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SENSITIVITY ANALYSIS OF INVESTMENT FEASIBILITY ON CITRONELLA OIL DISTILLATION INDUSTRY IN INDONESIA

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Abstract

The citronella plant is one of the essential oil-producing plants, and Indonesia is the second supplier of citronella oil after China. The world market demand for citronella oil increases every year, so there are still opportunities to meet the needs of the world market. The citronella oil distillation industry makes a major contribution to improving the community's economy, namely farmers and citronella processing industry players. However, the reality shows that citronella farmers and distillers do not get the same benefits as other industry players. Based on these problems, this study was conducted to discuss the feasibility of investing in the citronella distillation industry from the point of view of industrial engineering, especially with regard to economic feasibility. Sensitivity analysis was conducted to determine the effect of changes in production parameters on changes in production system performance in generating profits. The results of the study show that economically the citronella distillation industry is feasible to run with several possible alternatives. In addition, such important financial parameters as operational costs and investment meet the minimum requirements of the SMEs' investment.

Keywords: Citronella, Distillation industry, Investment feasibility, Sensitivity analysis.

1. Introduction

Citronella is one of the currently popular plantation commodities, the leaves and stems of citronella can be distilled into oil. The industrial potential of citronella oil is quite high because it contains the main components in the form of citronellal, citronellol, and geraniol which give a characteristic citrus smell that is favoured. The plant with the Latin name *Cymbopogon nardus* is used as a mixture for anti-fungal, antioxidant and anti-bacterial drugs, mosquito repellent lotions, perfumes, cosmetics, aromatherapy, and bio-additive base materials that are useful for saving vehicle fuel [1-5].

Citronella oil is a mainstay commodity of essential oils in the agribusiness sector which has a good market and strong competitiveness in foreign markets. In the trading world, there are two types of Citronella Oil, namely the *Ceylon* type from the *Cymbopogon nardus* plant (*Ceylon citronella*) and the Javanese type from the *Cymbopogon winteratus* plant (*Java citronella*). The Ceylon type is mostly produced in Sri Lanka, while the Java type is produced in Java, China, Honduras, and Guatemala [6].

The world market demand for citronella oil is increasing 3-5% per year. The importing countries for Indonesian citronella oil (citronella oil of Java) are the United States, China, Taiwan, Singapore, the Netherlands, Germany, and the Philippines [7]. According to the Director General of Transportation in 2020, currently world consumption of citronella oil reaches 2,000-2,500 tons per year, while only 600-800 tons per year are supplied, so there is still an opportunity for Indonesia to meet the needs of the world market. The citronella oil processing industry makes a major contribution to improving the community's economy, especially farmers and citronella oil processing industry players. However, the management of the citronella oil industry faces many challenges in production.

Anwar et al. [8] examined the challenges faced by the citronella oil industry in production, namely the large production costs and low market prices. The unclear product supply chain in the citronella oil distillation industry is a challenge that must be considered [9]. In addition, investment in this product industry also requires very large costs, causing farmers' reluctance to continue the production of citronella oil [10]. Because of the large economic contribution of citronella oil production to the community, the feasibility of investments that support the community's economy needs to be studied. This study aims to determine the feasibility of investing in the citronella distillation industry in terms of the economic aspect.

Small-scale industry is an industry in which the manufacture, production and provision of services is carried out on a small or micro scale. This industry makes a one-time investment in machinery, factory, and industry, so it is necessary to analyse the feasibility of the investment in terms of the economic aspect [11]. One example of a small-scale industry is the citronella oil refining industry, since the dominant business players are farmers who cultivate citronella as well as carry out the distillation process. In accordance with the problems faced by the business players of citronella distillation and in order to develop their business, it is necessary to make the feasibility of investing in the business [12].

There are several studies on investment/economic feasibility for small-scale industries to inform potential production when businesspeople run their business. Among them are investment feasibility analysis for several economic evaluation

parameters (i.e., gross profit margin (GPM), internal rate of return (IRR), payback period (PBP), cumulative net present value (CNPV), break-even point (BEP), break-even capacity (BEC), return on investment (ROI), and profitability index (PI)) [13, 14].

Another research on the evaluation of the feasibility of producing low-cost and portable Arduino-based spectrophotometers with white LED lights. The results confirm that the project has the potential to be applied in small-scale industries because all processing steps can be carried out with simple equipment and are commercially available in the market [15]. In addition, there are studies on the thermal, environmental, and economic performance of small-scale ethanol distillation systems using solar energy as the primary energy source. The results show that if the improvement process is carried out continuously, the project will further increase its feasibility [16].

Research on the impact of air pollution control regulations on industrial secondary lead smelting in an unorganized sector in two wards in Kolkata India. The results show that after adopting emission reduction technologies, additional investment in control devices is economically feasible and also beneficial for society and the environment in general [17]. An assessment of the economic feasibility and environmental impact of ethanol production in small-scale distillates in Brazil shows that this business is feasible to develop because it has a role in supplying liquid fuel in Brazil [18].

This research on the investment feasibility of the citronella distillation industry is expected to provide several benefits. The first benefit is that it is considered as input to the relevant agencies in formulating policies and strategic steps for the development of the citronella distillation industry. Moreover, the second one is as a basis for making decisions for business actors in the citronella oil refining industry when running their business, especially for investment feasibility.

2. Research methods

2.1. Context of research

West Java Province is located in the western part of Java Island. Its territory is bordered by the Java Sea in the north, Central Java in the east, the Indian Ocean in the south, and Banten and DKI Jakarta in the west. The north coast area is lowland, the middle is mountainous, which is part of a mountain range that stretches from west to east of Java Island. The highest point is Mount Ciremay, which is in the southwest of Cirebon City. The essential rivers are the Citarum River and the Cimanuk River, which empties into the Java Sea. The climate in West Java is tropical, with a temperature of 9°C at the summit of Mount Pangrango and 34°C on the North Coast, rainfall averaging 2,000 mm per year, but in some mountainous areas between 3,000 and 5,000 mm per year. The total area of West Java Province is 35,377.76 km^2. West Java Province consists of 18 regencies and 9 cities, with Bandung as the capital city.

Lemongrass is widely found in several areas in West Java because the geographical conditions are in accordance with the technical culture of citronella which does not require many requirements. Based on information obtained from the Director General of Transportation of West Java Province in 2020, citronella has the following growing conditions: live at an altitude of 200-1,000 m above sea

level with an ideal altitude of 350-600 m above sea level. At this height, citronella produces good yield and quality of essential oils. The optimum growing temperature is 180-250°C, requires rainfall throughout the year around 1,800-2,500 mm/year and an even distribution of rain for 10 months.

Citronella in West Java Province is found in West Bandung Regency, Ciamis Regency, Garut Regency, and Subang Regency. In addition, during the survey, citronella is also found in Bandung Regency and Sumedang Regency (see Table 1). The process of cultivating and distilling citronella is easy and possibly done with conventional technology with high market demand, so that quite a lot of farmers depend on this type of commodity for their daily life.

Table 1. Land area and production of citronella plants in West Java 2017 [19].

Regency/City	Land Area	Production	
		Total (ton)	Average (kg/ha)
Bandung Barat	1.448	492	340
Ciamis	5	4	-
Garut	28	1	39
Subang	35	6	168
Total	1.516	503	332

2.2. Research design

Citronella plants are spread in almost all parts of Indonesia. However, the main area to produce citronella oil are the Provinces of Nanggroe Aceh Darussalam (NAD), West Java, and Central Java, with production of more than 95% of Indonesia's total production (Directorate General of Plantations). Other regions that produce citronella oil are West Sumatra, South Sumatra, West Kalimantan, and South Sulawesi. This research is a continuation of previous research on the Indonesian citronella distillation industry in West Java Province [8, 20-22]. The current study aims to test the feasibility of investing in the citronella oil distillation industry in West Java.

The results of the preliminary survey and the information obtained are that there are 4 regencies/cities in West Java Province which are designated for the cultivation and distillation of citronella, so the researchers set these 4 regencies/cities as research sites. The survey was conducted to obtain information on issues related to the feasibility of investing in the industry.

Information from the West Java Provincial Plantation Service stated that the selected areas were citronella plant producing areas as well as citronella oil distilleries. Citronella plants can grow on various types of soil both in the lowlands and highlands up to an altitude of 1,200 m above sea level, with an optimum altitude of 250 m above sea level. The research areas have almost the same characteristics because the citronella distillery will be close to the citronella planting location, to avoid the high cost of transporting citronella plants to the distillery location. The research location can be seen in Fig. 1 as follows:

Fig. 1. Research location in West Java Province.

2.3. Participants

This study involved 20 entrepreneurs from the citronella distillation industry from 4 areas where the research was conducted. The selection of entrepreneurs is done randomly when visiting the research area. There are two characteristics of entrepreneurs who are involved as participants, namely citronella distillers and citronella farmers who double as citronella distillers. This was done in order to obtain more in-depth information about the components of costs and revenues needed as the main variables in this study.

2.4. Instrumentation

Data collection was carried out in several ways, namely interviews with citronella distillation business players and direct observation. Interviews were conducted in an unstructured manner to obtain information regarding investment costs, operational costs, income, and the constraints faced during the activities of the citronella distillation industry. The interview process to obtain complete information was carried out several times with a span of one week to three months, namely from January to March 2020. The citronella distillation industries observed were the home-scale industries, where many of the business players were concurrently other than as citronella farmers and as citronella distillers. Direct observations were made in the citronella distillation industries in the selected areas, to directly see the distillation process carried out.

2.5. Data analysis (procedure)

The approach used in this study is the sensitivity analysis approach to see the investment feasibility against changes or fluctuations in parameters or financial components, such as a decrease in income and an increase in operating costs. Sensitivity analysis is used to provide more detail about how quickly a changing variable, such as a commodity, can affect the profitability of the equipment under review. This technique is especially useful when the model contains a large number of input parameters, allowing the observation of various profitability for each variable [23]. Only one variable in the financial model is destructive of the other variables.

Sensitivity analysis is a general methodology to find out the uncertainty in any assessment, the impact of certain parameters of any numerical analysis and the

consequences of certain assumptions. In this study, sensitivity analysis was used to measure both. Simple sensitivity analysis is applied to determine changes in economic outcomes such as IRR, NPV, PP and ROI due to changes in certain parameters or assumptions.

Economic analysis begins with the calculation of working capital, investment costs, and operational costs needed to run the production process. The investment costs include the estimated price of machinery, distillation equipment and buildings for the distillery. While the operational costs include estimates of raw materials (citronella leaves), labour wages, maintenance of machinery, equipment, and buildings, as well as depreciation losses. Meanwhile, to calculate income, it is necessary to know the amount of citronella oil produced in each production process and the price of citronella oil per kg.

The analysis is then continued by calculating the value of profit, cash flow, and economic parameters. There are 2 types of cash flows that are commonly used in economic studies, the cash flows needed for new investments are called net cash outflows, while the annual cash flows obtained from investments are called cash inflows. Annual cash inflows are also known as income [24]. Cash accumulation is the reduction of cash outflows by cash inflows. The economic parameters to be calculated are Net Present Value (NPV) and Internal Rate of Return (IRR). The NPV value is the result of subtracting the present value of the yield with the present value of the initial investment cost. Cash flow calculation is done by assuming a discount rate of approximately 10%.

To determine the feasibility of investing in the citronella distillation industry, a Net Present Value (NPV) calculation is carried out which is used to analyse profits in a project to be implemented.

$$NPV = \frac{Rt}{(1+i)^t} \quad (1)$$

Where *NPV* is net present value; *Rt* is net cash flow at time *t*; *i* is discount rate; and *t is* time of the cash flow.

If the project is economically viable, the NPV is greater than zero (NPV > 0). When the NPV is positive, it means that the benefits of the project outweigh the costs. The NPV criterion is limited because it cannot be used to rank a number of alternative investment projects since the project NPV is likely to be positively related to the cost or scale of the project investment. Investment decision making in this method uses the following assumptions: If NPV0 > NPV1, then the investment or project is considered unfeasible because it is at risk of loss. If NPV0 < NPV1, then the investment or project is considered feasible because it has the potential to generate profits.

The next step is to determine the Internal Rate of Return (IRR) which is an indicator of the efficiency level of an investment. IRR is an interest rate that will equate the present value of future proceeds with the present value of investment expenditures. IRR is the highest interest rate that the project owner must economically pay. In other words, the IRR is the discount rate at which the NPV is zero. The project selection criterion is that the IRR must be greater than the social discount rate.

$$0 = NPV = \sum_{n=0}^{N} \frac{CFn}{(1+IRR)^n} \quad (2)$$

where *CFn* is cash flow; *n* is each period; *N* is holding period; *NPV* is net present value; and *IRR* is internal rate of return.

An investment is said to be feasible if the resulting IRR is greater than the applied interest rate. An investment is said to be unfeasible if the resulting IRR is less than the applied interest rate.

After the NPV and IRR calculation process is complete, the next step is to conduct a sensitivity analysis to see the feasibility of the investment against changes in the financial component. The decision is said to be sensitive if every change in the value of the parameter or calculation factor will change the investment decision. Parameters that usually change and their changes can affect investment decisions are investment costs, cash flows, residual value, interest rates, tax rates and so on.

3. Results and Discussion

3.1. The results of a survey to the perpetrators of citronella oil distillation in West Java Province

The survey was conducted in December 2019 – February 2020. The activities carried out in each research area were interviewing farmers and distillers of citronella, as well as visiting the distillery to see how the distillation was carried out and see the technology of the machines or tools and distillation methods used. The results of interviews with businesspeople/industry of citronella distillation will be described below.

3.2. The investment feasibility of citronella distillation

At this time, at the location of the citronella plantation and distillery, a farmer group for the cultivation of citronella has not been formed. Cultivation of citronella is not done full time, but only as a side activity of farming. At the research location, about 40% of the population grows citronella either on their own land, village land, forestry land and plantations. But the population is more dominant in planting on their own land, and from time to time the number of citronella farmers is increasing. Farmers prefer citronella over coffee because every 3 months they can harvest, after 6 months of the initial harvest. The oil from citronella has a fairly high price compared to oil from other types of lemongrasses.

Based on the results of interviews, 1 ton of citronella leaves can produce about 8-10 kg of citronella oil. Every day, there are at least 4 times the distillation of citronella. The distillation process has been going well using fuel from citronella waste. The heating process only takes one and a half hours with citronella waste fuel so that it can be distilled. The citronella oil produced is grade 1, with an average selling price of IDR 180,000,-/kg.

The study of economic aspects in this research will be carried out on investment in citronella oil distillation, with a production capacity of 300 kg of raw materials for one process. Each processing/distillation produces 2 Kg of citronella oil, with one processing time of 2 hours. Distillation is carried out 4 times a day or produces 8 kg of citronella oil/day. Financial data for the study of the economic aspects of citronella

oil production can be seen in Tables 2, 3, 4 and 5. While the results of the calculation of investment in citronella oil production can be seen in Tables 6 and 7.

From the Table 6, it shows that the investment of citronella oil production for Year I to Year V gained the profit about IDR 55,500,000,-. By using cash flow data, the feasibility of investing in citronella oil production can be calculated using a 10% discount factor as the minimum interest rate in investment returns (MARR = Minimum Attractive Rate of Return). From Table 7, it can be observed that the cash flow per year is positive, Net Present Value (NPV) is positive (IDR 175,911,699,-) with Internal Rate of Return (IRR) = 58.89% > 10% more than the discount rate. This implies that the investment in citronella distillation is proven to be economically feasible.

Table 2. Investment cost.

Description	Quantity	Unit	Price Per Unit (IDR)	Total (IDR)
Distillation Machinery and Equipment	1	Set	50.000.000	50.000.000
Building	250	m^2	200.000	50.000.000
Total				100.000.000

Table 3. Depreciation.

Description	Initial price	Economical Period (TH)	Residual Value (IDR)	Straight Line Annual Depreciation (IDR)	Value in Year 5 (IDR)
Distillation Machinery and equipment	50.000.000	20	0	2.500.000	37.500.000
Building	50.000.000	20	0	2.500.000	37.500.000
Total	100.000.000				75.000.000

Table 4. Operating cost per year.

Description	Quantity	Unit	Price Per Unit (IDR)	Total (IDR)
Raw Material (Citronella Leaves)	360.000	kg	600	216.000.000
Worker (2 people)	300	Day	500.000	150.000.000
Maintenance (Machinery, Equipment, Building)	1	Year	500.000	500.000
	1	Year	5000.000	5.000.000
Total				371.500.000

Table 5. Income per year.

Description	Quantity	Unit	Price Per Unit (IDR)	Total (IDR)
Citronella oil	2.400	kg	180.000	432.000.000

Table 6. Profit/loss year I to year V (in Rupiah).

Description	Year I	Year II	Year III	Year IV	Year V
Income	432.000.000	432.000.000	432.000.000	432.000.000	432.000.000
HPP:					
Operating	317.500.000	317.500.000	317.500.000	317.500.000	317.500.000
Depreciation	5.000.000	5.000.000	5.000.000	5.000.000	5.000.000
Total HPP	376.500.000	376.500.000	376.500.000	376.500.000	376.500.000
Profit/Loss	55.5000.000	55.5000.000	55.5000.000	55.5000.000	55.5000.000

Table 7. Cash flow.

Year	Income	Cost	Cash Flow	Discount Factor (DF=10%)	PV
0	-	100.000.000	(100.000.000)	1,0000	(100.000.000)
1	432.000.000	371.500.000	60.500.000	0,9091	55.000.000
2	432.000.000	371.500.000	60.500.000	0,8264	50.000.000
3	432.000.000	371.500.000	60.500.000	0,7513	45.454.545
4	432.000.000	371.500.000	60.500.000	0,6830	41.322.314
5	507.000.000	371.500.000	133.500.000	0,6209	84.134.489
				NPV	175.911.699
				IRR	58,89%

3.3. Sensitivity analysis

The unstable price of citronella oil causes fundamental changes in other costs such as utilities, machinery, and interest rates. Therefore, it is considered necessary to study the sensitivity of economic parameters to the variation of factors that affect the economic situation. Production achievement every year will be influenced by changes in raw material costs and other operational costs and will depend heavily on sales volume and prices. Sensitivity analysis is a way to examine the effect of uncertainty in forecasts on project viability. Sensitivity analysis is needed to see the feasibility of an investment against changes or fluctuations in financial parameters/components, for example a decrease in income and an increase in operational costs.

To perform the analysis, investments and cash flows are first calculated using the values considered most likely for various factors. The various parameters in the cost model are then adjusted, assuming various errors for each factor in turn. This will show how sensitive cash flow and economic criteria are to errors in forecast figures. Sensitivity analysis provides some idea of the level of risk involved in making judgments on project performance forecasts. Sensitivity analysis involves recalculation of the NPV or IRR for different values of the main input variable, which are varied one by one. Combinations of changing values can also be investigated. The results of the sensitivity analysis are usually presented in the form of tables and plots of economic criteria such as NPV or % IRR vs. parameters studied [25].

In this study, this sensitivity analysis will be carried out on 3 reviews, namely: fixed income and increased operating cost; decreased income and fixed operating cost; and decreased income and increased operating cost. The results of the sensitivity analysis for the production of citronella oil are shown in Table 8 below:

Table 8. Results of sensitivity analysis.

Condition	Financial Parameter Changes	NPV, df=10%	IRR	Conclusion
1	Fixed income and increased operating cost by 12%	IDR 6.918.425	11,98%	Feasible
	Fixed income and increased operating cost by 13%	IDR (7.164.348)	7,94%	Not feasible
2	Decreased income by 10% and fixed operating cost	IDR 12.149.710	13,48%	Feasible

3	Decreased income by 11% and fixed operating cost	IDR (4.226.489)	8,78%	Not feasible
	Decreased income by 6% and increased operating cost by 6%	IDR 23.092.486	15,69%	Feasible
	Decreased income by 7% and increased operating cost by 7%	IDR (2.377.383)	9,43%	Not feasible

Explanation:

- Option 1: Fixed income and maximum operating costs increased by 12%, so the investment in citronella oil production is still feasible. Therefore, the sensitivity limit is a maximum of 12% for an increase in operating costs (low sensitivity = good).
- Option 2: Income decreased by a maximum of 10% and operating costs remained, so the investment in citronella oil production is still feasible. Therefore, the sensitivity limit is a maximum of 10% for a decrease in income (low sensitivity = good).
- Option 3: Income decreased by a maximum of 6% and operating costs increased by a maximum of 6%, so the investment in citronella oil production is still feasible. Therefore, the sensitivity limit is a maximum of 6% for a decrease in income and a maximum of 6% for an increase in operating costs with concurrent conditions (the sensitivity can still be said to be quite low = quite good).

In this study, sensitivity analysis has various aspects considered and has been selected for option 3 because it has the highest PV value and % IRR compared to option 2 which has the second highest NPV and % IRR. The purpose of the sensitivity analysis is to identify the parameters that have a significant impact on the viability of the project over the expected range of parameter variations. The typical parameters investigated, and the range of variation usually assumed [25], are shown in Table 8. In terms of the economic analysis, it can be concluded that the investment in the small-scale citronella distillation industry is feasible. Fundamental indicators, such as Net Present Value (NPV) and Internal Rate of Return (IRR), show positive results before the specified instalment period. Sensitivity analysis also shows good results with NPV shows positive results (> 0), even though the input conditions are made pessimistic up to 6% of the base case NPV. NPV of Rp84,134,489 will be obtained in the 60th month or 5th year after surgery. IRR also resulted in a decent investment value at 13.48% and 15.69%, respectively. It is in line with previous works proving that investment in small-scale industry in a variety of fields, including in oil industry, is feasible as long as the key points are highlighted [26-28].

4. Conclusions

Based on the sensitivity analysis conducted on the feasibility of investing in the citronella distillation industry, it can be seen the optimal point for changes in financial parameters, such as operating costs and income, so that the investment can be declared feasible. However, to see the process of improving the performance of this small-scale citronella distillation industry, further research needs to be conducted, especially those related to its implementation. In addition, citronella oil

refiners need to be given training, especially related to financial and marketing aspects, so that they can develop their business.

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