

Investment Analysis of Excavator in Sand Mining on the Slopes of Mount Merapi

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Abstract— The definition of mining and quarrying is constructed as an activity that includes research, management, and exploitation. Sand mining is part of non-metal mining business activities that aim to produce its associated minerals. This study aims to determine the results of the evaluation of the feasibility of heavy equipment investment in Excavators based on calculations using the NPV (Net Present Value), IRR (Internal Rate of Return), BEP (Break Event Point) and PP (Payback Period). This research was conducted surveys, observations and interviews to obtain data. The results of this study Investment in the procurement of heavy equipment Excavator is feasible to run because the Net Present Value (NPV) value is positive (+) which means it is good and acceptable while the resulting NPV value is Rp1,944,640,086.47. Then analyze the calculation of the feasibility of the Internal Rate of Return (IRR) obtained 26%. Thus $IRR > MARR = 26\% > 15.5\%$ or according to the calculation of IRR this investment is RIGHT to run. Furthermore, from the analysis of the calculation of the Break Even Point (BEP), the calculation results obtained are 5.2153 years or BEP occurs when the break-even point occurs when $PM - PK = \text{Rp } 5.006.705.873$. In the Payback Period (PP) research, the investment turning point occurred in year 5.6856 at a value of Rp 4.009.690.743,31. It can be interpreted that for investment within a period of 10 years is FAIR.

keywords: Feasibility Analysis, Break Even Point, Cash Flow, Internal Rate of Return, Net Present Value

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1. Introduction

Mining and quarrying are defined as activities involving the exploration, management, and exploitation of natural resources. In particular, sand mining is classified as a non-metallic mineral extraction operation that involves diverting subsurface materials, either from the land or beneath riverbeds, to obtain economically valuable sand deposits [1]. Although these activities contribute to local economies, they often cause environmental degradation, such as land and water resource damage, due to excessive or improper exploitation that prioritizes profit over sustainability, justice, and compensation [2]. As one of the world's most resource-rich nations, Indonesia possesses both renewable (forests, water, rivers, seas) and non-renewable (oil, gas, minerals) natural resources [3]. However, the mismanagement of these assets, especially in extractive industries like mining, can lead to long-term ecological and socio-economic challenges [4], [5].

Specifically, in rural areas, natural resources serve as both a livelihood and a reserve for future generations [6]. This study addresses the feasibility of investing in excavator equipment for sand mining activities. The research is narrowed to the evaluation of a single excavator unit—CAT 320D2—focusing on

technical, operational, and financial aspects. The analysis is constrained to the use of Net Present Value (NPV), Internal Rate of Return (IRR), Break Even Point (BEP), and Payback Period (PP) as investment evaluation tools. In addition, the owner's assets are considered as part of the investment capital. The calculations of depreciation, taxes, maintenance, repair, and operational costs are adjusted to the current market conditions during the time of the study [7]–[10].

This research is urgent considering the increasing demand for sustainable and financially sound decisions in capital-heavy sectors such as sand mining, particularly in high-risk areas like the Merapi region [4], [11]. Previous studies have shown that the position of heavy equipment, particularly excavators, plays a crucial role in operational stability and slope safety in open-pit mining [6]. Furthermore, in many regions, especially rural ones, local investors often rely on intuition rather than structured analysis when procuring heavy equipment, leading to inefficient investments and economic losses [12], [13].

The novelty of this study lies in its application of integrated investment analysis methods (NPV, IRR, BEP, PP) in a real-world sand mining scenario involving a single-unit excavator. While prior research often presents generic feasibility studies on mining operations or focuses on large-scale multi-equipment systems [8], [14], this study offers a focused approach by aligning financial calculations with actual market-based inputs such as depreciation, tax structure, local labor costs, and operational characteristics specific to the region [15]–[17].

The aim of this research is to provide a comprehensive evaluation of the investment feasibility of procuring a CAT 320D2 excavator for use in a sand mining operation. The study seeks to determine whether the initial capital outlay can be recovered, identify the breakeven point, and assess annual profit margins using established investment analysis tools. The research is limited to one unit of heavy equipment, with assumptions and parameters drawn from field conditions and primary financial data. This work contributes to a more accurate and practical investment planning framework for local entrepreneurs and mining operators in similar settings [18]–[22].

2. Method

This research was conducted at PT Darma Parabawa Kemalang, with the subject of the study focusing on the procurement process of heavy equipment, specifically covering both purchase and rental schemes. The object of the research is the CAT 320D2 excavator unit, which is utilized by the company for its operational activities in sand mining operations. This unit represents a significant capital investment and is central to the company's excavation and material transport processes, making it a suitable focus for economic feasibility analysis. The data collected for this study on heavy equipment procurement at PT Darma Parabawa Kemalang includes several key components: the company profile, the excavator rental procedure, data regarding the purchase and rental history of heavy equipment, operational costs associated with the equipment and company operations, and financial records comprising cash inflows and outflows over a certain operational period. These data are crucial to understanding both the fixed and variable costs involved in operating the CAT 320D2 excavator.

The method of analysis employed in this research is investment analysis, which utilizes several financial assessment tools including Net Present Value (NPV), Internal Rate of Return (IRR), Break Even Point (BEP), and Payback Period (PP). These tools are used to evaluate the economic feasibility and investment performance of heavy equipment procurement. Data analysis involves processing the collected data using the aforementioned investment analysis methods. The outcomes of this analysis, including the calculated values of NPV, IRR, BEP, and PP, are expected to provide a quantitative basis for decision-making regarding capital investment in heavy equipment. The overall research workflow is illustrated in the flowchart shown in Figure 1, which outlines the sequential stages of data collection, processing, financial calculation, and interpretation.

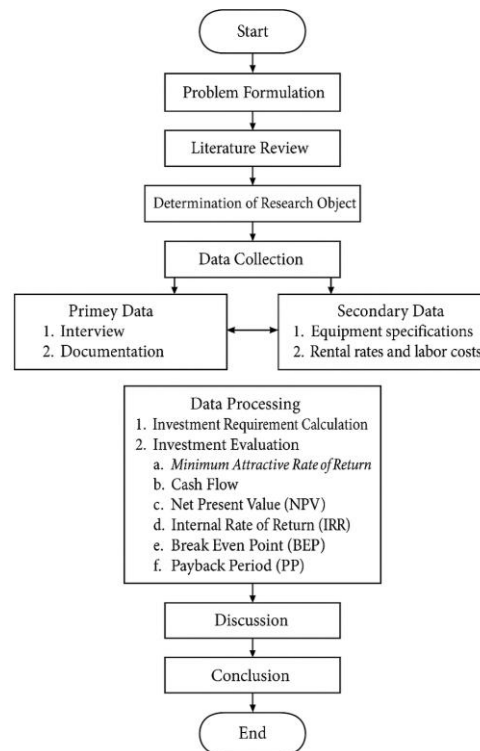


Figure 1. Flow Chart

3. Result and Discussion

Data regarding the procurement of CAT 320D2 excavator heavy equipment was obtained through direct interviews with the owner and relevant personnel at PT Darma Parabawa Kemalang. This data includes the unit price, which serves as the foundation for calculating the initial investment and subsequent financial analysis. The summary of the excavator's brand, type, price, and condition is shown in Table 1.

Table 1. Excavator information data

No	Data Information	
1	Merk	Caterpillar
2	Type	CAT 320D2
3	Cost of CAT 320D2	Rp 1.300.000.000/unit
4	Condition	New

In addition to price data, technical specifications such as fuel tank capacity, lubricant requirements, and other operational components are crucial to estimating equipment operating costs. These specifications are presented in Table 2.

Table 2. Excavator Specifications

No.	Item	Capacity
1.	Fuel Tank	345 litre
2.	Coolant system	25 litre
3.	Engine oil	15 litre
4.	Final drive	5 litre
5.	Swing drive	5 litre
6.	Hydraulic tank	115 litre

To calculate the hourly operating cost of the equipment, it is necessary to assess the required volume of fuel and lubricants, along with their respective unit costs. This information is compiled in Table 3, while the calculated coefficients for fuel and lubricant consumption per hour are presented in Table 4.

Table 3. Fuel and Lubricant Prices

No.	Item	Volume	Unit	Cost
1.	Fuel Tank	1	Litre	Rp12.000,00
2.	Coolant	1	Litre	Rp22.000,00
3.	Engine	1	Litre	Rp76.296,23
4.	Final Drive	1	Litre	Rp86.356,56
5.	Swing Drive	1	Litre	Rp86.356,56
6.	Hydraulic	1	Litre	Rp71.428,57

Table 4. Fuel and lubricant coefficient

No	Item	Capacity (litre)	Interval	coefficient L/hour
1	Fuel Tank	345	24 hour	14,375
2	coolant	25	2000hour	0,0125
3	Engine oil	15	500 hour	0,03
4	Final drive	5	1000 hour	0,005
5	Swing drive	5	1000 hour	0,005
6	hydraulic	115	4000 hour	0,02875

The resulting hourly operational costs for each component, based on their consumption coefficients and unit prices, are then summarized in Table 5. The total cost per hour reflects the direct operating cost of the excavator.

Table 5. Operating Cost Per Hour

No	Item	Cost	Coefficient	Total Cost
1.	Fuel Tank	Rp12.000	14,375	Rp172.500
2.	Coolant	Rp22.000	0,0125	Rp275,00
3.	Engine	Rp76.296	0,03	Rp2.288,89
4.	Final Drive	Rp86.356	0,005	Rp431,78
5.	Swing Drive	Rp86.356	0,005	Rp431,78
6.	Hydraulic	Rp71.428	0,02875	Rp2.053,57
Total cost Excavator per hour				Rp177.981

In addition to machine operating costs, office-related expenses such as employee salaries, taxes, and equipment maintenance must also be considered. These are calculated based on local market salaries, tax regulations, and maintenance allowances. The breakdown of office-related expenses is listed in Table 6.

Table 6. Office Operating Cost per hour

No.	Item	Vol.	Unit	Cost
1.	Maintenance	1	Hour	Rp. 1.779,81
2.	Operator salary	1	Hour	Rp. 15.000,00
3.	Admin Salary	1	Hour	Rp. 15.000,00
4.	Tax	1	hour	Rp. 20.000,00

For analytical clarity, the total operational expenses are extrapolated into annual values. These annual costs are based on 8 hours of daily operation, 25 days per month, and 12 months per year. The corresponding annual costs are detailed in Table 7.

Table 7. Operations per Year

No	Item	Vol (month)	Cost	Total Cost
1	Maintenance	12	Rp1.779,9	Rp4.271.544
2	Operator Salary	12	Rp15.000	Rp36.000.000

No	Item	Vol (month)	Cost	Total Cost
3	Admin Salary	12	Rp15.000	Rp36.000.000
4	Tax	12	Rp20.00	Rp48.000.000
Cost per year				Rp124.271.544

Spare part replacement costs are also taken into account by estimating usage intensity and calculating the cost of replacement per year. The breakdown of this component is provided in Table 8.

Table 8. Sparepart Replacement Cost per Year

No	Item	Intensity	Cost	Total Cost
1	Fuel Tank	2400	Rp172.500	Rp414.000.000
2	Coolant	2000	Rp550.000	Rp660.000
3	Engine Oil	500	Rp1.326.181	Rp6.365.668
4	Final Drive	1000	Rp1.535.506	Rp3.685.214
5	Swing Drive	1000	Rp1.535.506	Rp3.685.214
6	Hydraulic	4000	Rp15.000.000	Rp9.000.000
Cost of Sparepart per year				Rp437.396.097

Depreciation is included to account for asset replacement at the end of the service life. For this study, a 15-year useful life is assumed, with no residual value. The annual depreciation values are summarized in Table 9.

Table 9. Depreciation

Year	Depreciation/year	Depreciation of tools
1	Rp1.300.000.000,00	Rp1.300.000.000,00
2	Rp86.666.666,67	Rp1.213.333.333,33
3	Rp86.666.666,67	Rp1.126.666.666,67
4	Rp86.666.666,67	Rp1.040.000.000,00
5	Rp86.666.666,67	Rp953.333.333,33
6	Rp86.666.666,67	Rp866.666.666,67
7	Rp86.666.666,67	Rp780.000.000,00
8	Rp86.666.666,67	Rp693.333.333,33
9	Rp86.666.666,67	Rp606.666.666,67

Contingency cost is calculated as 6.5% of the expected income from heavy equipment rentals, in accordance with risk management practices. This estimate is integrated into the total expenditure summary shown in Table 10.

Table 10. Expenses per Year

No.	Item	Total Cost
1.	Biaya operasional	Rp124.271.544,57
2.	Depreciation	Rp86.666.666,67
3.	kontingensi	Rp62.400.000,00
4.	Biaya pergantian Sparepart	Rp437.396.097,60
Total cash out/year		Rp710.734.308,84

To evaluate the investment's feasibility, several financial metrics are used. First, the Minimum Attractive Rate of Return (MARR) is determined by summing the average inflation rate and interest rate over the past three years, resulting in a MARR of 15.5%. Next, a cash flow analysis is performed over a 10-year horizon, capturing both cash inflows (income) and cash outflows (expenditures). The complete cash flow profile is displayed in Table 11, while its trend is visualized in Figure 2.

Table 11. Cash Flow

Th	Cash In	Cash out	In - Out
0	Rp.0,00	Rp.1.300.000.000	Rp.-1.300.000.000
1	Rp960.000.000	Rp710.734.309	Rp249.265.691
2	Rp1.017.600.000	Rp732.056.338	Rp285.543.662
3	Rp1.078.656.000	Rp754.018.028	Rp324.637.972
4	Rp1.143.375.360	Rp776.638.569	Rp366.736.791
5	Rp1.211.977.882	Rp799.937.726	Rp412.040.155
6	Rp1.284.696.554	Rp823.935.858	Rp460.760.697
7	Rp1.361.778.348	Rp848.653.934	Rp513.124.414
8	Rp1.443.485.049	Rp874.113.552	Rp569.371.497
9	Rp1.530.094.152	Rp900.336.958	Rp629.757.193
10	Rp1.621.899.801	Rp927.347.067	Rp694.552.734
total	Rp12.653.563.145	Rp9.447.772.339	Rp3.205.790.806

The Net Present Value (NPV) is then calculated to assess the economic viability of the investment. A positive NPV of Rp1,944,640,086 indicates that the investment is financially sound. The detailed NPV calculations are shown in Table 12, and the graph is presented in Figure 3.

The Internal Rate of Return (IRR) is determined using interpolation between 23% and 24% discount rates, resulting in an IRR of 26%. Since this exceeds the MARR, the investment is considered acceptable. Detailed interpolation data is shown in Table 13.

Table 12. NPV calculation

Th	NPV Cash in	NPV Cash out	Selisih
0	Rp.0	Rp.1.300.000.000	-Rp1.300.000.000
1	Rp831.168.831	Rp615.354.380	Rp215.814.451
2	Rp762.804.295	Rp548.757.586	Rp214.046.710
3	Rp700.062.816	Rp489.368.236	Rp210.694.580
4	Rp642.481.892	Rp436.406.306	Rp206.075.586
5	Rp589.637.061	Rp389.176.186	Rp200.460.875
6	Rp541.138.775	Rp347.057.552	Rp194.081.223
7	Rp496.629.525	Rp309.497.210	Rp187.132.314
8	Rp455.781.209	Rp276.001.841	Rp179.779.368
9	Rp418.292.711	Rp246.131.512	Rp172.161.199
10	Rp383.887.683	Rp219.493.903	Rp164.393.780
total	Rp5.821.884.799	Rp3.877.244.713	Rp1.944.640.086

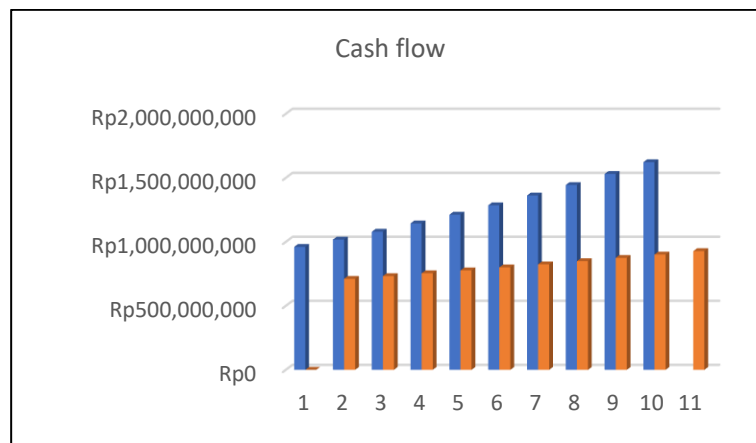


Figure 2. Cash Flow Graph

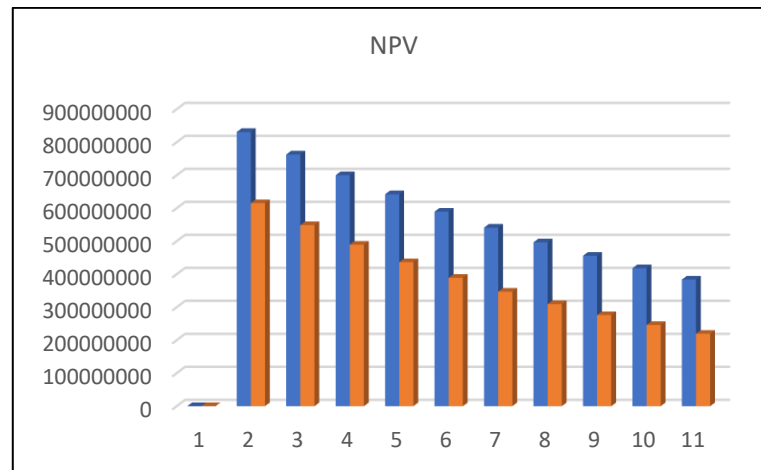


Figure 3. Net Present Value Graph

Table 13. IRR Calculation

Year	Discount 23%	Discount 24%
0	-Rp.1.300.000.000	-Rp.1.300.000.000
1	-Rp276.422.764	-Rp274.193.548
2	Rp202.832.766	Rp199.574.461
3	Rp186.257.084	Rp181.787.107
4	Rp170.109.243	Rp164.687.871
5	Rp154.633.053	Rp148.497.609
6	Rp139.989.370	Rp133.350.797
7	Rp126.275.567	Rp119.317.271
8	Rp113.541.019	Rp106.419.251
9	Rp101.799.347	Rp94.644.598
10	Rp91.038.071	Rp83.957.077
Total	-Rp289.947.245	-Rp341.957.506

Break Even Point (BEP) analysis is performed to identify the point at which total revenues equal total costs. The analysis indicates a BEP at 5.2153 years, with the supporting data shown in Table 14 and the graph in Figure 4.

Table 14. BEP Calculation

Th	Cash in	Cash out	In - Out
0	Rp0,00	Rp1.300.000.000	-Rp1.300.000.000
1	Rp960.000.000	Rp2.010.734.309	-Rp1.050.734.309
2	Rp1.920.000.000	Rp2.721.468.618	-Rp801.468.618
3	Rp2.880.000.000	Rp3.432.202.927	-Rp552.202.927
4	Rp3.840.000.000	Rp4.142.937.235	-Rp302.937.235
5	Rp4.800.000.000	Rp4.853.671.544	-Rp53.671.544
6	Rp5.760.000.000	Rp5.564.405.853	Rp195.594.147
7	Rp6.720.000.000	Rp6.275.140.162	Rp444.859.838
8	Rp7.680.000.000	Rp6.985.874.471	Rp694.125.529
9	Rp8.640.000.000	Rp7.696.608.780	Rp943.391.220
10	Rp9.600.000.000	Rp8.407.343.088	Rp1.192.656.912

Finally, the Payback Period (PP) is computed using NPV-based interpolation. The investment is expected to recover its initial cost within 5.6856 years, indicating a favorable return timeline. The supporting data is shown in Table 15, and the graphical representation is provided in Figure 5.

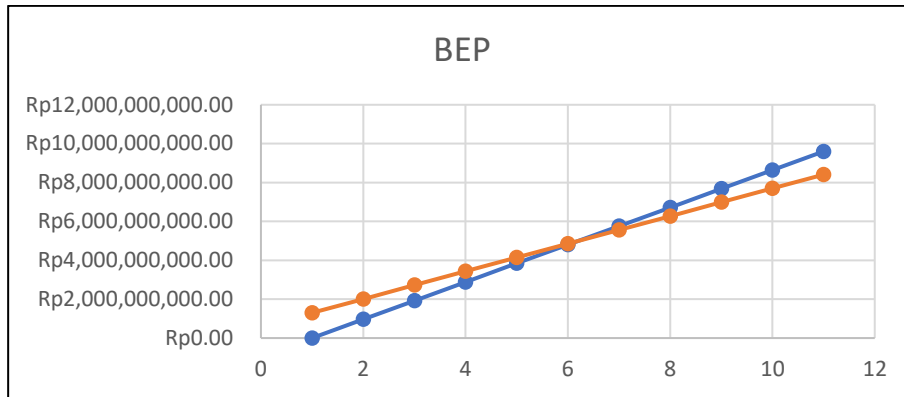


Figure 4. Break Even Point Graph

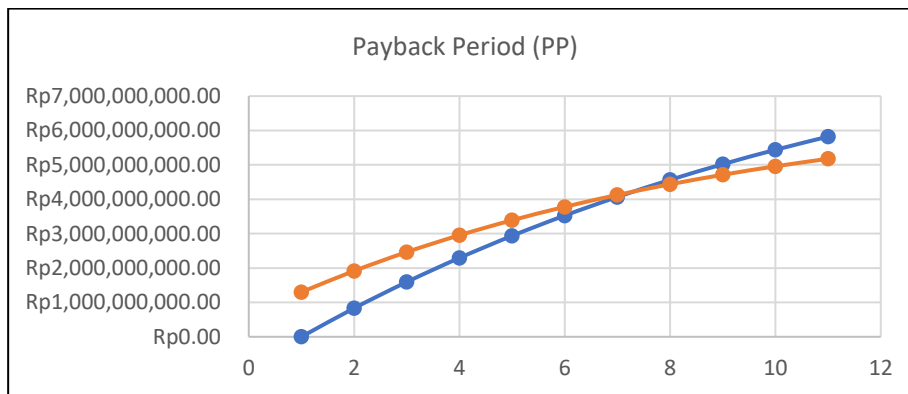


Figure 5. Payback Period Graph

Table 15. PP Calculation

Th	NPV Cash in	NPV Cash out	Deviation
0	Rp0,00	Rp1.300.000.000	-Rp1.300.000.000
1	Rp831.168.831	Rp1.915.354.379	-Rp1.084.185.540
2	Rp1.593.973.126	Rp2.464.111.965	-Rp870.138.839
3	Rp2.294.035.942	Rp2.953.480.202	-Rp659.444.259
4	Rp2.936.517.835	Rp3.389.886.508	-Rp453.368.673
5	Rp3.526.154.896	Rp3.779.062.694	-Rp252.907.798
6	Rp4.067.293.670	Rp4.126.120.246	-Rp58.826.575
7	Rp4.563.923.195	Rp4.435.617.456	Rp128.305.739
8	Rp5.019.704.404	Rp4.711.619.297	Rp308.085.106
9	Rp5.437.997.116	Rp4.957.750.810	Rp480.246.306
10	Rp5.821.884.799	Rp5.177.244.712	Rp644.640.086

4. Conclusion

Based on the results of the analysis and discussion of the investment analysis of heavy equipment in the form of Excavators, it can be concluded that the investment in the procurement of Excavator heavy equipment is feasible to run because the Net Present Value (NPV) value is positive (+) which means it is good and acceptable while the resulting NPV value is Rp1,944,640,086.47. Then analyze the calculation of the feasibility of the Internal Rate of Return (IRR) obtained 26%. Thus $IRR > MARR = 26\% > 15.5\%$ or according to the calculation of IRR this investment is RIGHT to run. Furthermore, from the analysis of the calculation of the Break Even Point (BEP), the calculation results obtained are 5.2153 years or BEP occurs when the break-even point occurs when $PM - PK = \text{Rp}5,006,705,873$. In the Payback Period (PP) research,

the turning point of the investment occurred in year 5.6856 at a value of Rp.4,009,690,743.31. It can be interpreted that for investment in a period of 10 years is feasible.

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