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Technical and Economic Analysis of Modified *Payang* Fishing Gear in the Fishing Port of Tawang Beach in Kendal District, Indonesia

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Abstract

Payang is one of fishing gears that is used to catch some kinds of pelagic fish that live in the top layer of the water and tends to run into the bottom layer of the water when it has been covered by the net. The addition of top window on *Payang* cod end is used for selectivity in order that the fishes with the certain size outside the fishing target can get out through the window when the gear is being operated. The aim of this research was to identify and analyze the composition of fish caught from modified *Payang*, to find out the number of fish escaped from the square mesh cod end and to analyze the economic aspects (Revenue, Cost, Profit, and R/C Ratio) of common *Payang* fishing gear without window and modified *Payang* fishing gear with window. This research used experimental fishing method. The analysis method used were t-test analysis method, percentage breakouts of fish analysis and economic analysis method. The result showed that the fish caught by common *Payang* fishing gear (18 kg) was bigger than the fish caught by modified *Payang* fishing gear (15 kg). The catches was dominated by Trevally Fish. The result of Paired Sample t-test showed that *Payang* with window modification has no effect towards catch result, because it is more than α ($0.396 > 0.05$). The level of Trevally fish breakouts square mesh cod end was 48 %. The revenue from modified *Payang* fishing gear was less than the revenue from common *Payang* fishing gear. The R/C ratio value from both of the fishing business was more than one so they were efficient to be operated continuously.

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1. Introduction

Payang is one of fishing gear that can chase and cover a group of pelagic fish in order that they can get in the *Payang* net. It is operated by circling the group of fish, and then the ship will pull the seine net. Both of its wings are used for scaring or shocking and leading the fish to get into the cod end (Yusfiandayani, 2011).

Most of coastal fishermen in Kendal District rely on *Payang* fishing gear because they believe that it can produce a great number of pelagic fish so it can give more profits to the fishermen who use the kind of gear. The fishes that have been trapped by the *Payang* gear are still alive, so they can be a kind of high commercial fish. Fishermen usually apply the smallest mesh size in the net cod end in order to get the fish as many as possible without regarding on the size of the targeted fish.

Fishing business using *Payang* fishing gear will be overfishing especially for pelagic fish if it is uncontrolled (Zen et al, 2002). To prevent the bad effect, the *Payang* gear is modified by giving side window on the cod end. It is aimed to let the small size and unfit pelagic fishes get out through the window so it can be more profitable to the fishermen for a long-term. Window is woven thread nets with square shape (square mesh) mounted on the side of the net, whether it is the right or the left. This window aims to separate catches between large fish and small-sized fish.

In this research, the *Payang* fishing gear was modified by giving side window on the net cod end because the fishes in the shocked condition would probably move to the side window in the cod end. The cod end was used to accommodate the fish catches. The net cod end in this fishing gear had about 9 m length. The material was made of *waring* with 2 mm mesh size and the side window modification used PE material with 1 in mesh size (in = inch, 1 m is equal to 39.3700787402 in) and 2.54 cm for each side of the square shape size. The square shape of the net on the window will allow small fish can escape without a lot of hurting his body.

The modification in the *Payang* fishing gear can give influence to the fish catches and the fishermen revenue, therefore, the obtained fish caught, the incurred total cost, and the obtained revenue and profits need to be modified and be analyzed.

Related to the problems, this research was aimed to:

- Analyze the fish caught difference between common *Payang* and modified *Payang*.
- To find out the number of fish that escaped from the square mesh cod end.

Analyze the economic aspect (Revenue, Cost, Profits and R/C Ratio) of genuine *Payang* and modified *Payang*.

2. Material and methods

The method used in this research was experimental fishing that was conducted by trying to operate the *Payang* fishing gear with additional side windows modification for gear selectivity and to operate common *Payang* fishing gear. This research compared between the common *Payang* fishing gear used this far and the new modified *Payang* fishing gear. The method of election of the respondents using a purposive sampling method. Respondents selected are fishermen who are willing to work together to put into practice these modifications with the addition of side window.

The sampling point method in this research was simple sampling method. The sample needed in this research were eight samples for genuine *Payang* and eight samples for side windows modified *Payang*, so the total amount were 16 samples. The data from departure point to sampling point (latitude and longitude position) were saved in GPS so the direction and grooves taken from the departure to the fishing area could be seen in GPS monitor. The data analysis methods used in this research were mentioned as follow:

- Comparison of the Number of Fish Escaped from the Squire Mesh Cod End

The number of fish that escaped from the square mesh cod end during the research were noted and then compared to the total number of catches. The comparison was done to get the information the number of fish escaped and the total number of catches.

$$\text{Percentage breakouts} = \frac{\text{fish that escaped from the square mesh cod end}}{\text{the number of fish in the treatment}} \times 100 \% \quad (1)$$

- Revenue Analysis

Revenue analysis is aimed to figure out how high the level of the business and to know how much the revenue that will be obtained by the fishermen from the application of the modified *Payang* fishing gear. It uses the following formula:

$$TR = \sum P_i \times H_i \quad (2)$$

Where:

TR = Total Revenue
 i = Kind of the fish
 H = Haul
 P = Price

- Cost Analysis

Cost Analysis is the quantity that measures the total cost used for fishing operation activity. The calculation of the fishermen cost is formulated as follow:

$$TC = FC + VC \quad (3)$$

Where:

TC = Total Cost (IDR per trip)
 FC = Fixed Cost
 VC = Variable Cost

- Profit Analysis

Profit analysis is the result of the difference between total revenue and total cost. To figure out the profit that will be obtained by the fishermen from the application of the modified *Payang* fishing gear, it uses the formula as follow:

$$\pi = TR - TC \quad (4)$$

Where:

π = Net Revenue (IDR)
 TR = Total Revenue (IDR)
 TC = Total Cost (IDR)

- R/C Ratio Analysis

According to Soekartawi (2010), R/C Ratio is defined with the following formula:

$$R/C \text{ ratio} = TR/TC \quad (5)$$

Where:

TR = Total Revenue
 TC = Total Cost

Information :

If R/C Ratio value > 1, the activity is considered efficient
 If R/C Ratio value < 1, the activity is considered inefficient

- SPSS Data Analysis

SPSS 16 data analysis used in this research method was t-test. T-test was used to examine whether there was an influence of modified *Payang* fishing gear with additional window toward the fish caught. This test was used because from the result of normality test, the data were distributed normally. The hypothesis used in this analysis was:

Ho : There is no different fish caught between common *Payang* fishing gear and modified *Payang* fishing gear.

H1 : There is significant different fish caught between common *Payang* fishing gear and modified *Payang* fishing gear.

3. Result and discussions

3.1. Technical aspect

3.1.1. Fishing gear description

Payang belongs to seine net that is used for catching a group of surface fishes (Pelagic). Its ship has bamboo in the left and right side that is functioned as the counterweight in order that the ship will not be shaky and be sinked (Sudirman, 2004).

This ship of *Payang* used GT 5 boat (GT = Gross Tonnage, 1 GT = 2.83 m³). It has about 8 PK to 12 PK (10 PK in average) machine power (PK = *Paarden Kracht*, 1 PK = 0.74 kW, kW = 10³ W). The needs of the fuel is around 3.780 L to 5.175 L (4 458.21 L · yr⁻¹ in average). It spent one day for every trip with the fishing intensity around 180 trip to 207 trip (194 trip per year in average). The fish haul was around 14.044 kg to 30.490 kg (18 656.35 kg · yr⁻¹ in average). It had averagely six crews.

The *Payang* net operated in Gempolsewu was made of thread or single nylon string (monofilament) or double thread (multifilament). The overall length was about 180 m to 250 m. The net consisted of multifilament nylon with 8 in mesh size wing, multifilament nylon with around 1 in to 6 in mesh size body (in = inch, 1 m is equal to 39.3700787402 in), waring with 2 mm mesh size.

The fishermen did the fishing operation in ± 2 mi to 5 mi from the coastline (mi = miles, 1 mi = 1.6093440 × 10³ m), the mileage from fishing base to fishing ground was about ± 2 h. The trip of the *Payang* fishing in this research spent one day (one day fishing) with 10 times setting.

3.1.2. The construction of *Payang* fishing gear

Payang in this research was modified by adding side windows because the approaching fishes are shocked when they get trapped through side windows. The parts of the *Payang* fishing gear are as follow:

- Wing

Wing part is used for circling and blocking the group of fish when the gear is operated. The wing is divided into seven parts, each of the part has different amount of horizontal mesh. The length of the wing reaches to 120 m. The material is made of PA (Polyamide) with ± 8 inch mesh size.

- Bossom

According to Badan Standarisasi Nasional (2005), Bossom is net part that is located under the edge of the net that stands out forward. Bossom is the difference between the length of the wing and the length of the top wing. It is used to avoid the escape of the fishes that run into the bottom when the towing process.

- Net body

The net body is made of 210d/9 nylon multifilament materials with 1 in to 6 in mesh size. It is used for concentrating the fishes into the cod end. The size of the mesh in each piece is different, the deeper the position, the smaller the mesh size. It is aimed to avoid the escape of the fish. This body is functioned to lead the fishes to get in the cod end.

- Cod end

Cod end part is used for accommodating the fish caught. The material is made of waring with 2 mm mesh size. It is modified by giving cover to know the selectivity of the gear with side window. The length of the cover is 885 cm.

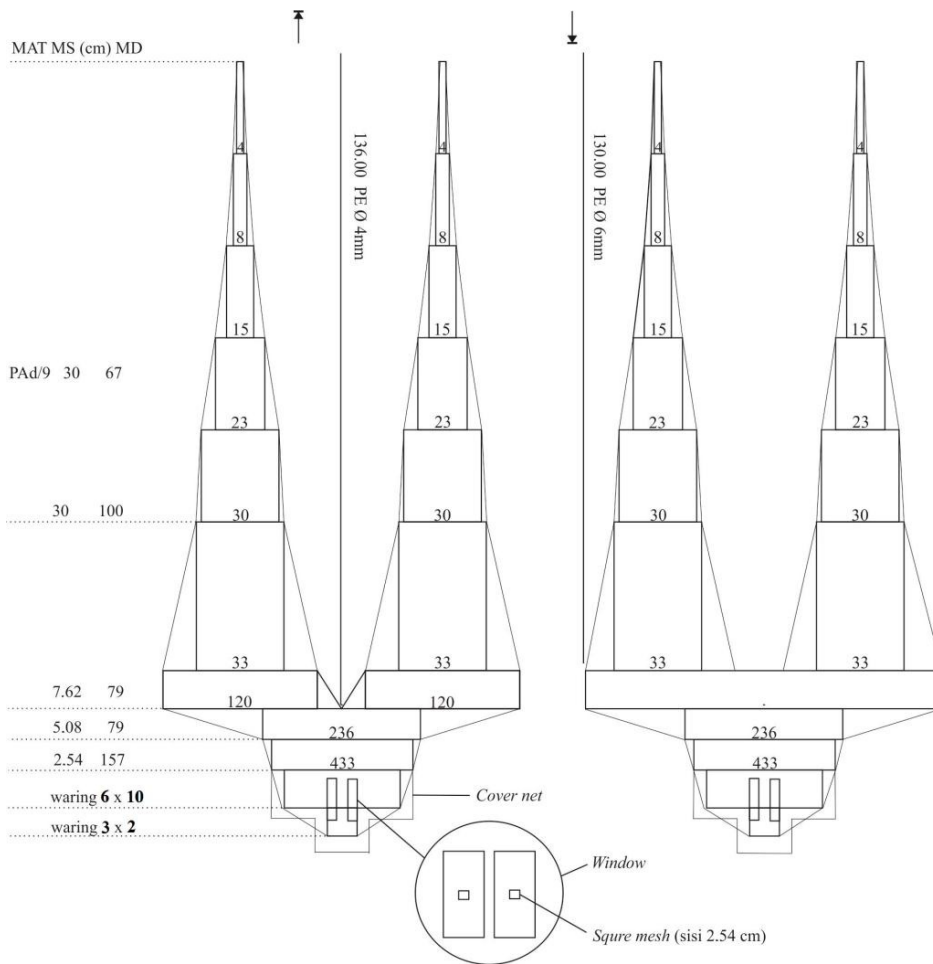


Figure 1. Design of Payang fishing gear with additional side windows modification

- Float

The floats used in the Payang are as follow:

- a. The float in the wing part

It uses styrofoam for the material as many as 95 pcs to 200 pcs (there are two pcs for each right and left side). The float has 30 cm length × 15 cm wide × 13 cm height with 23 cm to 30 cm distance among the float.

- b. Body float

The kinds of body float are as follow:

- Rectangular beam styrofoam with 30 cm length × 15 cm wide × 13 cm height as many as six pcs in the center. The distance among the float is 17 m.
- Cylindrical PVC (Polyvinyl Chloride) with 30 cm × 15 cm × 13 cm size as many as three pcs.

- Sinker

It is made of stone as many as 20 pcs to 30 pcs with ± 200 g each piece and the distance between each stone is 10 m to 15 m. it is used in order that the edge of the net can be opened so that the fish can get in through it.

- Rope

- Head rope: The material is made of polyethylene (PE) with 5 cm diameter and 50 cm length.
- Ground rope : It is made of polyethylene (PE) with 5 cm diameter and 50 cm length.
- Warp rope: It is made of polyethylene (PE) with 5 cm diameter and 50 cm length.

3.1.3. Fish caught

According to primary data that had been conducted in ten times hauling, the fish caught obtained by the common *Payang* and modified *Payang* can be seen in Figure 2 and Figure 3.

Table 1. Catch result common *Payang* and side windows modified *Payang*

No.	Indonesian name	Scientific name	English name	Fish Caught		Price (IDR · kg ⁻¹)
				Common	Modified	
				<i>payang</i> Quantity (kg)	<i>payang</i> Quantity (kg)	
1	Selar	(<i>Caranx</i> sp.)	Trevally Fish	7.7	7.01	14 000
2	Juwi/Tembang	(<i>Sardinella gibbosa</i>)	Sardine	2.28	2.13	6 000
3	Tengiri	(<i>Scomberomorus</i> sp.)	Narrow Barred Spanish Mackarel	2.3	1.6	35 000
4	Bledo/Parang	(<i>Chirocentrus dorab</i>)	Forskala	1.02	0.96	16 000
5	Wais/Daun Bambu	(<i>Chorinemus tol</i>)	Slender Leatherskin	1.32	0.9	12 000
6	Banyar	(<i>Rastrelliger</i> sp.)	Island Mackarel	1.5	1.2	22 000
7	Teri	(<i>Stelophorus</i> sp.)	Anchovy	0.58	0.44	16 000
8	Cumi	(<i>Loligo</i> sp.)	Squids	0.3	0.2	25 000
9	Kembung	(<i>Rastrelliger brachysoma</i>)	Indo Pacific Mackarel	0.22	0.1	18 000
10	Layur	(<i>Trychiurus</i> sp.)	Hairtails	0.05	0.1	18 000
11	Japuh	(<i>Dussumieria acuta</i>)	Round Herring	0.15	0.2	5 000
12	Kuniran	(<i>Upenehelus sulphureus</i>)	Yellow Goat Fish	0.15	0.035	6 000
13	Petek	(<i>Leiognathus</i> sp.)	Pony Fish	0.03	0.03	5 000
14	Barakuda	(<i>Sphyraena barracuda</i>)	Barracuda	0.1	0.05	20 000
16	Average			18	15	

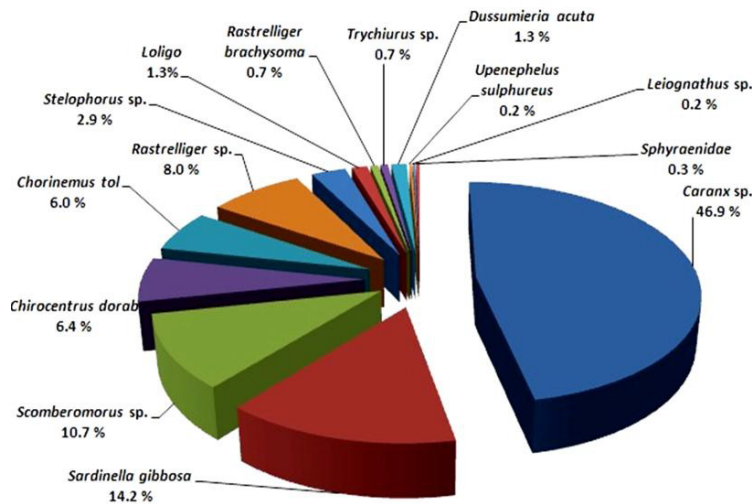


Figure 2. Fish caught amount of common *Payang* fishing gear during the research

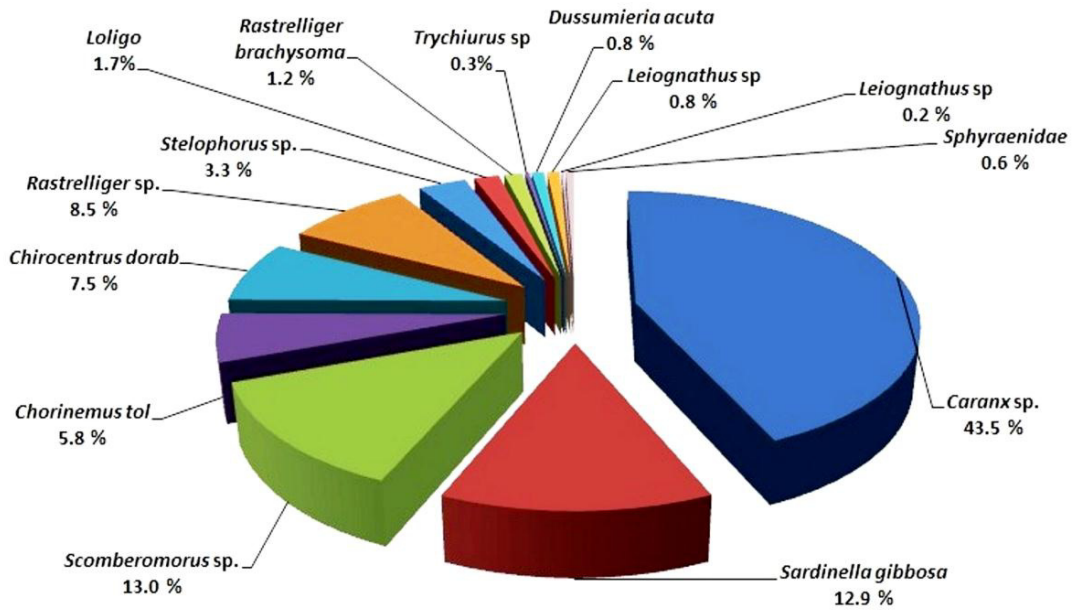


Figure 3. Fish caught amount of modified *Payang* fishing gear during the research

The average amount of the caught per trip using common *Payang* were 18 kg and they were dominated by *Caranx sp.* with 46.9 % percentage in 7 700 g and the fewest caught were *Trychiurus sp.* as many as 50 g and *Leiognathus sp.* as many as 30 g. While the average amount of the caught per trip using modified *Payang* with side windows were as many as 15 kg. *Caranx sp.* still dominated the caught with 43.5 % percentage as many as 7 010 g and the fewest caught were *Upenephelus sulphureus* as many as 50 g *Leiognathus sp.* as many as 30 g.

3.1.4. T-test of the fish caught difference between common *Payang* fishing gear and side windows modified *Payang* fishing gear influence

The calculation of statistic test used SPSS. The result of Paired Sample t-test showed that the probability was more than 0.05 standardized test, that was 0.396 > 0.05. Therefore, Ho was accepted or in other words, the difference toward the fish caught was not significant between common *Payang* and side windows modified *Payang*.

3.1.5. Comparison of the number of dish that escaped from the square mesh cod end

The chart shows information about the length of the interval number and Trevally fish that is in the cover nor the cod end.

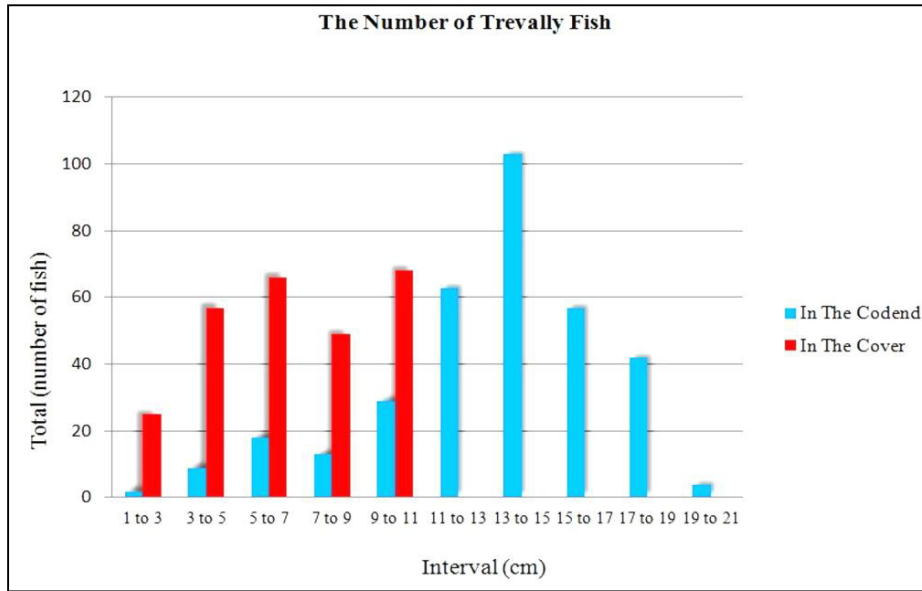


Figure 4. Graph of the number of Trevally Fish in the cod end and cover

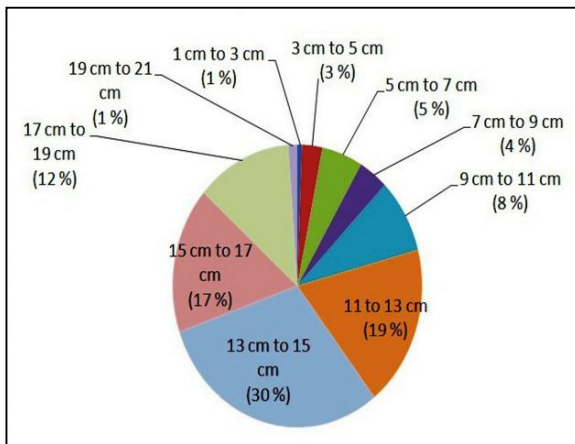


Figure 5. The graph of the percentage of the length (total length) (cm) Trevally Fish in the cod end

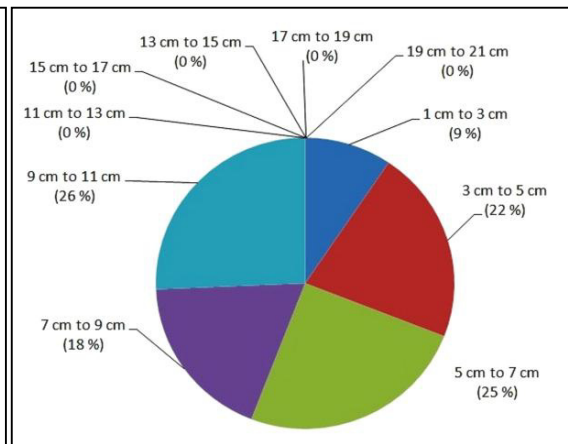


Figure 6. The graph of the percentage of the length (total length) (cm) trevally fish in the cover

In Figure 5 and Figure 6 shows the percentage size of Trevally Fish (*Caranx* sp.) in the cod end and cover. There is a difference in percentage of the total number of Trevally fish (*Caranx* sp.), where the differences caused the size and shape of square mesh cod end. Trevally fish (*Caranx* sp.) which located inside the cover is Trevally fish which escaped from the square mesh cod end.

$$\text{Percentage breakouts} = \frac{\text{fish that escaped from the square mesh cod end}}{\text{the number of fish in the treatment}} \times 100 \%$$

$$= \frac{265}{605} \times 100 \% = 43.8 \%$$

So it can be inferred square mesh cod end selective to Trevally Fish (*Caranx* sp.) in function selecting the Trevally fish get into the cod end. According to Sparre et al. (1990), fish which can escape from nets modification with a range of 25 % to 75 % is included in the category of good.

3.2. Economic aspect

3.2.1. Investment

Investment is the beginning capital that is spent when a business is started (Sayeed et al, 2014), Capital investment is the main factor in fishing business. The capital needed in the *Payang* fishing business is presented in the Table 2.

Table 2. The investment of fishing bussiness using common *Payang* fishing gear and modified *Payang* fishing gear.

No	Cost	<i>Payang</i> Fishing Gear	
		Common <i>payang</i>	Modified <i>payang</i>
1.	Fixed Cost		
	a. Depreciation cost (IDR)		
	Ship	2 600 000	2 600 000
	Machine	1 000 000	1 000 000
	Fishing gear	3 000 000	3 166 667
	Cool box	250 000	250 000
	b. Maintenance cost (IDR)		
	Ship	1 357 692	1 357 692
	Machine	565 385	565 385
	Fishing gear	223 846	223 846
	c. Licensing fee	500 000	500 000
	Total of Fixed Cost (IDR · yr ⁻¹)	60 878	61 946
	Fixed Cost (IDR per trip)	390	397
2.	Variable Cost (IDR per trip)		
	a. Fuel	90 000	90 000
	b. Consumption (rice, dishes, fresh water)	20 000	20 000
	c. Ice	5 000	5 000
	d. Cigarette	10 000	10 000
	Total Cost (IDR per trip)	185 878	186 946

Capital Investment of fishing business using *Payang* fishing gear involves ship, machine, fishing gear, and cool box. The ship used in this research was GT 4 with 8.6 m length and 3.1 m wide size. The machine was Dongfeng machine with 23 PK power. The average economic age of capital investment of *Payang* fishing gear in the research location was 10 yr for the ship, 5 yr for the machine, 3 yr for the gear, and 2 yr for the cool box. The investment cost of modified *Payang* was a little bit more expensive because of the additional windows.

3.2.2. Costs

Fixed cost is the cost that has to be spent and independent from production activity (Mangi et al, 2007). here will always be fixed cost and it will always be calculated as long as the business is still conducted so that no matter how much the amount of the production does not give any influence toward the fixed cost. The fixed cost in the fishing business consists of depreciation cost, maintenance cost and licensing fee (Mensah et al, 2014). Fixed cost in fishing business using modified *Payang* is little bit higher because there is additional window in the fishing gear. Depreciation cost is calculated using Straight Line Method based on the economic age of the calculated investment product.

Maintenance cost involves the ship maintenance cost (patching the leak part, painting or docking cost), machine maintenance cost (service and the broken spare part replacement) and the fishing gear reparation. The maintenance per component in a year is different for each component. The ship maintenance is conducted once every 6 mo. It involves painting and patching the leak part. Machine maintenance is conducted once every 4 mo. It involves

machine oil replacement. The fishing gear maintenance involves broken net reparation. This kind of maintenance cannot be ascertained because the broken net cannot also be ascertained and the fishermen usually prefer to replace the broken fishing gear with the new one better than to repair it.

Variable cost is the cost that can change based on the changing of production rate that will be achieved (Hapsari, 2013), The variable cost of *Payang* fishing business in the research location involves the cost of fishermen supplies and fuel cost. Labour cost is not included into the calculation because the business activity is conducted by the owners of the ship themselves. Retribution cannot also be involved into the variable cost calculation component because the fish haul are not sold through the fish port but they are directly sold to the trader.

Supplies cost is the cost for the consumption during the operation such as rice, side dishes, fresh water, ice, and cigarette. The fuel need is influenced by the size of the ship driving machine. The supplies cost depends on the duration of fishing operation. The longer the time of the operation, of course the higher needs for the fishermen supplies.

3.3.3. Revenue and profit

Revenue is the money value obtained from the result of fish product sales that is influenced by the amount of the caught and the price when the fish caught are being landed. The revenue is obtained from the amount of the caught. Every species of the fish is multiplied by the price of the species. The value depends on the kind and the total weight of the fish caught (Brandt, 2005), In this research, the fish caught was obtained from the accumulation of the total result from ten times setting repetition in one trip, based on the habit of the *Payang* fishermen this far. In the fishing business, the revenue obtained by the fishermen is unpredictable for every trip. It depends on the amount of the fish caught. While the fishing season and the water condition affect the amount of the fishermen fish caught.

The revenue of the modified *Payang* was less than the revenue of the common *Payang*. It was because modified *Payang* in the cod end was combined with the side windows in the right and the left side using PE material with 2.45 cm side size square mesh and 4 m × 2 m window size. It made the fish caught became slidely reduced because some fishes could get out through the square mesh that each side had 2.54 cm size.

Table 3. The average of fishing business revenue and profit

No.	Analysis	Fishing Gear	
		Common <i>Payang</i> (IDR per trip)	Modified <i>Payang</i> (IDR per trip)
1	Revenue	292 580	237 480
2	Total Cost	185 878	186 946
3	Profit	106 702	50 534

The profit can be obtained from the revenue that is taken from the selling result and the caught after being diminished by the spent total cost. The purpose of conducting fishing business is to achieve the highest profit. In order to get the high profit, the fishermen should obtain the high commercial fish with less production cost. It can be assumed that by obtaining the caught in a large quantity, the revenue will be higher and the profit will also be higher. It can also be obtained by pressing the operational cost.

3.3.4. R/C ratio analysis

R/C ratio analysis is the comparison between total revenue and total cost. It can be analyzed by seeing the amount of the revenue of every single cost that has been spent in the fishing business unit. The R/C ratio value of common *Payang* fishing business was 1.6. It means that every IDR 1 000 000 expense of production cost will result IDR 1 600 000 revenue. While in the modified *Payang* fishing business was 1.3. It means that every IDR 1 000 000 expense of production cost will result IDR 1 300 000. Based on R/C ratio of both of the kind of business, both common *Payang* fishing business and modified *Payang* fishing business are efficient to be conducted continually.

4. Conclusion

Based on the result of the research, the conclusion could be drawn as follow:

- The fish caught of common *Payang* was higher than modified *payang* that were 18 kg for common *Payang* and 15 kg for modified *Payang*. The catches was dominated by Trevally fish.
- The number of Trevally Fish which escaped from the square mesh cod end is 265 with breakouts level of 48 %.
- The revenue of the modified *Payang* fishing gear was less than the revenue of common *Payang*. Nevertheless, the R/C ratio value of both kinds of fishing business were more than one, so they are efficient to be conducted continuously.

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