Engineering Economics Evaluation For Manufacturing Competitiveness : A case study.

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Abstract. Cassava is one of the valuable commodities in Indonesia that can be used as various types of food. One of the foods made from cassava is Tapai which is the result of boiling and fermentation of cassava and has a high carbohydrate content. Tapai's business Mr. Legimin is a business that produces Tapai and sells it in plastic packaging. This business has been producing tapai since 20 years ago and has never conducted an economic analysis to prepare itself to enter the development of a rapidly growing industry. The research method used in this study consists of depreciation calculations, production costs consisting of fixed costs and variable costs, production costs, breakeven points and investment feasibility analysis using the Net Present Value (NPV) method, the benefit cost ratio (Net B) / Ratio C), Internal Rate of Return (IRR) and Payback Period (PBP). Based on an economic analysis with a project life of five years, it was found that the total production cost was Rp38,533,566.7 / month with production costs reaching Rp3,952.16 / kg, breakeven point 2,101 kg / month, NPV Rp2,355,523,695, B / C Net 2.41, IRR> MARR and the payback period is two months.

1. Introduction

Indonesia is an agrarian country, the livelihoods of its people are in the field of agricultural products. The development process in Indonesia drives industrial growth based on agricultural products [1]. Raw materials produced by the agricultural industry include cassava tubers. Cassava is included in food that is often produced by Indonesians and has become a common or staple food that is favored by many Indonesians [2]. Cassava is liked by many people because of its diverse nutritional content and is beneficial for human health. Cassava is rich in calories, carbohydrates, nutrients and more [3]. Because the nutritional content of the many benefits of cassava for health is maintaining the health of the digestive tract, controlling the content of pure sugar in the body and many other benefits of cassava for the body [4]. Because of the many benefits of cassava, many Indonesian people change cassava into various types of food one of which is tapai [5].

Cassava is fermented with the help of yeast sprinkled on the surface of yams that have been steamed into sweet ribbons. Tapai is a traditional Indonesian food which is a modification of cassava, tapai is produced from cassava fermented with the help of yeast as a substrate [6]. Tapai production is used by small and medium businesses as an opportunity to
open a business, as it is known that tapai is a food that is preferred by many Indonesians even outside Indonesia [6]. One of the small and medium enterprises reviewed is Tapai Pak Legimin, which produces tapai in one area in Medan. Tapai production is sold to the surrounding community using 13 units of pedicabs. During 20 years in running this business, Tapai Legimin has never conducted an economic analysis of its business activities. The development of industry in Indonesia, especially the city of Medan, which is getting faster and the demand to reach is increasing, making Mr. Legimin want to expand production capacity and add business branches [8]. This study aims to conduct an economic analysis of production prices, breakeven points and the feasibility of investing in businesses owned by Bpk. Legimin. The results of the study will be given to the Tapai Legimin business with the hope that the results of the study can help evaluate the Tapai Legimin business so that improvements and developments in the business can be done.

2. Methodology
2.1. Time and Place
The research was conducted in December 2019 at Mr. Legimin's Tapai business located on Setiabudi Street Pasar 1, Amal Hallway No. 25, Medan, North Sumatra.

2.2. Method of Collecting Data
The data used are primary and secondary data. Primary data were obtained through interviews with tapai business managers, while secondary data were collected through scientific publications that discussed cassava. The research procedures carried out are assumptions and approaches as a basis for doing calculations and analysis. The assumptions and approaches used consist of: (1) the economic life of production equipment is 5 years, (2) the final price of the equipment is 10% of the initial price, (3) the interest rate is 12% effective per year, (4) the equipment maintenance costs 2% / year, (5) working time 12 hours per day and 26 days per month, (6) the price of cassava raw materials is IDR 1,200 / kg and yeast IDR 200 / item, (7) the price of packaging IDR 5,000 / packaging, (8) electricity consumption is 12.33 kW / day.

2.3. Analysis Method
2.3.1. Depreciation Analysis
The amount of the cost of depreciating production equipment is calculated using the straight-line method. The straight-line method is a method in which the amount of depreciation in each period is the same that can be formulated as follows:

\[
\text{Depreciation} = \frac{\text{Acquisition Cost-Residual Value}}{\text{Economic Age}}
\]  

(1)

2.3.2. Production Cost Analysis
Production costs are the sum of fixed costs with variable costs. The amount of production costs is calculated using equation 3 as follows:

\[
\text{TC} = \text{FC} + \text{VC}
\]  

(2)

Symbol :
- TC = Total Production Cost (IDR/year)
- FC = Fixed Cost (IDR/year)
- VC = Variable Cost (IDR/year)

2.3.3. Cost of Goods Sold Analysis
The cost of production is all costs that have been incurred from the production process until it is finished becoming goods ready for sale. The base price can be calculated using the following equation:

\[
\text{Cost of Goods Sold} = \frac{\text{Total Production Cost}}{\text{Total Production}}
\]  \hspace{1cm} (3)

### 2.3.4. Break Even Production Analysis

The break-even analysis is a way for the company to determine sales volume and product mix in order to achieve the desired profit level. The formula for calculating the break-even point for production is as follows:

\[
\text{Break Even Production} = \frac{\text{Total of Fixed Cost}}{\text{Selling Price per Unit} - \text{Variable Cost Per Unit}}
\]  \hspace{1cm} (4)

### 2.3.5. Investment Feasibility Analysis

An investment is assessed for its feasibility from four factors namely NPV, BCR, IRR and PBP. An effort is said to be feasible if NPV > 0, BCR > 1, IRR > MARR interest rate.

**a) Net Present Value (NPV)**

Net Present Value is the present value derived from all cash flows from production to completion. The Net Present Value can be formulated as follows:

\[
\text{NPV} = \sum_{t=0}^{n} \frac{(C)_{t}}{(1+i)^t} - \sum_{t=0}^{n} \frac{(C_{0})_{t}}{(1+i)^t}
\]  \hspace{1cm} (5)

where:
- \((C)_{t}\) = t-year cash inflows
- \((C_{0})_{t}\) = cash flow out of the t-year
- \(n\) = investment age
- \(I\) = transition current
- \(t\) = year

**b) Benefit Cost Ratio**

Benefit cost ratio is done using two approaches for calculating Net BCR. Net BCR is the ratio between all value benefits to the cost value. The following is a mathematical formula from BCR.

\[
\text{Net BCR} = \frac{\sum_{t=1}^{n} B_{t} - C_{t}}{\sum_{t=1}^{n} C_{t} - B_{t}}
\]  \hspace{1cm} (6)

where:
- \(B_{t}\) = cash inflows in the t-year
- \(C_{t}\) = cash outflows in the t-year
- \(I\) = the actual interest rate

**c) Internal Rate of Return (IRR)**

The IRR method is used to solve interest rate problems by projecting to the present value of all cash flows from both receipts and expenses. The eligibility requirements are if IRR > MARR interest rates. The interest rate used as a reference in this study is the interest rate for PT. Bank Central Asia, Tbk, which is 12% effective annually. To calculate IRR you can use the following formula:

\[
\sum_{k=0}^{n} R_k \left(\frac{P}{F}, i\%, k\right) = \sum_{k=0}^{n} D_k \left(\frac{P}{F}, i\%, k\right) = 0
\]  \hspace{1cm} (7)

where:
- \(R_k\) = K-year reception
\[ D_k = K \text{-year expenditure} \]
\[ n = \text{Project Age} \]

d) Payback Period

Payback period (PBP) is the period of the initial refund fee. The faster the return, the alternative is more attractive compared to other alternatives. The formula of the Payback period (PBP) is as follows:
\[
\text{Payback Period} = \frac{\text{Investment}}{\text{Cashflow}} \times 1 \text{ year} \tag{8}
\]

3. Result and Discussion

3.1. Overview of Tapai Processing Business in Mr Legimin Business Tapai

Tapai is a superior product in the UKM Legimin Tapai. Tapai is the result of boiling and fermenting from cassava. Cassava (M. esculenta) is a plant that has a high carbohydrate content and high energy (Wardany, 2012). According to the Ministry of Agriculture (2012), the water and carbohydrate content of cassava is 60 grams and 37.9 grams per 100 grams of cassava.

Mr. Legimin's tapai UKM runs its business by selling tapai in the form of 500 gr plastic packaging. Tapai sold is in a ready-made state so that the tapai can be eaten without further processing.

The tapai production process at UKM Legimin Tapai is carried out continuously and is not dependent on orders (carried out continuously). Workers needed in the tapai production process at the business are 6 workers in the stripping section, 8 workers in the cutting section and 2 workers in the cassava boiling section. All tapai production activities are carried out by manual with the help of simple tools such as knives and cassava slicer. The production process of tapai is difficult and is not optimally done by machine due to several factors, namely: 1). The size of cassava is different so it is not suitable for slicing and cutting using a machine. 2). Lack of knowledge and experience of workers to operate machinery.

3.2. Economy Evaluation

Economic evaluation is carried out on tapai production which is still done manually without the aid of a machine. This is done manually due to differences in the size of cassava so that the cutting process cannot be done using a cutting machine.

a. Tapai Business Investment

Investment is an investment in the form of money or goods in a company with the aim of obtaining profits. Equipment investment in tapai production can be seen in Table 1.

| No | Equipment Name       | Amount | Unit | Unit Cost (IDR) | Total Cost (IDR) |
|----|----------------------|--------|------|-----------------|-----------------|
| 1  | Knife                | 7      | Piece| 10.000          | 70.000          |
| 2  | Wrapping tapai       | 3      | Kg   | 37.000          | 111.000         |
| 3  | Large basin          | 8      | Piece| 20.000          | 160.000         |
| 4  | Refrigerator         | 3      | Unit | 3.300.000       | 9.900.000       |
| 5  | Balance              | 3      | Unit | 63.000          | 189.000         |
| 6  | Stewpan              | 6      | Unit | 200.000         | 1.200.000       |
| 7  | Cassava peeler       | 7      | Unit | 12.000          | 84.000          |

**Total (IDR)** 11,714,000

Calculation of the cost of tapai production is based on data and several assumptions that can be seen in Table 2.
Table 2. Data Variables and Assumptions of Tapai Production Business

| No | Equipment Name | Value | Unit | Information |
|----|----------------|-------|------|-------------|
| 1  | Age of the project | 5     | Year | Based on the age of the engine |
| 2  | Bank interest rates | 12    | %    | People's business credit (kur) |
| 3  | Value of the beat of the engine | 10    | % of investment costs | Assumption |
| 4  | Machine maintenance costs | 2     | % of investment costs | Assumption |
| 5  | Business hours (hours) | 12    | Hour | Real condition |
| 6  | Business Day (days) | 26    | Day / month | Real condition |
| 7  | Cassava raw material | 500   | Kg / day | Real condition |
| 8  | Cassava Prices | 1.200  | IDR / kg | Real condition |
| 9  | Cost of cassava raw materials | 600.000 | IDR / day | Cassava raw material x price of cassava |
| 10 | Yeast raw material | 2     | Grain / kg of cassava | Real condition |
| 11 | Yeast Prices | 200   | IDR | Real condition |
| 12 | Cost of raw yeast | 200.000 | IDR / day | Yeast raw material x yeast price |
| 13 | Manual stripping capacity | 41,67  | Kg / hour | The calculation results |
| 14 | Stripping results | 75    | % of cassava raw materials | Measurement results |
| 15 | Tapai produced | 375   | Kg / day | Raw material x |
| 16 | Price of packaging (500 gr) | 5.000 | IDR / Packaging | Real condition |
| 17 | The price of electricity is 900 VA | 1.352 | IDR / kwh | PLN |
| 18 | Electricity energy costs | 16.666,67 | IDR / day | Calculation |
| 19 | Consumption of charcoal fuel | 5     | Kg / day | Assumption |
| 20 | Price of charcoal | 8,500 | IDR / kg | Tokopedia |
| 21 | Fuel costs | 42.500 | IDR / day | Calculation |
| 22 | Wages | 1.000.000 | IDR / month | Real condition |
| 23 | Total manpower | 16    | Person | Real condition |
| 24 | Labor costs | 16.000.000 | IDR / month | Employment wage x number of workers |

b. Total Tapai Production Costs

The total cost of producing tapai can be calculated by adding up the total fixed costs with the total variable costs. Fixed costs in the tapai production process are the costs of employee salaries. While the variable costs are determined from the total use of electricity, charcoal, cassava and yeast. Depreciation costs can be calculated using equation [1]. Data on the calculation of fixed costs can be seen in Table 2. The results of the calculation of fixed costs can be seen in Table 3.

Table 3. Fixed Costs of Tapai Production Business

| No | Cost Components       | Fixed Cost (IDR/Year)   | Fixed Cost (IDR/Month) |
|----|-----------------------|-------------------------|------------------------|
| 1  | Labor costs           | 192.000.000             | 16.000.000             |
| 2  | Depreciation costs of equipment | 2.108.520   | 175.710               |

5
Based on Table 3, it is known that the fixed costs of the tapai business are IDR.16,195,233.33/month or IDR. 194,342,800/year. While the details of the variable costs of the tapai business can be seen in Table 4.

**Table 4. Variable Costs of Tapai Production Business**

| No | Cost Components       | Variable Costs (IDR/Day) |
|----|-----------------------|--------------------------|
| 1  | Cassava raw material  | 600,000                  |
| 2  | Yeast raw material    | 200,000                  |
| 3  | Electrical energy     | 16,666.67                |
| 4  | Charcoal fuel         | 42,500                   |
|    | **Total (IDR)**       | **859,166.67**           |

Based on Table 4, it is known that the variable cost of the tapai business is IDR859,166.67/day or IDR22,338,333.4/month. Tapai production costs can be calculated by adding up fixed costs with variable costs using equation [2], namely: TC = FC + VC

Based on calculations it is known that:

- FC = IDR 16,195,233.33/month
- VC = IDR 22,338,333.4/month
- So the amount of production costs (TC) is IDR 38,533,566.7/month

c. Cost of Goods Sold Tapai Business

The cost of Tapai business production is influenced by the number of products that can be produced in a certain period of time. The cost of production can be calculated using equation [5]. Based on calculations it is known that:

- TC = IDR 38,533,566.7/month
- TP = 9,750 kg/month
- So that the cost of producing the Tapai business is : IDR 3,952,16 /kg

d. Break Even Point (BEP) Tapai Business

Break Even Point is the point where a business return on investment. The break-even point of a business is influenced by the total cost of production, the total production and the selling price of a product. Based on the results of the interview, the tapai is sold at IDR 10,000 / kg. By using equation [6], the break-even point for Tapai business can be known that is 25,211 kg / year or 2,101 kg / month.

e. Estimated Tapai Business Revenues

The revenue of the tapai business was obtained from the tapai sales which were assumed in the first month to the third month only 50% of the tapai was sold, the 4th month to the 6th month as many as 75% of the tapai was sold and in the 7th to the month 60% of 100% of the production tapai was sold.

Details of the Tapai business income and expenditure over the life of the project which is 5 years can be seen in Table 5.

**Table 5. Business Benefits of Tapai Production**

| Year | Incomes (IDR/Year) | Expenses (IDR/Year) | Profit (IDR/Year) |
|------|--------------------|---------------------|-------------------|
|      |                    |                     |                   |
Based on Table 5, it can be seen that in the 0th year, the profit gained is not yet available due to the UKM having to pay investment costs for the equipment to be used in the amount of IDR. 11,714,000, but in the 1st year, this Tapai business has been getting a profit of IDR. 476,508,200 where in the first year tapai sales were assumed to be still unstable. Whereas for the 2nd to 5th year the tapai sales are assumed to be stable so that the profit of the Tapai business is IDR 707,597,200/year.

f. Investment Feasibility Analysis

Before making an investment in a business, we must first analyze its feasibility. This analysis is carried out so that we can obtain information about the level of success (prospects) of the business. The analysis can also provide certainty of income from the business so that we avoid investments that do not provide benefits. In this study 4 methods were used to assess the feasibility of the Tapai SME investment, namely: 1) Net Present Value (NPV), 2) Internal Rate of Return (IRR), 3) Net Benefit Cost Ratio (Net B / C), 4) Payback Period (PBP). The business is declared feasible if NPV > 0, Net B / C > 1, IRR > MARR and PBP interest rates are needed, the shorter the better.

1) Net Present Value (NPV)

Expenditures incurred during the observation period are equipment investment costs at the beginning of the business, namely IDR. 11,714,000 and production costs as much as IDR. 462,402,800/year, and income derived from tapai sales is IDR. 950,625,000 in the first year and IDR. 1,170,000,000 in the second year to the fifth year with the final value of the equipment which is assumed to be 10% of the initial investment cost, which is IDR 1,171,400. A cash flow diagram that contains details of income and expenses per period can be seen in Figure 1, where income is indicated by an up arrow while expenses are indicated by a down arrow.

Based on Figure 1, the income and expenditure at the present value is in accordance with KUR Bank BCA of 12% so that it is found that the income of the SME Tapai is at the present value of IDR4,022,382,304 while the expenditure of the SME is at the present value of IDR1,666,858,609. The NPV value can be calculated using equation [5] and the results show that NPV = IDR2,355,523,695 where NPV > 0 then the business is declared feasible.

2) Net Benefit Cost Ratio (Net B/C)

Net Benefit Cost Ratio is a comparison between total income at present value with total expenditure at present value within a certain time period in which this study is 5 years. The
The amount of Net Benefit Cost Ratio (Net B / C) can be calculated using equation [6] of 2.41 where Net B / C > 1, then the business is declared feasible.

3) Internal Rate of Return (IRR).

Internal Rate of Return abbreviated as IRR is an indicator of the efficiency level of an investment. An effort can be made if the rate of return is better than the rate of return if an investment is made elsewhere. Other places referred to are interest rates on bank deposits, mutual funds and others or commonly denoted as market interest rates or Minimum Attractive Rate of Return (MARR). In this study the MARR used is the Bank BCA interest rate of 12%. IRR calculation can be done using equation [7] so that the calculation results obtained are the amount of IRR > 12% then the effort is declared feasible.

4) Payback Period (PBP)

Payback Period (PBP) can be used to find out at what period the initial investment capital of a business can cover the initial capital of money already issued. PBP indicates in what period the business has generated greater revenue compared to business expenses. Details of SME Tapai income and expenditure in the initial period to the period in which the total cost of income has been greater than the total cost of expenditure can be seen in Table 6.

Table 6. Tapai Business Income and Expenses

| Month | Income (IDR/month) | Expenses (IDR/month) | Balance (IDR/month) |
|-------|---------------------|-----------------------|---------------------|
| 0     | 0                   | 11.714.000            | -11.714.000         |
| 1     | 48.750.000          | 38.533.566,7          | -1.497.566,7        |
| 2     | 48.750.000          | 38.533.566,7          | 8.718.866,6         |

Based on Table 6, it can be seen that the balance is positive in the 2nd month. This indicates that the business has already received initial investment costs in the 2nd month. So in the second month of the business has earned more revenue than expenses.

4. Conclusion

1) The amount of the cost of producing tapai is IDR 38,533,566.7 / month and the cost of production is IDR 3,952.16 / kg.

2) The break-even point for tapai production is 25,211 kg / year or 2,101 kg / month where the break-even point is affected by fixed costs, variable costs and total production.

3) Based on investment feasibility analysis, NPV > 0, Net B / C ratio > 1, IRR > 12%, PBP in the 2nd month.

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