Analysis of Gayo wine-coffee processing facility development

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Abstract. The Indonesian plantation sector plays an important role in the overall national economy. The development of coffee processing methods into a variety of products, including the relatively new product Gayo wine coffee, will provide added value for farmers. However, the main question that is often asked about relatively new ventures is how viable they are. Thus, a techno-economic analysis of Gayo wine-coffee processing facility development was aimed to answer how viable is the business to ensure sustainability. The results of this research are expected to add scientific information regarding the feasibility study of developing a sustainable Gayo wine-coffee processing facility. The research was conducted in Aceh Tengah District by conducting a comparative study to a micro-scale wine coffee producer in the location, the Syukran Kopi Wine processing facility. Analysis of the facility development was more focused on the technological and financial aspects. The research results considered that Aceh Tengah District is very suitable as a location for a wine coffee factory to minimize the purchasing costs. Moreover, the process of wine coffee production is more difficult than the process of common coffee production. However, the Gayo wine-coffee processing facility uses semi-modern technology like the common coffee processing facility. Besides, all financial indicators meet the financial feasibility criteria for five years economic life of the project. Sensitivity analysis also shows that in both scenarios, all financial indicators still meet the financial feasibility criteria, although decreasing the benefit make a higher impact on most values of the investment criteria than increasing the operational cost.

1. Introduction

The Indonesian plantation sector plays an important role in the overall national economy. Coffee plantations are one of the fastest-growing plantation sectors [1]. Therefore, Indonesia has great potential to develop the coffee processing industry with a variety of unique flavour products. The goal of the coffee processing industry is to accelerate community economic empowerment as most coffee plantations belong to farmers. Thus, the development of coffee processing methods into a variety of products, such as green beans, roasted beans, and coffee powder, will provide added value for farmers [2–4].

Aceh Tengah District is one of the main coffee production areas in Indonesia [1,5]. The total planted, harvested, and damaged areas, as well as coffee production in Aceh Tengah District in 2021 is as shown in Table 1. Gayo coffee is an Indonesian arabica coffee variety, one of the mainstay commodities originating from the Gayo highlands, Aceh, Indonesia. Gayo coffee has gained international and national recognitions such as a Fair Trade certificate from the International Trade Organization [6]. Gayo coffee...
is quite famous in the global market because of its unique aroma [7], predominantly in the form of coffee powder.

**Table 1.** Total areas and coffee production in Aceh Tengah District in 2019.

| No. | Commodity       | Immature plant (Ha) | Harvested plant (Ha) | Damaged/old plant (Ha) | Total areas (Ha) | Production (ton) |
|-----|-----------------|----------------------|----------------------|------------------------|------------------|-----------------|
| 1.  | Arabica coffee  | 2.936                | 42,569,3             | 4.329,6                | 49.834,9         | 34.608,8        |
| 2.  | Robusta coffee  | 73,5                 | 834,5                | 142,5                  | 1.050,5          | 446,5           |

Source: [5]

Other coffee products currently starting to be widely available in the Gayo highlands are in the form of green beans diversified into various products. One of the diversified products is wine coffee that is processed through a modified fermentation process. The fermentation process into wine coffee aims to reduce the bitter taste to produce a distinctive taste in the brew of coffee like wine. The reshuffle of complex compounds at the time of fermentation can improve the quality of coffee products. In the end, quality improvement is often correlated with an increase in the selling price of the product [8].

However, the main question that is often asked about relatively new ventures is how viable they are. Thus, a techno-economic analysis of Gayo wine-coffee processing facility development should be done as the answer about how feasible the business is. The study is expected to be useful for business actors who want to plan the establishment of a similar business or can be used as consideration and guidance for business owners to develop businesses that have been run. In the end, the results of this research are expected to add scientific information regarding the feasibility study of developing a sustainable wine-coffee processing facility.

2. Materials and methods

2.1. Research location and data collection

The research was conducted from April to May 2021 in Aceh Tengah District, one of the main coffee producers in Gayo highlands, Indonesia, by conducting a comparative study to a micro-scale wine coffee producer in the location, the Syukran Kopi Wine processing facility. The results of this comparative study are then used as a reference in compiling a techno-economic study of wine coffee processing facility in Aceh Tengah District. Some parameters were adjusted so that the results are more optimal.

This study used both primary and secondary data. Primary data collection was carried out through direct observations in the field and interviews with the company leader and workers of the Syukran Kopi Wine processing facility to obtain information related to management, marketing, law and environmental, technology, and financial aspects; while secondary data collection was obtained from various literatures, such as: books, articles, journals, or other scientific reading sources.

2.2. Data analysis

The analysis of Gayo wine-coffee processing facility development was more focused on the techno-economics (technological and financial) aspects. To do the complete analysis, several stages of analysis must be carried out as described in Figure 1. Furthermore, several basic assumptions used in the analysis are as follows:

1) Financial analysis is carried out during the economic life of the project and the machineries, which is 5 (five) years.
2) The interest rate that is the basis for the calculation in this study is 10% according to the common bank loan interest rate.
3) All investment costs are assumed to be invested in year 0.
4) The list of initial investments and their values (business permits, buildings, machinery and production equipment) is a list of the initial prices for starting a business based on the information from the business owner of Syukran Kopi Wine.

5) Working time in the Gayo wine coffee processing facility is eight hours per day for six working days per week, 24 days per month, 12 months per year.

6) The yield of processed (green beans) wine coffee is 70% of the cherries.

7) The sensitivity analysis is calculated based on the assumption of the following scenarios: (1) operational cost increases by 5%; and (2) benefit decreases by 5%.

Figure 1. Logical framework of the techno-economic study of the Gayo wine-coffee facility development.

Furthermore, the steps to analyse the financial data of the Gayo wine coffee facility development are as follows:
1) Calculating investment costs
2) Calculating production costs
3) Making assumptions about the financial structure
4) Estimating sales
5) Estimating production costs
6) Preparing cashflow
7) Fulfilment of financial feasibility criteria: net present value (NPV), internal rate of return (IRR), analysis of payback period (PP), and Break-event point (BEP)
8) Performing sensitivity analysis
The financial feasibility criteria used are as the following, where the NPV, IRR, PP are among the popular techniques for evaluating investment projects [9]:

1) Net present value (NPV)

Net present value (NPV) is the difference between expenses and income or estimated future cash flows with the current discount. The NPV formula is as follows [10,11]:

\[
NPV = \sum_{t=0}^{n} \frac{NCF_t}{(1+i)^t}
\]  

Where:
- \(NPV\) = Net present value (IDR)
- \(NCF_t\) = net cash flow generated by innovation project in year \(t\)
- \(i\) = Discount rate (%)

The decision-making criteria are: if the NPV > 0, then the investment is feasible; if NPV = 0, then the investment is break-even; and if NPV < 0, then the investment is unfeasible.

2) Internal rate of return (IRR)

Internal rate of return (IRR) is a method of calculating the interest rate which is equal to the present value of all cash inflows and is equivalent to cash outflows. The IRR formula is as follows [12]:

\[
IRR = i_1 + \frac{NPV_1}{NPV_1 - NPV_2} (i_2 - i_1)
\]  

Where:
- \(i_1\) = The interest rate when the NPV is positive
- \(i_2\) = The interest rate when the NPV is negative
- \(NPV_1\) = Positive NPV value (IDR)
- \(NPV_2\) = Negative NPV value (IDR)

The decision-making criteria are: if the IRR is greater than the interest rate, the investment is feasible; if the IRR is less than the interest rate, the investment is unfeasible.

3) Payback period (PP)

This method describes the time spent to return funds invested in a project. The payback period is the time spent from the fund's investment to the same cumulative net cash flow as the initial investment. The PP formula is as follows [12]:

\[
PP = \frac{Value\ of\ investment}{Net\ cash\ flow} \times 1\ year
\]  

The decision-making criteria is investments can be accepted if the payback period value obtained is shorter than the maximum payback period.

4) Break-even point (BEP)

Break-even point (BEP) is a tool used to analyse a company's break-even point. The BEP formula is as follows [12,13]:

\[
BEP\ unit = \frac{FC}{p - vc} \quad \text{or} \quad BEP\ Rupiah = \frac{FC}{1 - \frac{vc}{p}}
\]  

Where:
- \(FC\) = Fixed cost
- \(p\) = Price per unit
- \(vc\) = Variable cost per unit

5) Sensitivity analysis

Sensitivity analysis is one of the analyses used to measure the sensitivity of a project carrying out to any changes that may occur when the investment is running. In this research, sensitivity analysis was used to evaluate how much the value of the financial feasibility criteria change with the following scenarios: (1) operational cost increases by 5%; and (2) benefit decreases by 5%, which means that the business will be more volatile.
3. Results and discussion

3.1. Technological aspect

3.1.1. Facility location. The location of the wine coffee processing facility is planned in Aceh Tengah District, around where the location of the Syukran Kopi Wine processing facility is currently located. Aceh Tengah District is located at an altitude between 200 - 2600 meters above mean sea level (mamsl). This place is a strategic business location, located in Takengon City, the capital of Aceh Tengah District, making it easier to market as well as to export wine coffee. The location is close to the raw materials used (coffee beans), thus minimizing the purchasing costs. It is important to note that one of the requirements in the process of making wine coffee is that the coffee tree must be planted at an altitude of ±1500 mamsl [8,14] or higher, also stated by owner of the Syukran Kopi Wine at around 1300-1500mamsl. Several researches also stated that altitude has a positive correlation with coffee quality [15,16].

3.1.2. Operation scale and production process. The process of wine coffee production is quite difficult because it requires a relatively long time. The process starts from the fermentation process of red coffee beans (cherry) picked without first peeling the skin of the fruit in a closed container. The fermentation process is usually carried out in a closed plastic for 30-60 days. Then, the whole coffee drying process is done until the beans are completely dry, usually carried out for 3-4 weeks, depending on weather conditions, while the natural process of coffee takes approximately two weeks to dry. After the coffee beans are completely dry, the grinding process of the skin of the coffee fruits are carried out using a grinding machine (huller). After the fruit peels are peeled off, then the green beans of wine coffee are dried again until they are completely dry, then the beans are sorted. The process of wine coffee is as shown in Figure 2. Moreover, the planned production capacity was 250 kg of wine-coffee/month based on the results of observations on the Syukran Kopi Wine processing facility, although its operating capacity is limited its maximum capacity from 60% of operating capacity in the first year to 80% of operating capacity in the fifth year (see Table 9).

3.1.3. Tools and machinery. Generally, the Gayo wine-coffee processing facility uses semi-modern technology with a cherry fermentation process that still uses single-use plastic. The use of single-use plastic in the fermentation process is what distinguishes wine coffee processing from ordinary coffee processing. This fermentation process is one way of enzymatically processing food ingredients that involves the presence of microorganisms. The main purpose of fermenting coffee cherries is to remove the layer of mucus (mucilage) attached to the skin of the horn of the coffee beans which affects the taste of coffee beans, especially to reduce the bitter taste. In addition, in the drying process, it is still possible to use simple tools such as tarpaulins and drying racks made using simple tools and still utilize the existing land. This drying process aims to allow the sap contained in the skins to seep into the bean. Then, in the process of grinding, the skin of the coffee fruit using a grinding machine (huller) with a capacity of 10 kg/milling. The fermentation and drying processes in the Gayo wine coffee processing facility unit is as shown in Figure 3.
Figure 2. The process of wine coffee production.

Figure 3. Fermentation and drying process in the Gayo wine coffee processing unit.

3.2. Financial aspect
3.2.1. Investment cost. Investment costs for the development of the five years of Gayo wine-coffee processing facility for a production capacity of 250 kg of wine-coffee/month include licensing fees (Table 2), land and building costs (Table 3), main equipment costs (Table 4), and supporting equipment (Table 5). A small amount of money is assumed to be invested for promotion, about IDR 5,000,000/year.
Table 2. Licence fees of the Gayo wine coffee processing unit.

| No. | Components                                      | Total (IDR) |
|-----|-------------------------------------------------|-------------|
| 1   | Taxpayer Identification Number (NPWP)           | *3,500,000  |
| 2   | Building Permit (IMB)                           | 1,500,000   |
| 3   | Business Place Permit (SITU)                    | 2,500,000   |
| 4   | Certificate of Business Registration (SKDP)*     |             |
| 5   | Business license (SIUP)                         |             |
| 6   | Company Registration Certificate (TDP)           |             |
| 7   | Company deed                                    | 1,000,000   |
| 8   | Export Permit (SPE)                             | 5,000,000   |
|     | **Total**                                       | **13,500,000**|

Table 3. Land and building costs breakdown of the Gayo wine coffee processing unit.

| No. | Detail costs                  | Area (m²) | Price/ unit (IDR) | Total cost/ month (IDR) | Total cost/ year (IDR) | Total cost/ 5 year (IDR) |
|-----|-------------------------------|-----------|-------------------|-------------------------|------------------------|--------------------------|
| 1   | Land rental                   | 500       | 20,000            | 833,333                 | 10,000,000             | 50,000,000               |
| 2   | Building rental               | 240       | 50,000            | 1,000,000               | 12,000,000             | 60,000,000               |
|     | **Total**                     |           |                   | **1,833,333**           | **22,000,000**         | **110,000,000**          |

Table 4. Main equipment cost breakdown of the Gayo wine coffee processing unit.

| No. | Detail costs                  | Amount | Unit | Price/ unit (IDR) | Total cost (IDR) |
|-----|-------------------------------|--------|------|-------------------|------------------|
| 1   | Grinding machine (huller)     | 1      | unit | 4,500,000         | 4,500,000        |
|     | Cap. 10 kg/ milling           |        |      |                   |                  |
|     | **Total**                     |        |      |                   | **4,500,000**    |

Table 5. Supporting equipment costs breakdown of the Gayo wine coffee processing unit.

| No. | Detail costs                  | Amount | Unit | Price/ unit (IDR) | Total cost/ month (IDR) | Total cost/ year (IDR) |
|-----|-------------------------------|--------|------|-------------------|-------------------------|------------------------|
| 1   | Scales                        | 1      | unit | 2,800,000         | 46,667                  | 560,000                |
| 2   | Plastic 25 kg                 | 1      | kg   | 150,000           | 150,000                 | 1,800,000              |
| 3   | Plastic bucket                | 5      | unit | 50,000            | 20,833                  | 250,000                |
| 4   | Plastic basket                | 5      | unit | 80,000            | 33,333                  | 400,000                |
| 5   | Tarpaulin 8x12 m              | 10     | unit | 90,000            | 75,000                  | 900,000                |
| 6   | Gunny sack                    | 100    | unit | 5,000             | 41,667                  | 500,000                |
| 7   | Wink                          | 5      | unit | 90,000            | 37,500                  | 450,000                |
|     | **Total**                     |        |      |                   | **405,000**            | **4,860,000**          |

3.2.2. Operational cost. Operational costs are the overall costs required in operations whose amount is determined by the number of products produced, which consists of fixed costs (Table 6) and variable costs (Table 7). The source of funds for the costs (investment and operational costs) is assumed to be obtained from bank credit funds with a flat loan interest of 10%/year and a loan repayment period of 5 years.
### Table 6. Fixed costs of the Gayo wine coffee processing unit.

| No. | Detail costs                      | Amount | Unit            | Price/ unit (IDR) | Total cost/ month (IDR) | Total cost/ year (IDR) |
|-----|-----------------------------------|--------|-----------------|-------------------|-------------------------|------------------------|
| 1   | Workers                           | 5      | workers/month   | 3,000,000         | 15,000,000              | 180,000,000            |
| 2   | Transportation cost               | 1      | month           | 500,000           | 500,000                 | 6,000,000              |
| 3   | Machine and Equipment Depreciation Cost | 1 | month           | 75,733            | 75,733                  | 908,796                |
| 4   | Electricity cost                  | 1      | 1               | 4,000,000         | 4,000,000               | 48,000,000             |
|     | **Total**                         |        |                 |                   |                         | **234,908,796**        |

### Table 7. Variable costs of the Gayo wine coffee processing unit.

| No. | Detail costs    | Amount | Unit | Price/ unit (IDR) | Total cost/ month (IDR) | Total cost/ year (IDR) |
|-----|-----------------|--------|------|-------------------|-------------------------|------------------------|
| 1   | Raw material cost | 250   | kg   | 6000              | 1,500,000               | 18,000,000             |
| 2   | Fuel cost       | 100    | cubic | 7500            | 750,000                 | 9,000,000              |
|     | **Total**       |        |      |                   |                         | **27,000,000**         |

#### 3.2.3. Estimating sales, production cost, and cash flow.

Table 8, 9, 10 show the estimated cash flow for five years of the Gayo wine coffee processing unit. The changes in the total costs in Table 8 are mainly triggered by the changes in the variable costs. In this case, it is assumed that the operating capacity of the plant will increase slowly, from 60% of operating capacity in the first year to 80% of operating capacity in the fifth year as mentioned in Table 9. Table 9 shows that the total net income after tax earned by the company for five years of production is IDR 210,150,418.

### Table 8. Cash outflow of the Gayo wine coffee processing unit.

| Year | Investment costs (IDR) | Fixed costs (IDR) | Variable costs (IDR) | Total cost/ month (IDR) | Total cost/ year (IDR) |
|------|-------------------------|-------------------|----------------------|-------------------------|------------------------|
| 0    | 143,460,000             |                   |                      |                         | 31,460,000             |
| 1    | 19,575,733              | 1,350,000         | 20,925,733           | 251,108,796             |
| 2    | 19,575,733              | 1,462,500         | 21,038,233           | 252,458,796             |
| 3    | 19,575,733              | 1,575,000         | 21,150,733           | 253,808,796             |
| 4    | 19,575,733              | 1,687,500         | 21,263,233           | 255,158,796             |
| 5    | 19,575,733              | 1,800,000         | 21,375,733           | 256,508,796             |
| **Total** | 105,753,665          |                   |                      | **1,412,503,980**       |

### Table 9. Cash inflow of the Gayo wine coffee processing unit.

| Year | Production quantity (kg/year) | Operating capacity (%) | Sales price (IDR/kg) | Total production values (IDR/year) |
|------|-------------------------------|------------------------|----------------------|-----------------------------------|
| 0    | 0                             | 0%                     | 0%                   | 0%                                |
| 1    | 1260                          | 60%                    | 250,000              | 315,000,000                       |
| 2    | 1365                          | 65%                    | 250,000              | 341,250,000                       |
| 3    | 1470                          | 70%                    | 250,000              | 367,500,000                       |
| 4    | 1575                          | 75%                    | 250,000              | 393,750,000                       |
| 5    | 1680                          | 80%                    | 250,000              | 420,000,000                       |
| **Total** |                                  |                        |                      | **1,837,500,000**                |
Table 10. Cash flow of the Gayo wine coffee processing unit.

| Year | Cost (IDR/year) | Income (IDR/year) | Net income before tax (IDR/year) | Tax (IDR/year) | Net income after tax (IDR/year) |
|------|-----------------|-------------------|----------------------------------|---------------|----------------------------------|
| 0    | 143,460,000     | -                 | 143,460,000                      |               | 143,460,000                      |
| 1    | 251,108,796     | 315,000,000       | 63,891,204                       | 6,389,120     | 57,502,084                       |
| 2    | 252,458,796     | 341,250,000       | 88,791,204                       | 8,879,120     | 79,912,084                       |
| 3    | 253,808,796     | 367,500,000       | 113,691,204                      | 11,369,120    | 102,322,084                      |
| 4    | 255,158,796     | 393,750,000       | 138,591,204                      | 13,859,120    | 124,732,084                      |
| 5    | 256,508,796     | 420,000,000       | 163,491,204                      | 16,349,120    | 147,142,084                      |
| Total| 1,412,503,980   | 1,837,500,000     | 368,150,418                      |               |                                  |

3.2.4. Investment criteria and sensitivity analysis. The investment criteria used in the calculation are NPV, IRR, PP, and BEP; then a sensitivity analysis was performed. The values of the investment criteria are as shown in Table 11. The table shows that all financial indicators meet the business feasibility criteria. Although the NPV is arguably small, since the size of planned business can be categorised as a micro and small business level [17], owners and their families also have a chance to earn income as workers. Furthermore, the sensitivity analysis was done the following scenarios: (1) operational cost increases by 5%; and (2) benefit decreases by 5%. In both scenarios, all financial indicators still meet the business feasibility criteria. Additionally, Table 12 and 13 also shows that decreasing the benefit make a slightly higher impact (more sensitive) on most values of the investment criteria than increasing the operational cost, thus preventing the sales price from sharp decreasing is essential.

Table 11. Value of investment criteria of the Gayo wine coffee processing unit.

| No. | Investment criteria                  | Value               |
|-----|--------------------------------------|---------------------|
| 1   | *Net Present Value* (NPV)            | IDR 269,596,789     |
| 2   | *Internal Rate of Return* (IRR)      | 58.09%              |
| 3   | *Payback Period* (PP)                | 1 year 10 months 19 days |
| 4   | *Break Event Point* (BEP)            | 81.2 kg/month       |

Table 12. Sensitivity analysis result of scenario (1), operational costs increase by 2.5%.

| No. | Investment criteria                  | Value               |
|-----|--------------------------------------|---------------------|
| 1   | *Net Present Value* (NPV)            | IDR 221,538,622     |
| 2   | *Internal Rate of Return* (IRR)      | 49.71%              |
| 3   | *Payback Period* (PP)                | 2 year 1 months 5 days |
| 4   | *Break Event Point* (BEP)            | 83.34 kg/month      |

Table 13. Sensitivity analysis result of scenario (2), benefit decrease by 2.5%.

| No. | Investment criteria                  | Value               |
|-----|--------------------------------------|---------------------|
| 1   | *Net Present Value* (NPV)            | IDR 200,885,783     |
| 2   | *Internal Rate of Return* (IRR)      | 46.52%              |
| 3   | *Payback Period* (PP)                | 2 year 7 months 22 days |
| 4   | *Break Event Point* (BEP)            | 83.39 kg/month      |
4. Conclusions
Because Aceh Tengah District as one of the main producers of coffee in Indonesia is located at an altitude between 200 - 2600 meters above sea level, as well as the need for raw materials for producing the wine coffee which must come from coffee trees planted at an altitude about 1300-1500 mamsl, Aceh Tengah District is very suitable as a location for a wine coffee factory to minimize the purchasing costs. The process of wine coffee production is more difficult than the process of common coffee production because it requires a relatively long time, including 30-60 days for fermentation process dan 3-4 weeks for sunshine drying process. The Gayo wine-coffee processing facility uses semi-modern technology, where most tools/ machineries and materials used are like those used in common coffee processing facility. Moreover, all financial indicators meet the business feasibility criteria for five years economic life of the project. Sensitivity analysis also shows that in both scenarios, all financial indicators still meet the business feasibility criteria, although decreasing the benefit make a slightly higher impact (more sensitive) on most values of the investment criteria than increasing the operational cost.

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