 has exceeded its conservation potential (red color indicator). The depletion of pelagic fish stocks is an impact due to uncontrolled fishing efforts. The declination in pelagic fish production occurred due to unbalanced fishing with low recovering power of fish stocks [1,8].

Fish-capture units that get the highest score are better than the others. The value function (V) is used to get this exchange rate, which is a relative comparison value. The best alternative is the one that can give the highest V (x) value.

Table 3. Function value of fish-capture units.

| Production                          | Standard Value |
|------------------------------------|----------------|
|                                    | Non-VMA | VMA |
| Per trip                           | 0       | 1   |
| Per fishing gear operation         | 0       | 1   |
| Per vessel size                    | 0       | 1   |
| Per motor power                    | 0       | 1   |
| Per fuel usage                     | 1       | 0   |
| Per number of crew members         | 0       | 1   |
| Amount                             | 1       | 5   |

Based on the table above, vessel units equipped with VMA are considered to be more technically efficient in increasing the productivity of payang vessels in PPN Palabuhanratu, West Java. Technically, VMA units seem to be more superior based on their production per trip, per fishing gear operation, per vessel size, per motor power, and per number of crew members. However, technically, based on fuel consumption, units without VMA are more efficient than those with VMA.

Payang fishing gear has a characteristic of active movement to look for groups of pelagic fish. The indicators that are used to determine fish groups by looking at the signs such as foams on the air surface ripples because fish swim near the surface, and birds swoop the sea surface [9]. With the help of VMA, fishermen no longer need to do this because the VMA devices provide this information. However, due to its non-optimal use, fishermen in PPN Palabuhanratu must keep looking for fish traditionally. Hence, fuel consumption and fishing time are not efficient.

4. Conclusion
The utilization of VMA by fishermen can be optimal if periodic assistance is provided until they are proficient enough to use the tool. Technical efficiency with trip indicators, operating time, vessel size,
motor power, and the number of crew members indicate that ships installed with VMA are more efficient.

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