Techno-Economic Study on Improvement of Slaughterhouses by Considering Sensitive Analysis and Exchange Rate

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Abstract

This article discusses the improvement of Aqidawati & Sutopo's (2017) article, related to the analysis of the feasibility of investing in facilities that meet the standards to obtain Safe, Healthy, Whole, and Halal Beef at the Surakarta Slaughterhouse. Previous studies evaluated using a technical-economic approach with investment feasibility criteria indicated by the value of NPV>0, PP <20 years (economic age), B/C ratio 1, and production yields greater than the amount of BEP. Then, a proposed improvement is made by adding aspects of the techno-economic study by considering exchange rates and sensitivity analysis. As a result, the best alternative is obtained; namely alternative level 1-C with an NPV value of Rp 88,462,036, MARR < IRR (3% < 7.23%), BC ratio value of 1.06, and a payback period that meets company requirements (11.15 < 20). So it can be concluded that the investment can be said to be feasible. In addition, the sensitivity analysis results also show that the Annual Worth (AW) is the most sensitive to changes in retribution prices so that it considers the government in determining the decision on the amount of the retribution price.

Keywords

Investment feasibility analysis, Slaughterhouse, Sensitivity analysis, Techno-economic Study

1. Introduction

Providing beef in traditional markets has become a problem for every region. The problems usually occur due to quality beef, cleanliness, and health. The government has launched a standardization program for a safe, healthy, whole (ASUH) and halal beef to improve beef quality (Adawiyah et al., 2022). The slaughter process influences the quality of beef at the Slaughterhouse (RPH) and the handling method during the distribution process to the market. RPH must have excellent clean facilities and infrastructures to improve beef quality (Lupita et al., 2017). Facilities and infrastructure can support it through unique clothes, plastic aprons, head coverings, nose covers, and boots. In addition, it is also necessary to have a box equipped with a cooling device that can maintain the inside temperature of the fresh meat at 7°C and the inside temperature of the viscera at 3°C (SNI 01-6159-1999). Then, the government must carry out ante and post-mortem inspection controls on beef cuts.

Based on Aqidawati & Sutopo's research (2017), RPH in Surakarta City has weaknesses in the meat slaughtering, handling, packaging, and distribution system that does not meet SNI 01-6159-1999 regarding the technical standards

of abattoirs. First, the slaughter of cattle in this RPH is still using conventional methods and has not used the help of modern tools. Second, the workers involved do not use unique clothes according to SNI. Third, put the meat in using plastic bags as packaging. Lastly, it does not equip the vehicles transporting meat from the slaughterhouses to the market with refrigeration. These four aspects will impact the safety and hygiene risks of meat. Aqidawati & Sutopo (2017) also discuss the feasibility of investing to realize a suitable slaughterhouse for beef cattle according to SNI standards. In the feasibility study, procuring several facilities and tools to provide RPH with facilities that meet SNI calculates the suitable investment. The investment feasibility study in this study has considered several methods, such as Net-Present Value (NPV), Payback Period (PP), Benefit-Cost Ratio (B/C ratio), and Break-Even Point (BEP). However, Aqidawati & Sutopo's (2017) research still has several shortcomings in conducting techno-economic studies related to investment feasibility analysis in abattoirs in Surakarta. First, calculating the income received is not certain. Second, income and depreciation expenses are still unclear in the calculation. Third, it only considers the actual value of the rupiah so that it is less accurate to actual events. Fourth, there is no analysis of the changes in each variable that can influence decisions.

According to Sutopo et al. (2018), the exchange rate and price exchange influence seasonal staple food changes under free trade considerations. Increasing the exchange rate's value will increase the price of capital to increase the company's cost. Meanwhile, according to Sullivan (2015), changes in the exchange rate between two currencies over time are analogous to changes in the general inflation rate because the relative purchasing power between the two currencies is changing, similar to the relative purchasing power between actual and accurate dollar amounts. In addition, according to Rezzouk and Mellit (2015), it is also necessary to consider aspects of sensitivity analysis in the analysis of investment feasibility. It is used to study the effect of some parameters′ and variations. Many studies consider sensitivity analysis in their investment feasibility studies, such as Kurniyati et al. (2016), Apriliana and Sutopo (2017), and Park & Yang (2017). Several studies have researched techno-economic studies, including research by Hanafi et al. (2021) and Christover et al. (2021). Their research stated that companies could invest in replacing production machinery or fixed assets with increasing efficiency and production capacity.

Based on the problems above, this research improves or develops the research of Aqidawati & Sutopo (2017). According to the evaluation results, improvements are to complete aspects of a more comprehensive investment feasibility analysis, from considering more complete data, calculating income and depreciation costs, and exchange rates to sensitivity analysis. The urgency of this research is to provide a more comprehensive investment decision in an abattoir in Surakarta. In addition, it also provides convenience in knowing the effects of changes in something and better understanding investment projects with sensitivity analysis.

2. Literature Review

Investment is an investment in the present to get results or something desired in the future. Investment activities are usually understood to generate benefits for a certain period. Analyzing the feasibility of investment is a must to know whether an investment can provide the desired return and determine what caused it to happen (Sullivan, 2015). There are several methods to determine the feasibility of investment. Conduct the feasibility analysis using several methods, namely the Net-Present Value (NPV), B-C Ratio, Internal Rate of Return (IRR), payback period (PP), and BEP points. In addition to conducting a feasibility analysis, there is also an analysis of the characteristics of the investment. It is helpful for a deeper understanding of the investments made. The method in question is a break event analysis method and sensitivity analysis.

a. Break Even Point

Analysis of the break-even point is a point of production where the sales proceeds have the same value as the total cost required (Prawirosentono, 2001). To make a profit, the project implemented must produce and distribute its products greater than or equal to the number of break evens (Sutojo 2002). The formula of the break-even point is:

$$EW_A = f_1(y)$$

Information:
EWa = Equivalent value (PW inflow – PW outflow)

y = Factors that affect the value of EW

In addition to getting factor points, break-even can also be mapped in a graph to determine the project's characteristics. It is helpful to see the interval at which one alternative is better than the other.

b. Sensitivity Analysis

This step is sensitivity analysis to explore what happens to the project's profitability when the estimated values of several study variables are varied (Sullivan 2015). This sensitivity analysis is on 3 variables: the investment value, the annual fee, and the retribution price. The analysis in the range of -50% -50% factor changes. This analysis will produce a spider plot graph that contains information about the range of changes in which the project is still profitable.

So that through the BEP and sensitivity analysis, it is hoped that Aqidawati and Sutopo's (2017) study related to feasibility analysis on annual investments in slaughterhouses, as in the study of Wulandari et al. (2022), Christopher et al. (2021), Yasuha and Saifi (2017).

3. Methods

Based on a previous study entitled "Kajian Tekno Ekonomi Perbaikan Rumah Potong Hewan untuk Mendukung Penyediaan Daging Sapi di Pasar Tradisional yang Aman, Sehat, Utuh dan Halal: Studi Kasus" by Aqidawati & Sutopo (2017), this study criticizes and refines the analysis of the feasibility of investing in have been done. This research refines the previous research, which analyzed the feasibility of procurement investment in RPH using NPV, PP, B/C, and break-even analysis methods. Then, this study considers some data and information, such as income and expenditure information, tax calculation factors, exchange rate, and sensitivity analysis. The assumptions used in this study consist of unchanged abattoir goals and stakeholders and no shift in the core business of the abattoir in Surakarta. The steps to process and analyze the data in this study are to follow the flowchart: (Figure 1)

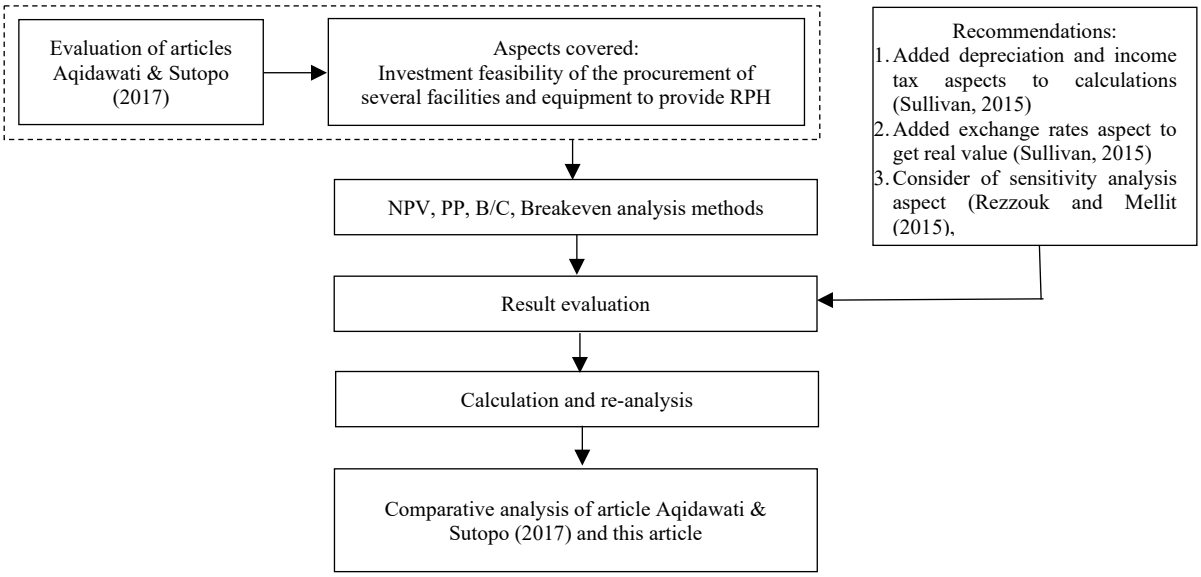

Figure 1. Research Methodology

4. Data Collection

Based on the flowchart research, data collection for each stage supports this research. From the observations, several facilities need to be implemented by the abattoir. The investment requirements for the addition of new facilities at the Surakarta City RPH are detailed as follows in Table 1:

Table 1. Details of Investment Needs

No	Equipment Name	Function	Quantity (unit)	Price (IDR)	Total (IDR)
1.	Waterproof apron	Protects workers from blood-slaughtered animal	11	10,500	115,500
2.	Headcover	Covering the head for hair no smell and decompose	11	17,500	192,500
3.	Gloves	Protect hands so meat rubber is not contaminated	11	38,000	418,000
4.	Wearpack	Protect workers from blood-slaughtered animal	11	170,000	1,870,000
5.	Check and cut rubber boots	Maintain cleanliness and hygiene of workers' feet and meat during the process	11	90,000	990,000
6.	Box container	The place to store meat during the distribution time	10	110,000	1,100,000
7.	Cattle automatic bleeding conveyor	As a railing system and bleeding conveyor for hanging cows	20	5,341,200	106,824,000
8.	Double pale hydraulic elevator	It lifts cows and makes it easier for butchers to remove the entrails of a cow	1	510,218,885	510,218,885
9.	Carcass splitting saw	Splitting the cow's body into two parts	1	166,375,000	166,375,000
10.	Pneumatic reverse box	Hold cattle to make the box easier for the slaughterer to cut	1	649,161,975	649,161,975
Total (IDR)					**1,437,265,860**

There are three alternative investment facilities from the detailed list of investments, described in more detail in the following Table 2:

Table 2. Investment Alternative

Investment			**Retribution**	
Level	**Facilities**	**Total Investment**	**Level**	**Price**
1	1,2,3,4,5,6,7,8,9	Rp 788,103,885.00	a	Rp30,000.00
2	1,2,3,4,5,6,9,10	Rp 820,222,975.00	b	Rp35,000.00
3	1,2,3,4,5,6,7,8,9,10	Rp 1,437,265,860.00	c	Rp40,000.00

This level 1 investment aims to improve the quality of beef through the cleanliness of butchers who wear personal protective equipment such as aprons, head and nose covers, clothing, boots, and rubber gloves, as well as maintaining the cleanliness of the meat after being cut through storage in box containers. In addition, level 1 also aims to increase the speed of slaughtering one cow by using tools 7, 8, and 9. Level 2 is the same as level 1 but is added with a pneumatic reverse box tool so that the slaughter of cows can be done only by one person, and there is no need to expend effort to hold the cow. That way, the number of cows slaughtered can be increased per day. At level 2, do not use the Double Pale Hydraulic Elevator and Cattle automatic bleeding conveyor. Level 3 investment provides complete equipment (numbers 1 to 10). This investment has the same objective as level 2, improving meat quality, speed, and slaughter capacity. With the Cattle automatic bleeding conveyor and a rail system for hanging cows, the cow's body can be transported quickly from one station to another.

The data used are RPH data from previous studies (Aqidawati & Sutopo, 2017). However, new information and data are also needed, such as the beef produced by the abattoir in Surakarta. It uses data to estimate income, multiplying the retribution price by the number of cattle slaughtered to collect the data. The estimate of the number of cattle using the average production method of RPH Surakarta cattle for the past 5 years (2015-2019) assumes the increase the same as the increase in population growth in Surakarta by 1%. The following is table 3 of data on beef production by RPH Surakarta in the past 5 years and annual inflation data.

Table 3. Beef Production at RPH Surakarta and annual inflation data in 2015-2019

Year	Amount	Percentage Inflation
2015	3181	3,35%
2016	3083	3,02%
2017	3347	3,61%
2018	3549	3,13%
2019	3178	2,72%
Average	3267,6	2,92%

In addition, an analysis that uses the rupiah's actual value supports the data on the growth rate of related goods or services. For this reason, data is taken by carrying out the average annual inflation of Indonesia for the last 6 years, namely from 2015 to 2020. The following table contains data on Indonesia's annual inflation for the past 6 years. In addition, an analysis that uses the rupiah's actual value also supports the data on the growth rate of related goods or services. For this reason, data is taken by carrying out the average annual inflation of Indonesia for the last 6 years, namely from 2015 to 2020. The following table contains data on Indonesia's annual inflation for the past 6 years.(Table 3)

In Aqidawati & Sutopo's (2017) research, the only data is estimated income. However, it is not explained about the origin of the data. Therefore, it does not give some assumptions to estimate the income obtained at each alternative level. The data on the average production of RPH Surakarta in 2015-2019 can estimate the income received each year. Assuming the increase in meat production is in line with the population growth rate of Surakarta (1%). In this study, the methods used to analyze the feasibility of investments consist of Net-Present Value (NPV) analysis, BC Ratio analysis, Payback Period, IRR, and Break-Even Point (BEP) analysis. Thus, it is obtaining a comparison of the values between each existing level. This sensitivity analysis stage determines the effect of several variables on the annual worth of the cash flow to be received. There are 3 variables analyzed: initial investment, annual costs, and retribution prices.

5. Results and Discussion

5.1 Estimated income and expenses

RPH income comes from collecting user fees for slaughtering cattle per head. The retribution price for cattle for 2015 is Rp. 25,000 per head. RPH increases the beef production capacity in the abattoir; it is necessary to improve the facilities by investing. To invest, it is needed to increase user fees to increase income. Therefore, there are several assumptions in the estimation of future income. Increasing meat production per year obtains income. The meat production growth is assumed to be directly proportional to population growth. As the population increases, beef consumption also increases, so beef production must also increase. So, beef production growth is assumed to increase by 1% per year. Then the income is obtained by multiplying the amount of meat produced by each retribution rate added with a tax fee of 1% of gross income. Thus, there are three estimates of alternative income based on the retribution level.

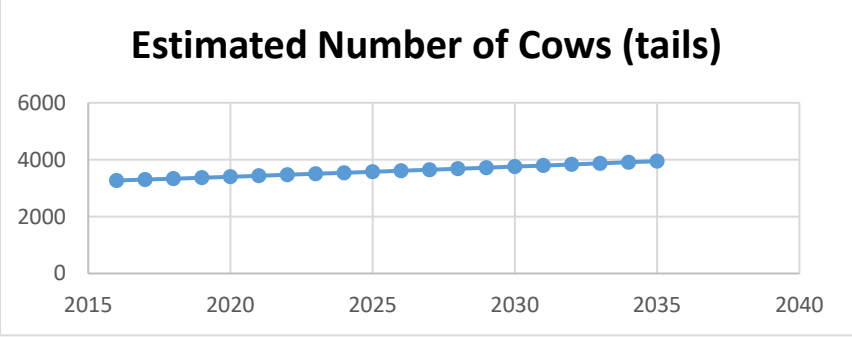

Figure 2. Estimated Number of Cows

Figure 2 shows the projected beef production or availability from 2016 to 2035 and an increase in population growth of 1%. Based on the figure, meat production has increased every year. Figure 2 shows the projected income of the abattoir based on level a with the retribution of Rp. 30,000/head, level b, with the retribution of Rp. 35,000/head and level c with the retribution of Rp. 40,000/head.

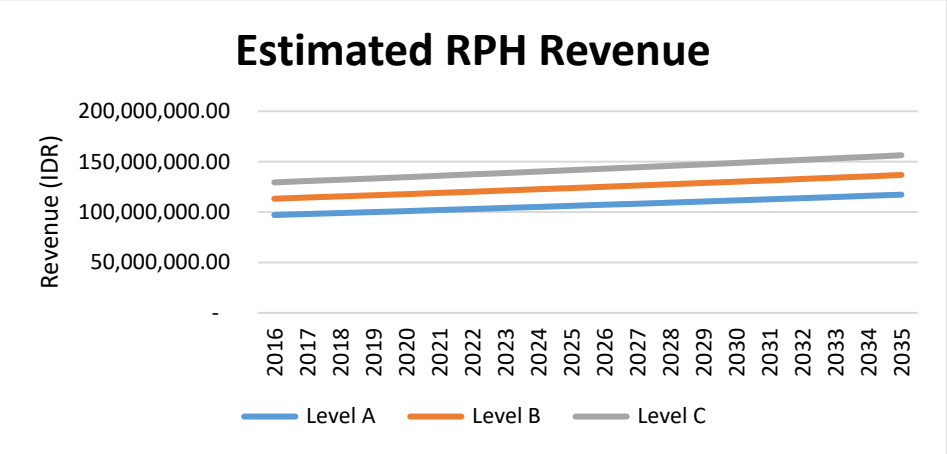

Figure 3. Estimated RPH Revenue

RPH expenditure comes from operating costs each year.(Figure 3) Expenditure costs are assumed to come from maintenance costs that provide repair services for work equipment and routine maintenance of office buildings. The total cost of this maintenance is Rp. 30,000,000. In addition, RPH expenditure comes from depreciation expense, which is calculated using the straight-line method to calculate depreciation per year, with MV, which is assumed to have a value of 10% of the initial investment. After data processing, the net cash flow projections for 2016 to 2035 for each level a, b and c. The following Table 4 shows the amount of expenditure for each level.

Table 4. Estimated Expenses Every Level

Content	Level A (IDR)	Level B (IDR)	Level C (IDR)
Maintenance	30,000,000.00	30,000,000.00	30,000,000.00
Depreciation	35,464,674.83	36,910,033.88	64,676,963.70
Total	**65,464,674.83**	**66,910,033.88**	**94,676,963.70**

5.2 Investment Feasibility Analysis

a. Net Present Value Analysis

Various investment alternatives were assessed for feasibility using the Net-Present Value (NPV) criteria. The analysis uses a 3% MARR value and adjusts the rupiah's actual value using the average inflation of the last 5 years of 2.92%. The following is a summary of Table 5 of the NPV of all available alternatives.

Table 5. Summary of NPV of All Investment Alternatives

Alternatif Harga	Alternatif Investasi		
	Level 1	Level 2	Level 3
Level A (IDR)	*-312,171,939.00*	*-359,860,891.00*	*-1,276,017,873.00*
Level B (IDR)	*-111,854,951.00*	*-159,543,904.00*	*-1,075,700,886.00*
Level C (IDR)	88,462,036.00	40,773,084.00	*-875,383,898.00*

Based on the table, only two investment alternatives meet the initial requirements: NPV> 0. This result is slightly different from the Aqidawati & Sutopo (2017) article, whose analysis results meet the requirements of four alternatives. The other two alternatives are levels 1-B. And levels 2-B. These different figures can occur due to differences in cash flow and MARR data used. In addition, the proposed analysis has also added two additional factors

that can make the analysis more in-depth and follow the existing reality, namely the addition of income tax facts and conversion of the actual value of the rupiah.

b. BC *Ratio*, Payback Period, dan IRR

This method measures the value of each rupiah invested in the form of present value. Only two kinds of investment alternatives meet the requirements of BC Ratio > 1, namely, alternatives 1-C and 2-C. The following is a summary of Table 6 of the BC Ratio of all available alternatives.

Table 6. Summary of BC Ratio of All Investment Alternatives

Alternatif Harga	**Alternatif Investasi**		
	Level 1	Level 2	Level 3
Level A	*0,79703*	*0,77272*	*0,48722*
Level B	*0,92987*	*0,90150*	*0,56842*
Level C	1,06270	1,03029	*0,64962*

Because only two alternatives meet the NPV and B-C Ratio requirements, the IRR and payback period calculation will only carry out on these two alternatives. Then, the IRR for alternative 1-C was 7.23%, and 2-C was 6.55%. Both of these values meet the requirements of MARR < IRR. In addition, the alternative 1-C has a payback period of 11.15 years. At the same time, alternative 2-C has a payback period of 11.77 years. The two periods are assumed to meet its criteria because they have fewer than 20 years of payback period. With a smaller payback period, alternative 1-C is the best alternative.

c. *Break-Even Point* (BEP)

In addition to the NPV and BC Ratio values for each alternative, further information is important to know is the BEP regarding how many cows were sold in the first year. The following is a summary of Table 7 of the BEP for the number of cows for all available alternatives.

Table 7. Break-Even Point (BEP) Summary of All Investment Alternatives

Alternatif Harga	**Alternatif Investasi**		
	Level 1	Level 2	Level 3
Level A	*4125*	*4255*	*5044*
Level B	*3536*	*3648*	*4324*
Level C	3094	3192	3783

The company can use the table to determine the target for slaughtering cattle if you have other alternatives. For example, a company wants to make a Level 3 investment with the retribution price set at only Rp. 30,000/head. So from the table, it is known that the company must slaughter 5045 head of cattle in its first year so that the company does not suffer losses. In addition, there is also a break-even analysis to find out how the relationship between several variables is. The following is a break-even analysis in Figure 4 for two alternatives that meet the requirements: alternatives 1-C and 2-C.

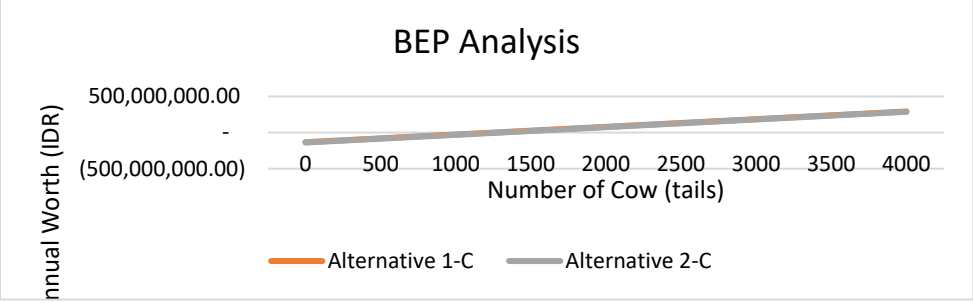

Figure 4. Break-Even Analysis Chart on Two Eligible Alternatives (1-C and 2-C)

It can be interpreted that the delta or the difference in the Annual Worth of the cash flow of the two alternatives is always constant, so the orange line (AW of alternative 1-C) is always above the gray line (AW of alternative 2-C). It can happen because both have the same level of effectiveness. The two alternatives only have differences in annual costs and initial investment.

5.3 Proposed Improvement

The following is a summary table of the results of the comparison between the articles of Aqidawati & Sutopo (2017) and the proposals that we provide in Table 8:

Table 8. Summary of Comparative Analysis of Old Articles and Proposed Articles

Aspek	Aqidawati & Sutopo (2017)	Proposed Model
NPV	Rp206,107,298.56	Rp88,462,036.00
BC Ratio	1.26	1.06
Payback Period (PP)	7.37 year	11.15 year
Break Even Point (BEP)	4884 Kg	3094 Kg
Internal Rate of Return (IRR)	-	7.23%
MARR	-	3%
Accurate Value Conversion (i%)	-	2.92%
Income tax	-	1% * Gross Income
Depreciation Cost	Rp58,416,367.00	Rp35,464,674.83
Operational	Rp30,000,000.00	Rp30,000,000.00

Based on the following Table 8, it is shown that there are differences in the previous and current research, namely the NPV of Rp 88,462,036,00; BC Ration is 1.06>0, the payback period is 11.15 years, BEP is 3094 kg, IRR is 7.23% > MARR, real value conversion is 2.92%, and depreciation cost is Rp. 35,464,674.83.

5.4 Validation

The validation in this study is in the form of a sensitivity analysis stage. There is a sensitivity analysis to determine the effect of several variables on the annual worth of the cash flow to be received. There are 3 variables analyzed: initial investment, annual costs, and retribution prices. The following is a spider plot table in Table 9 and the existing sensitivity analysis graph in Figure 5.

Table 9. Spider Plot Table for Sensitivity Analysis

% Change	Initial Investment	Annual Fee	Price Retribution
-50%	41,633,758.82	40,233,634.14	(63,114,151.14)
-40%	34,807,266.40	33,687,166.66	(48,991,061.57)
-30%	27,980,773.98	27,140,699.18	(34,867,971.99)
-20%	21,154,281.56	20,594,231.69	(20,744,882.42)
-10%	14,327,789.15	14,047,764.21	(6,621,792.85)
0%	7,501,296.73	7,501,296.73	7,501,296.73
10%	674,804.31	954,829.25	21,624,386.30
20%	(6,151,688.11)	(5,591,638.24)	35,747,475.88
30%	(12,978,180.53)	(12,138,105.72)	49,870,565.45
40%	(19,804,672.94)	(18,684,573.20)	63,993,655.02
50%	(26,631,165.36)	(25,231,040.68)	78,116,744.60

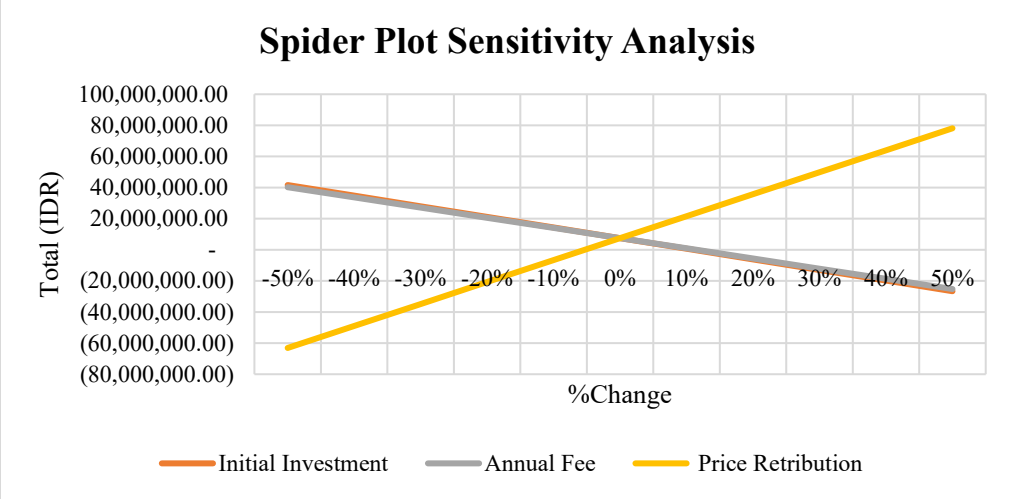

Figure 5. Grafik *Spider Plot* untuk Analisis Sensitivitas

Based on the graph above, we can understand the effect of changing the value of a variable on the obtained AW quantity. Initial investment and annual costs have the same relationship with AW, a negative relationship. An increase in initial investment or annual fee will decrease the AW received and vice versa. While the retribution price has a positive relationship with AW, adding the retribution price will cause an increase in the AW received, and vice versa. In addition, from the gradient (steepness) of the line, the AW value is the most sensitive to changes in the retribution price. From the graph, if the retribution price is reduced by 10%, AW will be negative, which means the project will not profit. As for the initial investment and annual costs, when the variable increases by approximately 10%. So that the company can find out the range of addition and subtraction of the three variables before the project becomes unfeasible or does not generate profits.

6. Conclusion

Based on the analysis of the improvements, the are some conclusions to answer the objective of the research:

a. The analysis produces the best alternative, which is still the same as Aqidawati & Sutopo's (2017) article, namely the level 1-C alternative. Choose alternative 1-C because it met the NPV > 0, PP < 20 years, IRR < MARR, and the shortest payback period than the other alternatives. However, with different values, one example is the NPV value of Rp.88,462,036, compared to the original article, which had an NPV of Rp.206,107,298, etc. This different value can occur because several additional factors include in the analysis, namely the tax factor and the conversion of actual values. It expects to provide a more definitive conclusion and align with the situation.
b. The relationship between the two alternatives that meet all the requirements, namely 1-C and 2-C, has a delta or the difference in the annual worth of the cash flows of the two alternatives, which is always constant. It can happen because both have the same level of effectiveness; the two alternatives only have differences in annual costs and initial investment. So alternative 1-C will always be better in all intervals compared to alternative 2-C.
c. Initial investment and annual costs have the same relationship with AW, a negative relationship. An initial investment or annual fee increase will decrease the AW received and vice versa. While the retribution price has a positive relationship with AW, adding the retribution price will cause an increase in the AW received, and vice versa. In addition, from the gradient (steepness) of the line, the AW value is the most sensitive to changes in the retribution price.

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