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Feasibility of *Pole-and-Line* Fishery: Comparison of Milkfish (*Chanoschanos, Forskal*) and Anchovy (*Stolephorussp*) as Live Bait

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Abstract—*This study was conducted from May to July 2019 in Bitung City, North Sulawesi Province using pole-and-line vessels in Bitung Fishing Port (PPS Bitung).The method used in this study is a survey method with case studies. Some of the analyzes used: (1) comparative descriptive analysis; (2) business analysis; (3) criteria analysis for investment.The objectives of this study are to compare the level of financial feasibility anddetermine the level of difference between pole-and-line fishing businesses that use milkfish seed and those that use anchovy. The calculation results of business analysis of pole-and-line businesses that use milkfish seed and anchovy are based on the criteria of the businesses in gaining profits and a fast payback period, with an ROI value greater than the capital expense. Investment feasibility is based on the criterion value of an investment, that is NPV>0, Net B/C > 1, and IRR value > 10% interest rate so that pole-and-line business units that use either one of those live baitsmeet the requirements, especially business units that use anchovy. However, milkfish seed still deserves a development as an alternative bait, especially in the condition in which anchovy is difficult to find.*

Keywords—***Pole-and-Line*, Milkfish, Anchovy, Business Analysis, and Investment Criteria.**

I. INTRODUCTION

Bitung is one of the centers of skipjack fishing in Indonesia. *Pole-and-line* or *huhate*isan environmentally friendly fishing gear usually used to catch tuna, mackerel tuna, and skipjack tuna in Bitung. Based on the International Seafood Sustainability Foundation data (ISSF, 2010), *pole-and-line* catch is dominated by skipjack by 57%, yellowfin tuna 27%, bigeye tuna 11%, and albacore 5%. *Huhate*greatly relies on the availability of live bait in nature (wild bait). Wild baits often used are anchovy (*Encrasicholinaheteroloba* and *Encrasicholinadevisi*) and fingerscalesardine (*Sardinella fimbriata*). Those wild baits can be obtained from floating *bagan*fishermen and small boats (*pajeko*). In 2014, there were about 104 *pole-and-line* vessels in Larantuka, North Flores, but only about 50 vessels were able to operate because of various problems, one of which was the declining availability of live bait obtained from floating *bagan* fishermen. This condition is caused by the limitation of *bagan*, which can only operate during a dark moon. Moreover, the population of baitfish tends to decrease because of overfishing since the fish is used not only as live bait but also as the cheapest consumption fish in local markets (Tokan, 2017).

The competition to get the same resources between fishing gear *Lampara* and purse seine to meet the needs of home industry, as well as *bagan* which is considered as an environmentally friendly fishing gear also contributes to the decrease of live bait availability in the sea. To overcome this problem, some *pole-and-line* vessels in Larantuka and Bitung tried to use cultivated milkfish seed as live bait. Therefore, it is important to analyze the comparison of *pole-and-line*fishing businesses to determine the differences in financial feasibility between those businesses that use milkfish seed and those that use anchovy as live bait.

II. RESEARCH METHODS

This study was conducted from May to July 2019 in Bitung City, North Sulawesi Province using *pole-and-line*

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vessels in Bitung Fishing Port (PPS Bitung). The method used in this study is a survey method with case studies (Arikunto, 2000). Study objects consist of four vessels, namely KM River, KM. Primadona, KM. CahayaBintang, KM. CahayaDaulinsa with 25-27 GT which were examined using milkfish and anchovy. The time of fishing and the fishing ground were assumed to be the same for each vessel. The selection of respondents was adjusted to the needs of the study using a purposive sampling method (Sugiyono, 2006).

The respondents in this study were the owner and crew of *pole-and-line* vessels, five people in total. In addition, other stakeholders namely two representatives from the Fisheries Service and four company employees were also interviewed to enrich the data. Thus, there were 11 respondents in total. Data collected consists of primary and secondary data. The primary data were obtained through direct observation while the secondary data were obtained using literature search method.

A. Data Analysis

1. Comparative Descriptive Analysis

Comparative descriptive analysis provides thematic comparative frequency distributions in the form of tables and figures. This analysis aims to observe the tendency and comparison of business feasibility between *pole-and-line* businesses that use milkfish seed cand those that use anchovy as live bait.

2. Business Analysis

Components used in business analysis include production costs, gross and net income gained from the *pole-and*-line fishing business. Various analyses are conducted in business analysis, namely analyses of business income, revenue and cost balance (R/C), payback period (PP), and Return of Investment (ROI) (Hernanto, 1989).

Business income can be calculated using the following formula:

$$\mu = TR - TE$$

where:

μ = Profit

TR = Total revenues

TE = Total expenses

with the following criteria:

If TR > TE, the business activity gets profits.

If TR<TE, the business activity does not get profits.

If TR = TE, the business activity is at the break-even point, i.e business activity does not get profits or losses.

Revenue and cost balance (revenue-cost ration) can be calculated using the following formula:

$$\mathbf{R/C} = \frac{TR}{TC}$$

with criteria:

If R/C > 1, the business activity gets profits.

If R/C < 1, the business activity gets loss.

If R/C = 1, the business activity does not get profits or loss.

Payback Period (PP) is calculated using the following formula:

$$\boldsymbol{PP} = \frac{Total\ Investment}{Profit\ in\ a\ year}$$

Return of Investment (ROI) is calculated using this formula:

$$\mathbf{ROI} = \frac{Profit}{Investment}$$

3. Comparative Descriptive Analysis

Investment feasibility analysis for the development of *pole-and-line*fishing business uses analysis instruments namely Net Present Value (NPV), Internal Rate of Return (IRR), dan Net Benefit Cost Ratio (Net B/C). The purpose of financial evaluation in this study is to observe the cost benefits of *pole-and-line*fishing business in production(Charles B. Purba et al. 2008).

Net Present Value (NPV) is calculated using this formula:

$$\boldsymbol{NPV} = \sum_{i=1}^{n} \frac{(B_i - C_i)}{(l+i)^t}$$

where:

B_t = Benefitsof a project in the yeart

C_t = Project cost in year t

n = Technical lifespan of a project

i = Applicable interest rate

The feasibility criteria are:

If NPV ≥ 0,means the investment is feasible

If NPV < 0 means the investment is a loss or not feasible to be implemented.

Internal Rate of Return (IRR) can be calculated using the following formula:

$$\boldsymbol{IRR} = D_f P + \left\{\frac{PPV}{NPV} - \left(D_f N - D_f P\right)\right\}$$

where:

$D_f P$ = Discount factor that produces a positive present value.

$D_f N$ = Discount factor that produces a negative presentvalue.

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PPV = Positive present value.
NPV = Negative present value.
The feasibility criteria are:
If IRR >i, then the investment is feasible to be implemented, and
If IRR <i, then the investment is not feasible to be implemented.

Net Benefit Cost Ratio (Net B/C) is calculated using this formula (Kadariah,2001).:

$$Net - B/C - ratio = \frac{\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} [(B_t - C_t) > 0]}{\sum_{t=1}^{n} \frac{C_t - B_t}{(1+i)^t} [(B_t - C_t) < 0]}$$

The feasibility criteria are:
B/C > 1 means that the investment is feasible to be implemented
B/C < 1 means that the investment is not feasible to be implemented,and
B/C = 1 means that implementation decisions depend on the investor.

III. RESULTS & DISCUSSION

A.*Pole-and-Line* Catching Unit

Bitung is the main base of *pole-and-line* vessels in North Sulawesi. There were 37 *pole-and-line* vessels in 2017. These vessels are generally made of wood sized 20-100 GT, most of which are vessels sized 50-100 GT.*Pole-and-line* vessels in Bitung Fisheries Port are made of wood with a fishing spot at the bow of the vessel. The Bow of the vessels is specially designed with a flying deck to ease the anglers. The bow is also designed rather high so that the fish caught can slide down to the center of the vessel near the catch tank. This design is intended to ease the handling of the catch. *Pole-and-line* has *huhate* fishing gear made of a fishing rod, fishing line, and fishing hook. Each vessel has 15-20 crews/workers.

Machines used consist of three engine units, namely the main engine, water circulation engine, and lighting engine. Navigation equipment consists of GPS Furuno GP32, compass, and SOG-VMS. The vessel is also equipped with water spray pipes with flattened ends to maximize the spray reach. These pipes are placed in the bow of the vessels under the flying deck or angler seats. There are eight in total, two each in the left and right sides of the vessel, and 4 in the bow.Live bait tanks are placed in the hull of a vessel. There are two tanks of the same size, that is 1.5 m long, 1 m wide, 1.5 m high and have a maximal capacity of 20 buckets or $\pm$ 400 L. The bait tank is the characteristic of a*pole-and-line* vessel. It is equipped with water intake and discharge holes that function as a water circulating system. In addition, there is also a bait pot to ease the throwing of live bait.

Pole-and-line vessel also has two units of hatches served as catch storage sized 1 long, 1 m wide and 1.2 m high, with capacity of 2 tons and two units of hatch for ice storage sized 1 m long, 1m wide, and 1.2 m high with capacity of 2 tons (60-70 ice blocks) each which are placed on the deck in front of the pilothouse. The ice hatches can also be used as storage if the storage hatches are unable to contain all the catches. Other parts of the vessels are the pilothouse, engine room, 1,000-L fuel tank, break room for crews, clean water tank, kitchen, and toilet.

Table 1. Specifications of pole-and-line vessels used in the study

Specifications	Details
Dimension	
a) Length (LOA)	14,60 – 21,50 m
b) Width (B)	2,50 – 4,60 m
c) Height (D)	2,25 – 2,50 m
d) Draft (d)	1,35 – 1,50 m
Tonnage	20 – 27 GT
Engine	120 – 160 PK

Source: Primary Data, 2019

B. Live Bait

The operation of *hutate* depends on the availability of baitfish. About 20-40% of the number of sea days cannot be carried out because there is no bait available, especially in skipjack season (Naamin, 2000). The main type of live bait that fishermen often use is anchovy (*Stolephorussp*), which, in this study, is compared to milkfish seed (*Chanoschanos, Forskal*) as a substitute when the main bait is scarce. Anchovy (*Stolephorussp*) is obtained from *bagan* fishermen around the path to the fishing ground. The price is IDR 20,000 per 20-L bucket. A vessel usually loads 15 – 20 buckets on each operation, depending on the capacity of available tank and fund.

On the other hand, milkfish seed are obtained from milkfish farmers in North MinahasaRegency since there are no milkfish farmers who sell milkfish seed (*Chanoschanos, Forskal*) in Bitung City. The price is IDR 300 per fish. A vessel usually uses 12 bags in which a bag contains 1000 milkfish seeds.

C. Catch Composition

On average, a *pole-and-line* catching unit can catch 7,666 kg/trip using anchovy as live bait and 7,168 kg/trip using milkfish. This indicates that the catch of *pole-and-line* using anchovy is 4% more than *pole-and-line* using milkfish. Fish caught are large pelagic fish, namely

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skipjack (*Katsuwonuspelamis*), tuna (*Thunnus sp.*), *tongkol*(*Auxis sp.*), mahi-mahi (*Coryphaenahippurus*), rainbow runner (*Elagatisbipinnulata*).

The production of *pole-and-line* catches in 2017 landed at Bitung Fishing Port (PPS Bitung) reached 112,398.7 tons of skipjack, tuna, and *tongkol* as well as 30,971.4 tons of rainbow runner and mahi-mahi. The catches are dominated by skipjack by 33%. From January to July 2019, the catches of four *pole-and-line* vessels used in this study consistedof skipjack, tuna, *tongkol*, rainbow runner, and mahi-mahi, which were dominated by skipjack with 152 tons. The types of tuna caught were yellowfin tuna (*Thunnusalbacares*) and albacore (*Thunnusalalonga*). There were morealbacore caught thanyellowfin tuna.

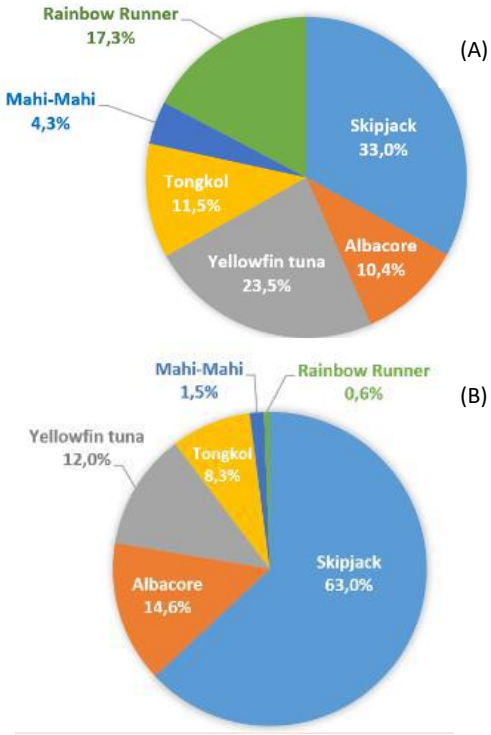

Fig 1. The composition of fish type caught using huhate in 2017 (A) and January-July 2019 (B)

There is a significant difference between the priceset by company and the local price used by fishermen to sell fish to retailers in fish season. These prices are set based on an agreement on the cutting operational costs.

Table 2. Fish prices set by company and local market

Fish Type	Price (IDR)	
	Partner Company	Retailer
Skipjack	9.000	13.000
Yellowfin tuna	13.000	25.000
Albacore	20.000	30.000
Tongkol	7.000	10.000

Source: Primary Data, 2019

On average, the income of *pole-and-line* using anchovy is IDR 877,731,765 per year while the income using milkfish seed is IDR 702,499,480 per year. This indicates that the income of *pole-and-line* using anchovy is greater by 11.1% than that of *pole-and-line* using milkfish seed. *Pole-and-line* vessels, either using anchovy or milkfish seed, have three fishing days (trip) per month in total, and 36 trips per year on average. The optimal fishing operation is nine months.

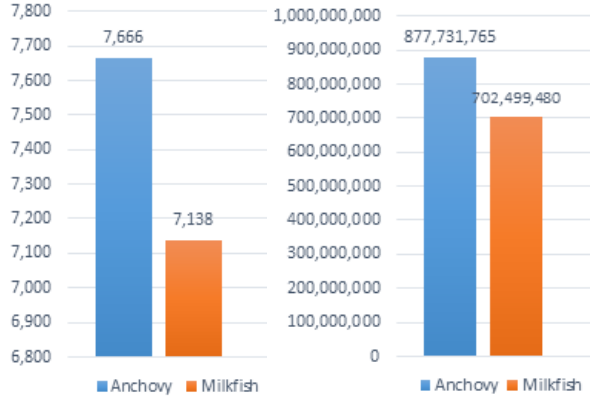

Fig 2. Production and revenue of pole-and-line catching unit: (A) catches per trip (B) Revenue per year

D. Business Analysis

1. Investment Costs for *Pole-and-Line* Fishing Business

Analysis of business feasibility is carried out to examine the financial and economic benefits of activities of each business unit so that the investment used will provide maximal benefits to fishermen's income. Investment costs are the initial costs incurred by the owner (fishermen) to start the business.

Table 3. Average prices of invested components of pole-and-line fishing business in Bitung

Type of Pole-and-line Investment	Price (IDR)	
	Anchovy Bait	Milkfish Bait
Vessel	680.000.000	680.000.000
Main Engine	287.500.000	287.500.000
Auxiliary Engine	32.000.000	32.000.000
Navigation Equipment	23.000.000	23.000.000
Catching Tool/Huhate	1.295.000	1.295.000
Sibu-sibu/Palo/Drain	140.000	140.000
Bait tank	1.500.000	1.500.000
Water Sprayer	3.500.000	3.500.000
Pickup Car	-	120.000.000
Total	**1.028.935.000**	**1.148.935.000**

Source: Primary Data, 2019

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2. Fixed Costs for *Pole-and-Line* Fishing Business

Fixed costs are costs that must be incurred even if there is no fishing operation. The components of fixed costs for *pole-and-line* business consist of maintenance costs and depreciation of vessels, machinery, navigation equipment (7 years), fishing gear (2 years), *sibu-sibu* (3 years), bait tank, water sprayer (5 years), and pickup car (10 years).

Table 4. Average prices of fixed-cost components of pole-and-line fishing business in Bitung

Type ofFixed Cost	Price (IDR)	
	Anchovy Bait	Milkfish Bait
Vessel Depreciation	97.142.858	97.142.858
Vessel Maintenance	15.000.000	15.000.000
Main Engine Depreciation	41.071.428	41.071.428
Auxiliary Engine Depreciation	4.571.429	4.571.429
Engine Maintenance	5.000.000	5.000.000
Navigation Equipment Depreciation	3.285.714	3.285.714
Catching Tool/Huhate Depreciation	650.000	650.000
Sibu-sibu/Palo/Drain Depreciation	11.667	11.667
Bait Tank Depreciation	300.000	300.000
Water Sprayer Depretiation	700.000	700.000
Pickup Car Depreciation	-	12.000.000
Total	**167.733.096**	**179.733.096**

Source: Primary Data, 2019

3. Variable Costs of *Pole-and-Line* Fishing Business

Variable costs are costs that are incurred only during fishing activities.

Table 5. Average prices of variable-cost components of pole-and-line fishing business in Bitung

Type of Variable Cost	Price (IDR)	
	Anchovy Bait	Milkfish Bait
Diesel Fuel	148.500.000	148.500.000
Oil	50.400.000	50.400.000
Ice	25.200.000	25.200.000
Consumption	108.000.000	108.000.000
Freshwater	1.620.000	1.620.000
Crew's Wage	1.464.783.339	1.353.750.625
Anchovy	100.800.000	-
Milkfish	-	129.600.000
Bensin	-	7.200.000
Total	**1.899.303.339**	**1.824.270.625**

Source: Primary Data, 2019

3. Calculation Results of Business Analysis

Analysis of *pole-and-line*fishing business is conducted to determine the level of business success that will be achieved financially and the feasibility of business development.

Table 6. The calculation results of business analysis on pole-and-line fishing business in Bitung

Business Analysis	*Pole-and-line Fishing Business*	
	Anchovy	Milkfish
Annual Profits (IDR)	877,731,765	702,499,480
Revenue and Cost Balance Ratio (R/C Ratio)	1.4	1.33
Payback Period (PP)	15.6 month	21.84 month
Return of Investment (ROI)	83%	60%

Source: Primary Data, 2019

4. Calculation Results of Analysison Investment Criteria

There are a few assumptions used in the analysis of investment criteria in *pole-and-line* business. First, *pole-and-line*fishing business in Bitung City is new. Second, project lifespan is determined based on investment with the longest technical lifespan, i.e vessel with a technical lifespan of 10 years, and the first year of the project started in 2019. Third, prices used are fixed throughout the project lifespan and during the study. In addition, the catches are assumed to be fixed throughout the lifespan of the project so that the revenue is also fixed at IDR 2,929,566,250 for *pole-and-line* vessels with anchovy as bait and IDR 2,707,501,250 for *pole-and-line* vessels with milkfish as bait. Furthermore, operational costs used throughout the project lifespan are considered fixed. The value of the discount factor is 10% per year (bank interest).

Table 7. Feasibility criteria of pole-and-line fishing business using anchovy and milkfish

Business Analysis	*Pole-and-line Fishing Business*	
	Anchovy	Milkfish
Net Present Value (NPV) at DF 10%	4,364,346,731	3,287,620,197
Net B/C at DF 10%	5.3	3.8
Internal Rate Of Return	85.81%	60.9%

Source: Primary Data, 2019

E. Marketing

The marketing of the catches in Bitung City is done in two ways:

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Marketing Channel 1

Marketing Channel2

Fig 3. Marketing channels of fishermen's catches in Bitung City

F. Profit-Sharing System

After profit sharing (50% : 50%) between the vessel owner and the crew as a whole, based on the calculation results of crew's income in skipjack catching business in the waters of Bitung City, with the price of fish set by the company, then the average net income gained by the owner of the vessels is IDR 24,381,438 per *pole-and-line* vessels per trip for vessels that use anchovy as live bait and IDR 19,513,874 per trip for vessels using milkfish seed. The average income of the crew for vessels with anchovy is IDR 2,159,795 per person per trip and IDR 1,996,923 per person per trip. Assume that there are three trips in a month, then the average income of the crew of *pole-and-line* vessels using anchovy is IDR 6,479,384 and IDR 5,990,768 for the crew of *pole-and-line* vessels that use milkfish as live bait.

Based on the calculation, it can be concluded that the income of these fishermen is feasible since it has exceeded the provincial minimum wage set by the Provincial Government of North Sulawesi, which is a minimum of IDR 3,051,076 per month.

IV. CONCLUSION

Based on financial feasibility, a significant difference in income can be observed between *pole-and-line*fishing businesses that use milkfish seed and those that useanchovy as live bait. The results of the business and investment feasibility indicate that *pole-and-line*fishing businesses that use anchovy as bait are still prospectively more profitable. However, the results also indicate that *pole-and-line*fishing businesses in Bitung City that use milkfish seed as bait still deserves a development.

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