Feasibility Study of Agropolymer Bricks from Silica Palm Ash for Sustainable Material (case Studi in Pelalawan)

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Abstract. The problem that arises from the development of the Palm Oil Industry is the problem of waste. Solid waste from the palm oil industry is primarily used as boiler fuel, with unused biomass ash as a by-product. Biomass ash contains silica and Alumina which can be used to reduce the use of cement in concrete brick. Agropolymer Brick business made from Biomass Ash, it is hoped that it can provide social and economic benefits for the community around the industry. The methods used in this research include Payback Period (PP), Net Present Value (NPV), and Internal Rate of Return (IRR). The PP required to return the investment that has been issued is 1 month. Based on the NPV calculation, the total value is Rp. 45,422,057.46 (NPV>0). IRR method of investment analysis is acceptable. Based on the calculation of NPV and IRR, investment in Agropolymer Brick is feasible.

Keywords: Waste utilization, Silica palm ash, Agropolymers brick, Sustainable material, Feasibility study.

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1 Introduction

Waste is a problem that frequently arises due to the development of the palm oil industry. Palm Oil Industry Waste includes liquid waste and solid waste. Solid industrial waste from oil palm is empty bunches and shells. Oil palm shells are the largest palm oil processing waste, reaching 59-61% of oil production [1], [2] and empty fruit bunches production ranges from 22-23% of the total weight of fresh fruit bunches processed in palm oil mills [3]. Palm oil industry solid waste is used as boiler fuel to produce mechanical and heat energy, with a by-product namely biomass ash that has not been utilized optimally [4].

One of the efforts in utilizing the Palm Oil Industry Biomass Ash waste is to utilize the waste into building material products [2], [5], [6], [7]. Shell ash and oil palm bunches contain 68.82% Silicate (SiO_2), 3.08% Alumina (Al_2O_3), 4.35% magnesite (MgO), and other oxides [6]. The content of silicate and alumina in shell ash and palm fruit bunches can be used to reduce the use of cement in concrete bricks, also known as agropolymer bricks [2].

Utilization of solid waste shell ash and palm fiber from boilers for making concrete bricks is carried out with variations of 10, 20, 30, 40,50 and 60% with the addition of other materials such as cement, limestone, gypsum, foaming agent, aluminum paste. The results showed that all variations of additions met the minimum and maximum limits of SNI 03-3449-2002 of 6.89 MPa and 1400 Kg/m3 and water absorption increased with the addition of ash [6]. Utilization of palm ash as a substitute for cement in bricks [8] was carried out with variations of 5%, 10%, 15 % and 20% and resulted in good strength at the addition of 10%. In this study, agropolymer bricks were made with the composition of Cement: Sand of 1:4 with the addition of 4.3% Silicate [2].

Making concrete bricks does not require capital-intensive investment and the manufacturing process is simple [9]. Therefore, the agropolymer bricks business utilized Biomass Ash from the Palm Oil Industry (Silica Palm Ash) is expected to provide social and economic benefits for the community around the industry. The socio-economic benefits that can be obtained include increasing income, business opportunities, reducing unemployment, and creating jobs [7].

In assessing the extent of the benefits derived from a business, it is necessary to conduct a feasibility study of the business [9]. The results of the study will be used as a consideration regarding whether or not the investment is appropriate for the business. The definition of feasible in this research is the possibility of the benefits obtained from the business investment carried out in terms of financial problems (financial). Financial calculations are carried out using cost components and investment criteria to determine the level of business feasibility quantitatively [7]. The purpose of this research is a feasibility study of agropolymer bricks from the Biomass Ash of the Palm Oil Industry (Silica Palm Ash).

2 Research methodology

2.1 Data collection

The data used in this study is divided into two parts, primary data and secondary data. There is currently no Agropolymer Bricks Business from Silica Palm Ash, so that primary data collection was conducted based on interviews with one of the Cement Bricks businesses, CV. Jaya Usaha which is in Bandar Petalangan/ Krumutan, Pelalawan Regency, Riau to get the actual value of the existing Cement Bricks businesses. Furthermore, it is adjusted to the composition used in this study. Secondary data obtained from various other reference sources.

2.2 Method

The data that has been obtained is then grouped into costs and benefits, then quantitative analysis is carried out to assess the business feasibility of using silica palm ash in making agropolymer bricks financially. Data processing was carried out using Microsoft Excel 2010.

Feasibility study as an activity that takes into account whether or not a business (investment) can be carried out successfully [10]. The purpose of conducting a feasibility study is to avoid large investment losses for unprofitable activities. Methods that can be used in assessing cash flow from a business or commonly referred to as investment criteria [7] include:

1. Payback Period (PP)
   The aim is to find out the time or payback period of the total value of the investment issued in the business. This business is said to be feasible if the PP value is less than the operating life of geopolymer brick making (PP < operating life). The payback period calculation is mathematically formulated in equation (1) and equation (2).
   If taking into account the interest rate (i)

$$\sum_{t=0}^{n} C_t \,(1+t)^{-t} = 0 \tag{1}$$

   If not taking into account the interest rate (i)

$$\sum_{t=0}^{n} C_t = 0 \tag{2}$$

2. Net Present Value (NPV)
   Net Present Value (NPV) can be defined as the present value of the income stream generated by investment. The NPV calculation can be formulated in equation (3). If the NPV value is zero (positive) then the business is prioritized for its implementation. If the amount of NPV is equal to zero, it means that the business returns exactly the amount of the Social Opportunity Cost of Capital [11].

$$NPV = \left\{ \sum_{t=1}^{i=n} \frac{Bt - Ct}{(1+i)^t} \right\} \tag{3}$$

   Where:
   Bt = benefits obtained in connection with a business or project in the t-th time series (year, month, etc.) (Rp)
   Ct = costs incurred in connection with the project in the t-th time series (Rp)
   i = is the relevant interest rate
   t = period (1, 2, 3, ..., n)

3. Internal Rate of Return (IRR)

IRR is used to determine whether an investment is implemented or not. The IRR calculation can be formulated in equation (4).

$$IRR = i_1 + \frac{NPV_1}{NPV_1 - NPV_2}(i_2 - i_1) \quad (4)$$

Where:

IRR	= internal rate of return
i_1	= The interest rate that produces a positive NPV
i_2	= The interest rate that produces a negative NPV
NPV_1	= positive NPV
NPV_2	= negative NPV

A business will be accepted if the IRR is greater than the opportunity cost of capital or greater than the predetermined discounted interest rate, and in the opposite case the business will be rejected. Usually, calculating the IRR is done by trial and error with a certain interest rate value (i) which is considered close to the correct IRR value and then calculating the NPV of the income and expense streams. If the IRR value is smaller than the interest rate (i) that applies as the social discount rate, then the NPV of the business or industry is zero (negative), meaning that the business should not be carried out.

3 Results and Discussion

3.1 Estimated Investment Cost for Utilization of Silica Palm Ash

After conducting field surveys that there was no concrete brick business made from Silica Palm Ash in Pelalawan Regency, the estimated investment calculation for the Agropolymer brick business made from Silica palm Ash was based on data and information collected from the CV. Jaya Usaha with the composition of brick materials only uses sand, cement and water. But in this case adjusted to the needs of the composition of the raw materials used. The components analyzed are components that occur when the research is conducted, including aspects of costs and benefits.

3.2 Analysis of Business Costs for Making Agropolimer Bricks

Feasibility analysis was carried out on Small and Medium Enterprises based on visits to CV. Jaya Usaha, the assumptions used in this study include:

1. The analyzed effort is one year
2. Constant demand every month in one year
3. Working days per month 20 days
4. Investment costs do not include buildings, vehicles, land and permits.
5. Depreciation calculation using the Sum of Years Digit (SOYD) method, the depreciation basis is the number of years of useful life.

Costs used:

1. Investment Costs
   The cost of the equipment used in this case is a form of investment in the concrete brick business being analyzed. The cost of the equipment used can be seen in table 1.

Table 1. Cost of brick making equipment

No	equipmnet	Amount	unit	Price	Total
1	Brick mold 30 x 15 x 10	5	pcs	Rp300,000	Rp1,500,000
2	Sand Sieve	2	pcs	Rp 50,000	Rp 100,000
3	Shovel	5	pcs	Rp 75,000	Rp 375,000
4	Hoe	3	pcs	Rp 67,000	Rp 201,000
5	Bucket	10	pcs	Rp 14,200	Rp 142,000
6	Plastic	5	ball	Rp125,000	Rp 625,000
7	Wheel barrows	3	pcs	Rp570,000	Rp1,710,000
	Total				Rp4,653,000

2. Production and income costs
The calculation of production costs with a production capacity per day produces 3000 pcs while the need for raw materials per pcs of bricks made from silica palm ash can be seen in table 2.

Table 2. Raw material requirements per day for 3000 bricks

No	Raw Material	Amount	unit	Price	Total
1	Cement	3930	kg	Rp 1,100	Rp 4,322,605
2	Sand	15719	kg	Rp 250	Rp 3,929,641
3	Silica	1352	kg	Rp 100	Rp 135,180
4	Water	982	ltr	Rp 100	Rp 98,200
	Total				Rp8,485,625

Assuming there are 20 working days per month, the amount of raw material needed per month is Rp. 169,712,503. Calculation of the cost of income (profit) with the selling price per pcs is Rp. 3,000, then the income from 3,000 pcs of production per day in one month is (Rp. 3,000 x 3000 pcs) x 20 equals Rp. 180,000,000.

3. Depreciation Expense
Depreciation is a method for allocating the cost of fixed assets to accounting periods [11]. In this analysis using the SOYD method with calculations in equation (5).

$$SOYD = (n+1)x\frac{n}{2} \tag{5}$$

The calculation of depreciation costs is carried out on molds and wheel barrows, with the information shown in table 3.

Table 3. Equipment information for which the depreciation cost is calculated

No	Equipment	Description
1	brick mold 30 x 15 x 10, 5 pcs	*Salvage Value* (SV) = 20% initial price, *usefull life* 3 years
2	wheel barrows, 2 pcs	*Salvage Value* = 20% initial price, *usefull life* 3 years

The graph of depreciation costs for 5 pcs of brick molds can be seen in **figure 1**.

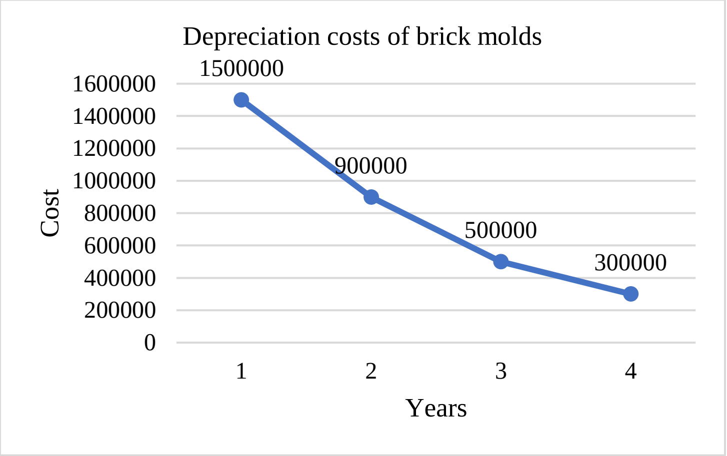

Fig. 1. Depreciation costs for 5 pcs of brick molds

$SOYD = (3+1)x\frac{3}{2} = 6$

SV = 20% x Rp. 1,500,000 = Rp 300,000

Dt_1 = Rp. 1,500,000

Dt_2 = Rp. 1,500,000 - (3/6 x (Rp. 1,500,000 - Rp 300,000))= Rp. 900,000.-

Calculation of depreciation costs for 3 pcs of wheelbarrows can be seen in **figure 2**.

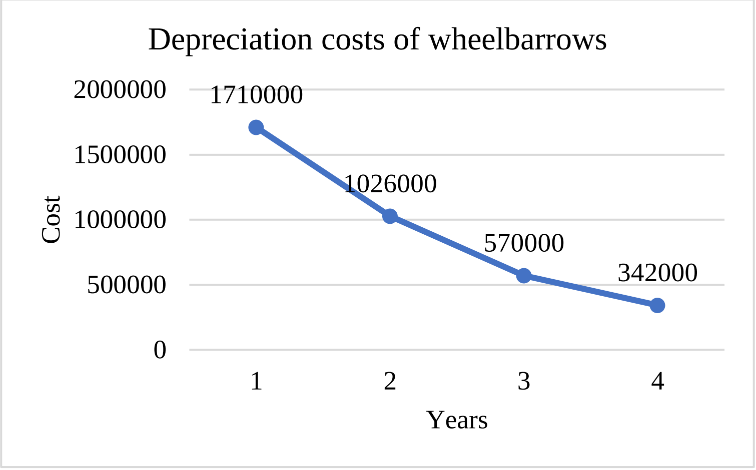

Fig. 2. Depreciation costs for 5 pcs of brick molds

$SOYD = (3+1)x\frac{3}{2} = 6$

SV = 20% x Rp. 1,710,000 = Rp 342,000

Dt_1 = Rp. 1,710,000

Dt_2 = Rp. 1,710,000 - (3/6 x (Rp. 1,710,000 - Rp 342,000)) = Rp. 1,026,000

The depreciation cost calculation is then converted for each unit of equipment so that the total depreciation cost can be seen in table 4.

Table 4. Total depreciation expense

No	Investment	First year depreciation expense per unit	Monthly depreciation expense
1	brick molds	Rp 120,000	Rp 10,000
2	wheelbarrows	Rp 288,000	Rp 19,000
	Total		Rp 29,000

4. Labor Cost
Based on interviews conducted, workers' wages per day are Rp. 50,000 with a working day of 20 days, the cost/wages of workers per month is Rp. 5,000,000. Based on the calculation of the costs that have been carried out, the overall cash flow in one year can be seen in table 4.

Table 4. Cash Flow

Period		0	1	2
Initial Investment		Rp 4,653,000		
Income				
	Total Income		Rp 180,000,000	Rp 180,000,000
Expenditure				
	Labor costs		Rp 5,000,000	Rp 5,000,000
	Raw Material Costs		Rp 169,712,503	Rp 169,712,503
	Depreciation Cost		Rp 29,000	Rp 29,000
Total Expenses			Rp 174,741,503	Rp 174,741,503
Net profit			Rp 5,258,497	Rp 5,258,497
Cash Balance		-Rp 4,653,000	Rp 608,830	Rp 5,870,661

Table 4. Cash Flow (continued)

Period		3	4	5	6
Initial Investment					
Income					
	Total Income	Rp 180,000,000	Rp 180,000,000	Rp 180,000,000	Rp 180,000,000
Expenditure					
	Labor costs	Rp 5,000,000	Rp 5,000,000	Rp 5,000,000	Rp 5,000,000
	Raw Material Costs	Rp 169,712,503	Rp 169,712,503	Rp 169,712,503	Rp 169,712,503
	Depreciation Cost	Rp 29,000	Rp 29,000	Rp 29,000	Rp 29,000
Total Expenses		Rp 174,741,503	Rp 174,741,503	Rp 174,741,503	Rp 174,741,503
Net profit		Rp 5,258,497	Rp 5,258,497	Rp 5,258,497	Rp 5,258,497
Cash Balance		Rp 11,132,491	Rp 16,394,321	Rp 21,656,152	Rp 26,917,982

Table 4. Cash Flow (continued)

Period		7	8	9
Initial Investment				
Income				
	Total Income	Rp 180,000,000	Rp 180,000,000	Rp 180,000,000
Expenditure				
	Labor costs	Rp 5,000,000	Rp 5,000,000	Rp 5,000,000
	Raw Material Costs	Rp 169,712,503	Rp 169,712,503	Rp 169,712,503
	Depreciation Cost	Rp 29,000	Rp 29,000	Rp 29,000
Total Expenses		Rp 174,741,503	Rp 174,741,503	Rp 174,741,503
Net profit		Rp 5,258,497	Rp 5,258,497	Rp 5,258,497
Cash Balance		Rp 32,179,812	Rp 37,441,643	Rp 42,703,473

Table 4. Cash Flow (continued)

Periode		10	11	12
Initial Investment				
Income				
	Total Income	Rp 180,000,000	Rp 180,000,000	Rp 180,000,000
Expenditure				
	Labor costs	Rp 5,000,000	Rp 5,000,000	Rp 5,000,000
	Raw Material Costs	Rp 169,712,503	Rp 169,712,503	Rp 169,712,503
	Depreciation Cost	Rp 29,000	Rp 29,000	Rp 29,000
Total Expenses		Rp 174,741,503	Rp 174,741,503	Rp 174,741,503
Net profit		Rp 5,258,497	Rp 5,258,497	Rp 5,258,497
Cash Balance		Rp 47,965,303	Rp 53,227,134	Rp 58,488,964

3.3 Feasibility Analysis

1. Payback Period (PP)

Graph accumulation per period can be seen in **figure 3**.

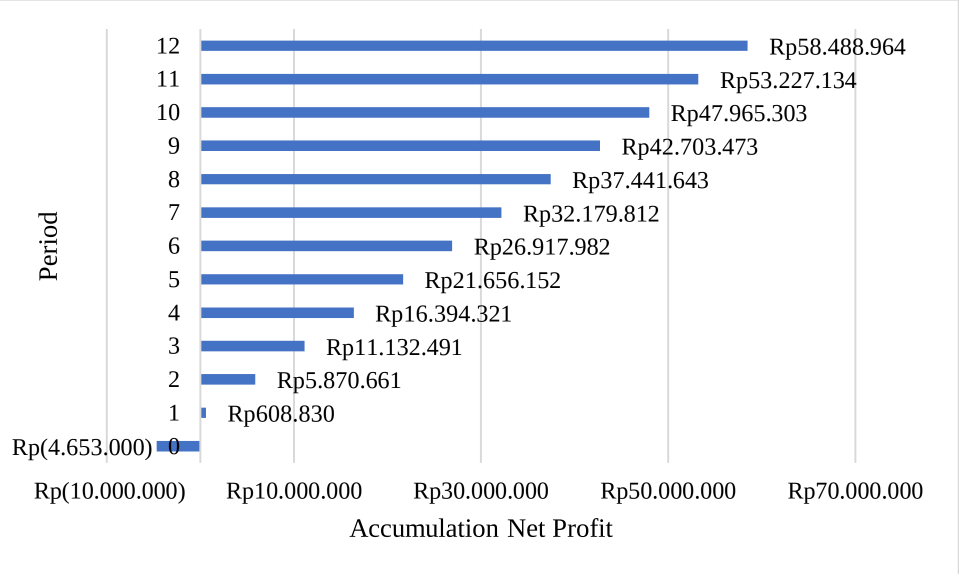

Fig. 3. Accumulation per period

Calculation of Payback Period, as follows:

Period profit 2 = IDR 5,870,661

Period profit x = 0

Period profit 3 = IDR 11,132,491

$$\frac{x-2}{3-x} = \frac{0-\text{Rp } 5{,}870{,}661}{\text{Rp } 11{,}132{,}491-0}$$

$$\frac{x-2}{3-x} = \frac{-\text{Rp } 5{,}870{,}661}{\text{Rp } 11{,}132{,}491}$$

Rp 11,132,491 x – Rp 22,264,982 = - Rp 17,611,982 + Rp 5,870,661x

Rp 11,132,491 x - Rp 5,870,661x = - Rp 17,611,982 + Rp 22,264,982

Rp 5,261,830x = Rp 4,653,000

x = 0.9

So the payback period occurs in a period of 0.9 or about 1 month.

2. Net Present Value (NPV)

NPV analysis, the Df used is 4.75% based on the BI reference rate dated 20 Oktober 2022 [12]. The calculation of NPV can be seen in **figure 4**.

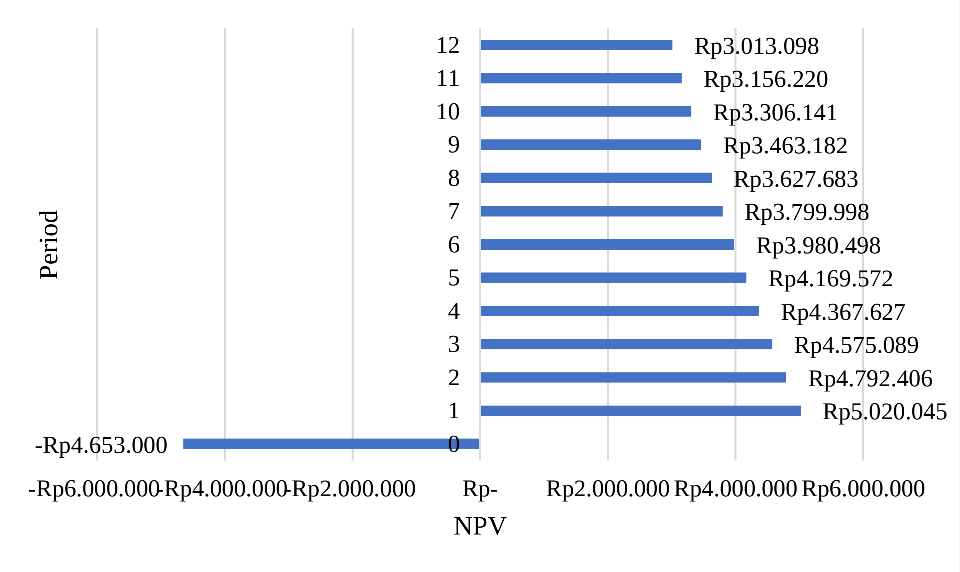

Fig. 4. The calculation of NPV

Based on the **figure 4**, it can be seen that the NPV value is positive (NPV > 0) with a total value of Rp 42,618,558.88. So investment in the future will generate profits so that the investment can be said to be feasible.

3. Internal Rate of Return (IRR)
A trial to obtain a negative NPV was carried out and a Df value of 114% was obtained with detailed calculations in **figure 5** with the total value NPV is - Rp 40,783.35. A trial to get a Positive NPV was carried out and a Df value of 113 % was obtained with detailed calculations in **figure 6** with the total value NPV is Rp. 3.56. Then with equation (4), the IRR value is obtained as follows

$$IRR = 113\% + \frac{3.56}{Rp\ 3.56-(-Rp\ 40{,}783.35)}(114\% - 113\%) = 113\%$$

Based on the calculation, it can be seen that the IRR value is 113% greater than the MARR value or the applicable discount rate, which is 4.75%. So it can be concluded that the IRR method of investment analysis is acceptable.

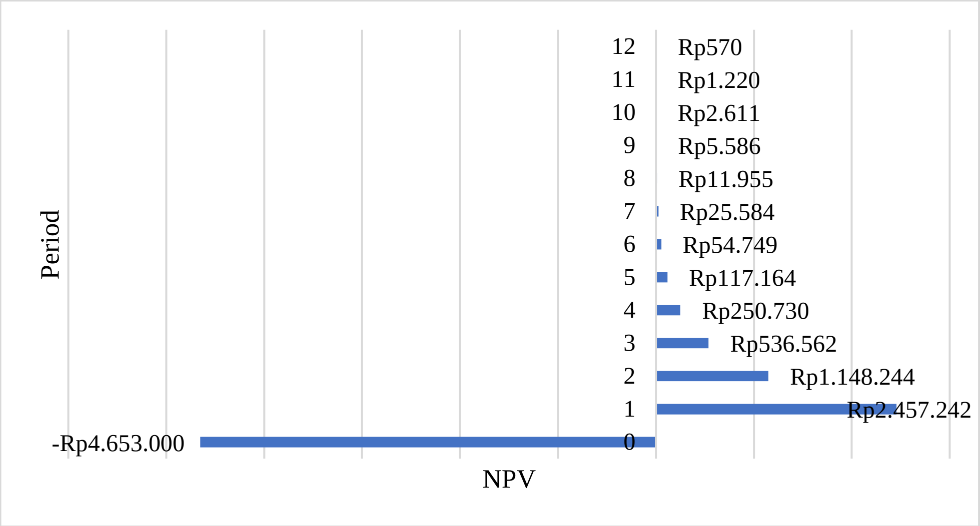

Fig. 5. The calculation of negative NPV

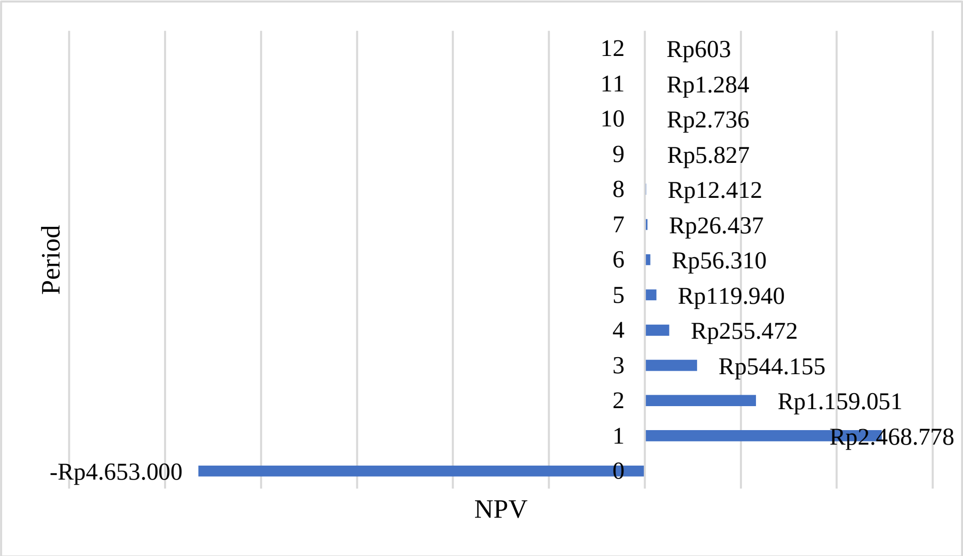

Fig. 6. The calculation of positif NPV

4 Conclusion

The payback period needed to return the investment that has been issued is 1 month. Based on the NPV calculation, the total value is Rp. 45,422,057.46 (NPV>0). IRR method of investment analysis is acceptable, the value is 113% greater than the MARR value or the applicable discount rate, which is 4.75%. From the calculation of NPV and IRR, it is found that the investment in the agropolymer brick business is feasible.

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