

# Implementing value engineering to generate recommended alternative to increase fish farmers' exchange rate in West-Borneo

Jovian Sandero<sup>1</sup>, Sugeng Santoso<sup>2</sup>, Rio Lawandra<sup>3</sup>

<sup>1</sup>Graduate in Master of Operational Management in Mercu Buana University,  
<sup>2</sup>Associate Professor at Mercu Buana University ; <sup>3</sup>Graduate in Food Technology in Wageningen University and Research

joviansandero@gmail.com<sup>1</sup>, sugeng.santoso@mercubuana.ac.id<sup>2</sup>,  
riolawandra@gmail.com<sup>3</sup>

**Abstract.** Since 2014 to 2018, statistic has shown that the fish farmers' exchange rate in West Borneo has an average of 99,47. This number is the evidence of low profitability rate experienced by the local fish farmers as the impact of ineffective existing business. By using the method of value engineering, this research aims to: 1) Introduce steps of implementing value engineering in West Borneo's fish farming sector, 2) select best alternative to increase product value and 3) measure the potential impact of implementing the selected alternative. This research succeeded in implementing value engineering steps by adjusting its variable measurement indicator and also transforming value engineering into a more qualitative approach. Based on the method, Production of Fish Protein Hydrolisate is the selected alternative to increase product value. Finally, the potential impact is measured based on primary and secondary information resulting in an predicted fish farmers' exchange rate of 207. This means that the value engineering method implemented has produced an alternative that can potentially contribute in increasing more than double of the existing fish farmers exchange rate and thus positively impacting their welfare. Finally the government must support this alternative by regulating policies to accommodate the growth of this industry, such as the development of supporting infrastructure, promoting the use of fish hydrolisate as solution to national nutritional program and even policy to ease export overseas.

**Keywords.** Value Engineering; Fish Farming; Exchange Rate

## 1. Introduction

Aquaculture is one of the marine economy sub-sector that contributes significant impact towards Indonesian national economy. In 2015, aquaculture sector contributes 1.41% of total Indonesian GDP (kkp.go.id, 2020). Internationally, Indonesia is the world's top 4 producer of farmed fish. In 2012, the country produces 3.067.660 tons of farmed fish or around 4.6% of global production (FAO, 2014).

Despite the fish farming growth and its economic potential in Indonesia, West Borneo's fish farmers are still struggling with a low exchange rate. From 2014 to 2018, the fish farmers' exchange rate are 97.05, 100.01, 102.59, 102.03, and 95.69 respectively and averaging in 99.47.

While fish farmers' exchange rate is a ratio between the revenue of fish farmers towards their expenses (including their live expense, etc.), getting an exchange rate below 100 means fish farmers have more expenses compared to the amount they are able earn. This leaves the fish farmers dependent on government subsidies and much more vulnerable to changes. Example of changes could be the pandemic situation we are currently experiencing, shift in trends related with aquaculture products consumption, emerging aquaculture technologies and increasing competition in the sector both nationally and globally. Figure 1 shows the graph of the Fish Farmers' Exchange Rate on the range mentioned above.

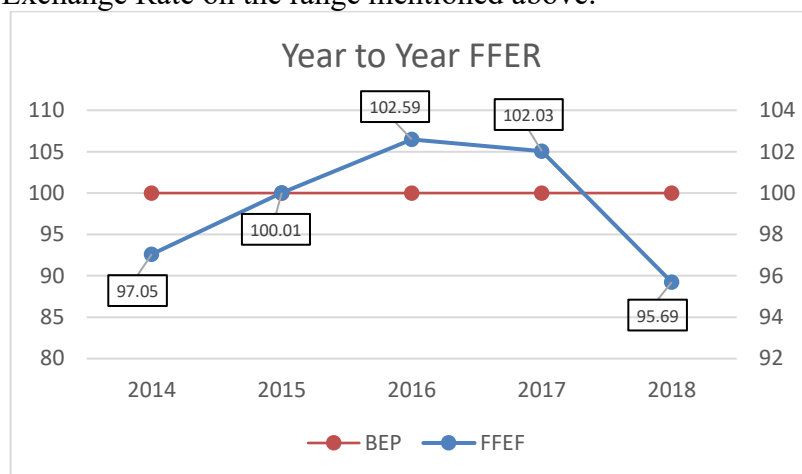


Figure 1. Fish Farmers' Exchange Rate in 2014-2018

This research was done in outer most islet near a remote village of 'Teluk Pak Kedai Dua' in West Borneo. There are nearly 300 fish farms located in the region. Observation and discussion were done on site with local fish farmers and value engineering along with possible alternatives were introduced to the fish farmers.

From the observation done, it is concluded that the farm uses traditional, non-intrusive method to farm milkfish. A non-intrusive fish farming is a practice of fish farming with minimum human involvement, including fish feed that are mostly comes from natural sources such as periphyton (carballo, et al.). Periphyton is a term used for an attached plant and animal organisms embedded in amucopolysaccharide matrix (Dam, et al., 2002). Examples of it are plankton, moss, etc.

The most significant problem faced by the local fish farmers are currently plummeting price of fish. In the past, fish prices in west borneo were already considered low, an example is a local milkfish that are valued as low as IDR 17,000 /kg. At present, the value dropped to IDR 11,000 /kg due to the global pandemic. The reason is due to closed export doors for the fishes, especially the export to Malaysia, India, and Brunei Darussalam. Etc.

Low prices are always identical to over-supply and therefore, instead of selling raw fish directly to the fish distributors, there are still lots of alternative that could be explored. For example, the high value-added fisheries products can be developed through diversification and fisheries distribution network improvement to fulfill the needs of nutrition in the community (Santoso, et al., 2020).

With a descriptive-explorative approach and mixed method of qualitative and quantitative, this research aims to: 1) Introduce steps of implementing value engineering in West Borneo's fish farming sector, 2) select best alternative to increase product value and 3) measure the potential impact of implementing the selected alternative.

## **2. Literature Review**

### **Value Engineering**

Value Engineering has been widely used in different industries as a guide to discuss possible alternative(s) to decrease cost and increase business performance. Although value engineering was first developed to help industries develop cost alternative in manufacture industries (Mandelbaum, 2012), it has been proven that the method is applicable in other industries such as medical related field (Sharma, et al., 2012), Agriculture (Mostafaeipour et al., 2017), Road Construction (Ismail et al., 2010 ; Rahim Et al., 2011 ; Atabay, 2013 ; Ahmed, 2013), Building construction (Apurva, 2013 ; Chavan, 2013 ; Tom and Gowrisankar, 2015 ; Rad and Yamini, 2016 ; Harini et al, 2018), manufacture (Sharma et al, 2012 ; Sharma and Kumar, 2017 ; Maksud and Yusof, 2013 ; Leber and Majda, 2013 ; Chougule and Kallurkar, 2012); SME's & Government (Andrea et.al, 2020); (Santoso et.al., 2021); and many other sectors

Value engineering is a dynamic method. It could be integrated with several other method to suits an organization's need. Several method that has ever been integrated with value engineering are Six Sigma (Mandelbaum, 2012; Rahayu & Santoso, 2021), Product Lifecycle Management system (Cerquiro et al, 2011), and Lean Construction (Musa et al, 2016).

Value engineering implementation may differs depending on the industry utilizing it but generally follows these consecutive phases (Mandelbaum, 2012):

- 1) Orientation Phase – An initiation phase where value engineering team is assembled or chosen and general overview of the problems are discussed.
- 2) Information Phase – The team is made familiar with the project, problems and other information that are related.
- 3) Functional Phase – The function of each processes (including cost, etc.) is presented and discussed with the help of Function Analysis System Technique (FAST) diagram.
- 4) Creative Phase – The possible alternative that could serve as the solution for the problems are listed. Brainstorming is the most commonly used method to develop the alternatives.
- 5) Evaluation Phase – Is an evaluation of the ideas developed in the previous phase. Method such as paired comparison is used to rank the ideas. Insignificant ideas are then discarded. The reason is to minimize the scope of discussion to ideas that may work best for time efficiency.
- 6) Development Phase – The best ideas selected are discussed and measured to know which is best to be implemented.
- 7) Presentation Phase – Is when the idea(s) / alternatives has been chosen and presented to the stakeholder or management.
- 8) Implementation Phase – The final phase where the alternatives got approval from the board and are implemented.

### **Fish Farming**

Fish farming is the practice of commercially reproducing and raising fishes including the maintenance and improvement of the fish qualities for the purpose of gaining economical profits. Generally there are 3 ways of raising fishes in the fish farming industry which is Extensive, Semi-intensive and intrusive fish farming. These terms refers to the level or intensity of human interference in the fish farm. The interference is mostly related but not limited to the giving of fish feed, etc.

An Extensive fish farming means there almost no human interference in the fish farming process. The fishes are left to find their own food, mostly periphytons like planktons and other biotic organism. This practice has the lowest cost factor but also gives lower yield.

A Semi-Intrusive fish farming refer to the practice of giving limited feed to the fishes. In this practice fish food comes from both biotic organism (nature) and feed (man-given). This practice has medium cost factor and gives higher yield compared to extensive fish farming method.

An intrusive fish farming has highest human interference in the fish farming process such feed giving. This method makes fishes relies on feed given by human and has highest yield and cost compared to the other two method.

### **Fish Farmers' Exchange Rate**

In Indonesia, Fish Farmers' Exchange Rate (FFER) is a derivatives from the term Farmers' Exchange Rate. It is a measure of how well the profitability of farmers which leads to their welfare. In other words, FFER is a proxy of the fish farmers' welfare which is calculated by comparing the revenue and cost (including living cost) of fish farmers.

$$\text{FFER} = \frac{\text{Revenue}}{\text{Cost}}$$

In short, if the FFER is below 1, then the cost endured by fish farmers are greater compared to their income which leads to their dependability towards government's subsidy and are more vulnerable to changes. FFER with value 1 means fish farmers has exact cost and income, or in business term it is said to reach their break event point. FFER more than 1 means they have more income compared to cost which means fish farmers has more room to save their money or expand/improve their business.

## **3. Research method**

### **Data collection**

In this research, data collection method comes from both primary and secondary sources. Primary sources includes data collected from participatory observation and interview, while secondary data comes from literature study and online sources.

Primary data includes the existing business process and elements involved in it. From the interview process, data regarding the cost, and profitability of the fish farm is collected. Participatory observation confirms the information and introduces additional factors such as predators' existence and farm condition to reinforce qualitative thinking. Data that are needed to calculate potential cost and profitability after implementing method chosen from value engineering process are also acquired from interview after the value engineering process is done.

Secondary data comes from other existing literature and online survey, mostly for prices and value related to the implementation of methods that are decided from the value engineering process. The data includes information/numbers to calculate potential cost and profitability of implementing the chosen method.

### **Methodology**

This research uses a descriptive-explorative approach which the main purpose is to describe, discover and explore new findings either it's a phenomena, problem, method etc. A mixed of qualitative and quantitative method is used in this research. The qualitative method is used to choose which alternative to be implemented during the value engineering process. The quantitative method is used to calculate the potential revenue, cost and FFER after the implementation of the chosen alternative..

#### 4. Result and Discussion

##### Orientation Phase

This stage is the beginning phase of value engineering where the agent of changes, usually from various related department / position in the organization is gathered. Discussions about the value engineering focus are then explained and discussion about the problems associated with the problem is held. The information gathered from this stage are problems related to low product selling price and concluded as follows:

- 1) Existing market price has always been low
- 2) Price drops significantly due to closed export market for fish, as the impact of COVID-19 Pandemic.

##### Information Phase

This stage is the beginning phase of value engineering where the agent of changes, usually from various related department / position in the organization is gathered. Discussions about the value engineering focus are then explained and discussion about the problems associated with the problem is held. The information gathered from this stage is as follows:

- 1) Selling raw fish instead of processing it into product derivatives to elevate selling price.

##### Functional Analysis

Functional analysis maps the fish farm business / operational processes to ease the understanding of each process and which part could be engineered so it could reach the desired outcome. In this method, FAST diagram is used to maps the processes related to product value. The diagrams are shown below:

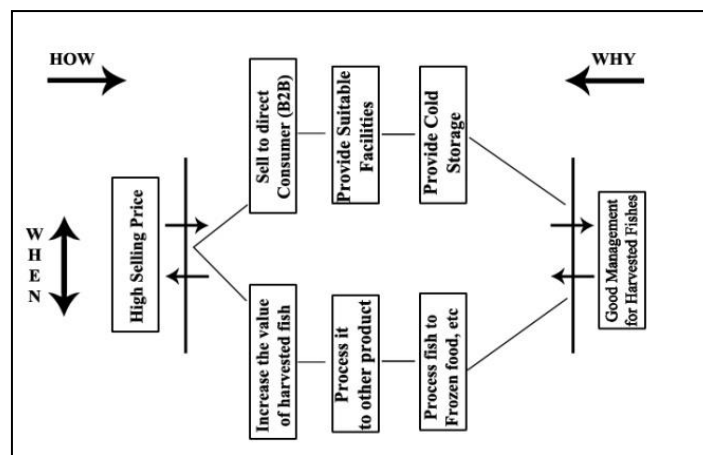


Figure 2. FAST Diagram of Product Value

##### Creative Phase

In this phase, ideas to solve problems mentioned in the informative phase are thrown out and discussed. The ideas are as follows:

- 1) Process the fish into fish flour
- 2) Process the fish into fish protein hydrolysate (FPH)
- 3) Process the fish into frozen food

### Evaluation Phase

In this phase, these variables below are agreed as indicator to measure and find out which alternative is more preferred. First the value engineering team determines the variable to assess. Determined variable are as follows:

- 1) Easy to implement
- 2) High selling price
- 3) Market Availability
- 4) Long Shelf-Life
- 5) Easy to be Distributed

Those indicators are than weighted for their significance using the weight-age analysis with terms as follow:

Table 1. Weight-age Factor

Weight Age Factor	Points
Less Prioritized	1
More Prioritized	2

Each value engineering team should give their though whether those factor counts as something more prioritized or less prioritized. Then based on the majority vote, a score is given based on the weight-age factor. The result are as given:

Table 2. Variable Assessment Table

	1	2	3	4	5	Total
1 (Easy to implement)		1	1	2	2	6
2 (High Selling Price)	2		1	2	2	7
3 (Market Availability)	2	2		2	2	8
4 (Long shelf-life)	1	1	1		2	5
5 (Easy to be distributed)	1	1	1	1		4

### Development Phase

The ideas formed in the creative phase are measured with the indicators along with their weight point formulated from evaluation phase, result are as follow:

Table 3. Measurement table for Alternative Ranking

	A	B	C	D	E	Pts	Rank
Based on the	6	7	8	5	4		
<b>Alternative a</b>	2/12	2/14	1/8	2/10	2/8	52	II
<b>b</b>	1/6	2/14	2/16	2/10	2/8	54	I
<b>c</b>	2/12	1/7	2/16	1/5	1/8	48	III

evaluation below, the idea chosen by the fish farmers to be implemented is alternative b which is the production of Fish Protein Hydrolysatate.

### Potential Implementation Cost:

- Enzyme to be used for hydrolyzing milkfish is Bromelain with a concentration of 6% (Wijayanti, et al., 2016)

- The yield of extract is 11.41% (Wijayanti, et al., 2016)
- Price for Bromelain enzyme is IDR 272/gr.
- Selling price of raw milkfish is IDR 11.000/kg
- Base on the yield of extract percentage, we can estimate that it needs 8.7642kg of milkfish to produce 1kg of FPH
- Total of Bromelain needed for production of 1Kg FPH is 8.7642kg x 6% = 525.852gr
- Cost of Bromelain for 1kg FPH is 525.852gr x IDR 272 = IDR 143,031.74
- Cost of raw fish for 1kg FPH is IDR 11.000 x 8.76642 = IDR 96.406
- Total cost of FPH production per kilo is IDR 143.031,74 + IDR 96.406 = **±Rp. 239.438 (If raw fish value of Rp. 11.000 is categorized as cost)**

### Potential Additional Revenue

- The FPH production uses raw milkfish harvested with an average of 20tonnes / year.
- 1Kg of FPH needs 8.7642kg of milkfish to produce, which means the production capacity for this case is 20.000kg : 8.7642kg = 2282kg
- Selling price for 1 kg of milkfish is IDR. 11,000
- Selling price for 1kg of FPH is average of IDR. 300,000
- Current revenue is IDR 11,000 x 20,000 kg = IDR. 220,000,000
- Potential Revenue for FPH is IDR. 300,000 x 2282kg = IDR. 684,600,000
- Potential added revenue is IDR. 684,600,000 – 220,000,000 = **IDR. 464,600,000**

### Potential FFER after Value Engineering

In this research the potential Fish Farmers' Exchange Rate is determined by the potential income after implementing value engineering per the existing fish farm cost plus potential cost for fish protein hydrolysis production.

- Existing fish farm cost = IDR 3,850,000 and **this cost eliminates the cost of raw fish** in the calculation because fish used for production are harvested from the farm.
- Potential Cost of Bromelain for FPH production = IDR. 143,031.74 x 2282kg = IDR. 326,398,430 / year
- Potential Revenue for FPH is IDR. 300,000 x 2282kg = IDR. 684,600,000
- The potential FFER is as follows:

$$\frac{\text{IDR. 684,600,000}}{\text{IDR 3,850,000+ IDR 6,398,430}} = 2.07$$

### 5. Conclusion

The existing FFER in west borneo still struggles to reach a break-even point. Condition got worse when the pandemic hit globally, closing doors for export opportunity, causing fish price to fall and so is the FFER.

Value Engineering is done in order to help increase the FFER. Based on the series of value engineering phases and method done, an alternative of processing the raw fish into fish protein hydrolysis is chosen.

A simple measurement is done so that a potential impact could be measured. Based on the primary and secondary data collected, the estimated / potential FFER after implementation of alternative selected by value engineering is 2.07. This means that fish farmer could potentially earn twice as much as they spend. Though, it is worth mentioning that this ratio would vary depending on the possible additional cost of production and fish farmers' personal spending as

well. Also, this research did a simple cost calculation of cost if fish farmers decided to produce more Hydrolisates, which mean they need more fishes and therefore resulting in an additional cost for buying fishes.

It is suggested that a corresponding field such as food technology needs to be involved in order to get a better and closer result estimate. Also, different research that aims to test the possibility of implementing this alternative, such as infrastructure, skill, market and technology availability must be carried on in response to the current preference of fish farmers in west borneo of conducting or processing fish protein hydrolisate.

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