

# Sensitivity Analysis Of Investment And Npv Analysis With Monte Carlo Simulation In *Asphalt Mixing Plant* (AMP) Industry

Wachid Hasyim<sup>1\*</sup>, Ayu Krisma Wardani<sup>2</sup>

<sup>1,2</sup> Department of Civil Engineering, Faculty of Engineering, Wiralodra University, Indonesia

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## ABSTRACT

The availability of proper transportation infrastructure in cities / districts with high population growth will support development growth. Development growth can be seen at the growth of the regional economic level, so that economic growth is strongly supported by the development of road transportation facilities. National development in the transportation sector begins with the implementation of roads as infrastructure that strongly supports the achievement of national development goals. Road planning standards state that for road pavement layers must meet certain classifications and specifications. Thus, to be able to meet the needs of materials with adequate quality and quantity, a supporting industry is needed, namely in the form of industry or asphalt mixing plants (*AMP*). This research is reviewed from the financial aspect which aims to analyze the feasibility of investing in asphalt mixing plants (*AMP*). According to the investment feasibility analysis, the NPV value is IDR. 30,777,082,259.61, BCR is 1.39, IRR is 30%, PP is 4.16 years. Based on sensitivity analysis, the value of sensitivity investment at IDR. 73,386,171,697.09. NPV value based on monte carlo simulation with two scenarios obtained values of IDR. 27,553,320,897.33 and IDR. 23,719,088,232.49 respectively.



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## Corresponding Author:

Wachid Hasyim,  
Department of Civil Engineering,  
Wiralodra University,  
Jalan Ir. H. Juanda KM. 03, Karanganyar, Indramayu, 45213, Indonesia  
Email: [\\*wachidhasyim@unwir.ac.id](mailto:*wachidhasyim@unwir.ac.id)

## 1. INTRODUCTION

The availability of proper transportation infrastructure in cities / districts with high population growth will support development. The growth can be seen at the growth of the regional economic level, so that the development of road transportation facilities will supports economic's growth in urban and sub urban. [1] [2].

In addition, roads become a means of connecting between regions to achieve the goals of national unity and integrity. National development in the transportation sector begins with the implementation of roads as infrastructure that supports the achievement of national development goals [3]. The cities and districts have the potential to realize government efforts in improving the economic of peoples. The manifestation of the government's efforts can be in the form of new construction and/or repair of existing

roads. The construction of the road aims to facilitate land transportation facilities that connect between cities and regencies. Based on this, road constituent materials with certain classifications and certain specifications and conditions are needed.

The construction of roads and land transportation facilities is carried out by meeting road planning standards determined by Standar Nasional Indonesia (SNI) and Bina Marga Standards. These standards state that road pavement layers must meet certain classifications and specifications. Thus, to be able to meet the needs of materials with adequate quality and quantity, a supporting industry is needed, namely in the form of industry or asphalt mixing plants (*AMP*).

AMP industry is a manufacturing industry where a factory is needed that has several heavy equipment and machines that function to produce Asphalt Concrete / Hotmix on a large scale. [4] The production of asphalt from AMP depends on the type and specifications of the tool. Several types of asphalt pavement layers produced by *asphalt mixing plants* include AC-BC, AC-WC, Ac-Base, Hot Rolled Sheet (HRS), Sand sheet (SS), and others.

The investment value of an industry is worth measuring considering that the AMP industry is considered for the sustainability of the production and production capacity. Based on this, the feasibility of investing in the AMP industry must be measured based on investment ability, costs and benefits, interest rates and investment return periods. The investment can be defined as contracts to sources of capital for a long period of time with the aim of being able to generate profits in the future. [5] [6]

## 2. METHODS

The results of the study are described according to the level of explanation and presented by data analysis using descriptive analysis techniques. The research variables involved are elaborated and discussed by describing the results of the analysis presented in calculations, tables, and figures. The results of the study are arranged in conclusion that show the final result and answer to the research objectives.

### 2.1. Level of explanation

The explanation used in the research prepared by descriptive method. The description of the problem in this study presents investment feasibility analysis, sensitivity analysis, and simulation of NPV value acquisition using Monte Carlo Method in AMP companies. Analysis of investment feasibility and sensitivity is carried out using technical economic approaches and simulations are carried out using numerical methods by taking into account the probability of events, the simulation is in the form of Monte Carlo simulation.

### 2.2. Data analysis techniques

The steps taken are to conduct an investment feasibility analysis using an approach to several investment feasibility parameters such as: *NPV*, *BCR*, *PP*, and *IRR*. Furthermore, sensitivity value is measured to the value of the investment when the net present value is equal to zero ( $NPV=0$ ). In addition, Monte Carlo simulations are conducted to determine the amount of investment value that occurs when involving uncertainty factors in parameters that affect cashflows from the AMP.

#### 2.2.1. Net Present Value (NPV)

The current net value of anticipated gains is known as NPV. [7]. The present time in question is the time calculated in a certain period of the 0th year period. NPV is calculated as the difference between cash inflows and outflows from *present value*, so NPV can be calculated by the following equation. [7]

$$NPV = \sum_{t=0}^n C_f \cdot (FBP) \quad (1)$$

$$C_f = C_b - C_c \quad (2)$$

Where

NPV : Net Present Value  
 Cf : Cashflow present  
 Cb : *cash in*  
 Cc : cash out

The criteria for NPV acceptance of investment feasibility are assessed from the nominal value shown based on the calculation results. Acceptances indicators are as follows. [7] [8]

If the  $NPV > 0$ , then the investment is considered feasible

If the  $NPV < 0$ , then the investment is considered unfeasible

NPV is used in capital budgeting and investment planning to analyze the profitability of a projected investment or project [9]. It is used to determine whether or not an investment, project, or business will be profitable down the line [10].

NPV has become a popular measurement tool due to its simplicity and reliability in measuring the future value of an investment. The NPV is compiled based on cash flows consisting of cash in and cash out, which are measured by involving an element of uncertainty, namely interest rates. NPV describes the amount of cash projected in the future but valued at the current value of money.

### 2.2.2. Benefit Cost Ratio (BCR)

BCR is an alternative measurement of investment feasibility, where the value of benefits and costs are compared so that the value of BCR ranges between 0 and 1. The BCR method pays attention to aspects of the benefits provided and attention to the costs that must be incurred so that the method is well used in the assessment of government projects that have a direct impact on the community. [7]

The equation used for analysis is as follows. [7] [8]

$$BCR = \frac{Benefit}{Cost} \quad (3)$$

The criteria for receiving eligibility in investment with the BCR method are as follows.

$BCR \geq 1$ , then the investment is considered feasible

$BCR < 1$ , then the investment is considered *unfeasible*

### 2.2.3. Payback Period (PP)

Investment feasibility analysis should be able to be displayed in several investment indicators other than the *cash* inflow component. One indicator that can be presented is in the form of a long / period of return on investment. The payback period must be measured when cash flows reach the principal return (*break even point*). [7]

The equation used to measure *the payback period* (PP) is as follows. [7]

$$k_{PBP} = \sum_{t=0}^k Cf_t(FBP_t) \geq 0 \quad (4)$$

Where

K : Payback period  
 Cf t : cash flow period t  
 FBP : present interest factor

The criteria for receiving investment eligibility with the PP method are stated that:

If  $k < n$ , then the investment is *feasible*

If  $k > n$ , then the investment is *unfeasible*

### 2.2.4. Internal Rate of Return (IRR)

One method of evaluating feasibility in investment can be the value of the amount of interest rates. When the NPV value is equal to zero, the interest rate that occurs is the internal interest rate. [7] Cashflow at  $NPV=0$  can provide internal interest rate (IRR) information that provides information expressed in % per time period.

The equation used to determine the magnitude of the IRR value is as follows. [11]

$$IRR = i_1 + (i_2 - i_1) \times \frac{NPV_1}{NPV_2 - NPV_1} \quad (5)$$

Where

- $I_1$  : 1<sup>st</sup> interest rate
- $I_2$  : 2<sup>nd</sup> Interest Rate
- NPV1 : positive NPV value
- NPV2 : negative NPV value

### 2.2.5. Sensitivity analysis

Sensitivity analysis describes the condition of influential parameters that form a balanced equation so that if there is a change in one of the parameters it will affect the equation as a whole. The analysis is carried out by changing one of the parameter values for further review of acceptability to investment. [12] The parameters that can change and affect decision making in general are investment, income, expenses, and interest rates. [7]. Sensitivity analysis is a mathematical tool used in scientific and financial modeling to study how different values of an independent variable affect a particular dependent variable under a given set of assumptions. [13], [14], [15]. It is also known as a "what-if" or simulation analysis. Sensitivity analysis is used to help make predictions in the share prices of publicly traded companies or how interest rates affect bond prices [13], [15]. Sensitivity analysis allows for forecasting using historical data, paving the way for important decisions to be made about businesses, the economy, and making investments. [16] It is used to understand the effect of a set of independent variables on some dependent variable under certain specific conditions [15]. By creating a given set of variables, an analyst can determine how changes in one variable affect the outcome [13].

### 2.2.6. Monte Carlo Method

A mathematical method called Monte Carlo Simulation is used to predict the likely outcomes of an uncertain event from probability distribution of data. The simulation predicts a set of outcomes based on estimated range value of data that shows the probability distribution such as normal or uniform distribution. [17]

Monte Carlo simulations have a high level of accuracy according to the amount of data used. The greater the number of data samples used, the higher the level of accuracy. The level of accuracy of simulation results in the number of samples of 100,000 will be higher than the sample of 10,000. [18]

The amount of data determines the percentage value of failure probability, where the greater the number of samples, the percentage of failure is likely to be small. The probability of failure is calculated as a comparison of the sample value  $x$  which is less than zero ( $x < 0$ ) divided by the number of samples. Determination of the number of random data samples to be generated can use the reliability index value approach, where the value is the value of the cumulative distribution function of the failure probability value. The reliability index is calculated according to the equation: [19]

$$\beta = -\Phi^{-1}(P_f) \quad (6)$$

$$P_f = \Phi(-\beta) \quad (7)$$

where

- $\beta$  = reliability index
- Pf = probability of failure

2.2.7. Flowchart

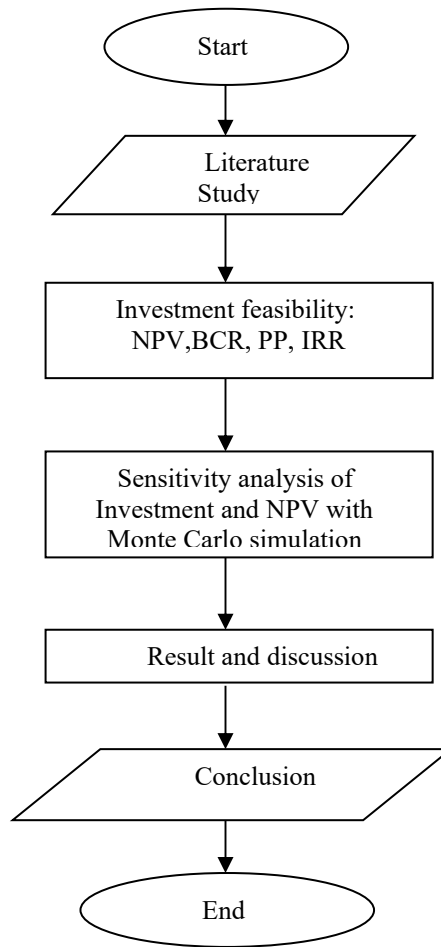


Figure 1. Flowchart

3. RESULTS AND DISCUSSION

Capital and operating costs Industrial *Asphalt Mixing Plant* (AMP) is an industry that provides the needs of road pavement layers built to meet market demand for transportation infrastructure needs. In general, the type of pavement layer provided by AMP is in accordance with the needs of a particular region. Based on this, industrial investment needs are adjusted to meet these needs. Industrial investment capital can be grouped into two costs, namely: capital costs and operating costs. For more details, details of the initial investment of industrial companies in establishing an *Asphalt Mixing Plant* (AMP) can be seen in the table 1.

Table 1. Cost of capital

No	Item	Price
A	Physical Building	IDR 17,992,500,000
B	Office Equipment	IDR 27.000.000
C	Laboratory Equipment	IDR 305.100.000
D	Mixing and Paving Machine	IDR 17,355,150,000
E	Operational Vehicles	IDR 600.000.000
Total		IDR 36,279,750,000

In addition to capital costs, other costs are in the form of operational costs where these costs arise during the operation of the industry and support the production process. Operational problems incurred can be in the form of labor wage costs as in table 2 below.

**Table 2. Operating costs**

No.	Description	Sum	Unit	Price	Total price
1	Head Manager	1	Person	IDR 13,000,000	IDR 13,000,000
2	Paving Workforce				
	Operator	7	Person	IDR 6,000,000	IDR 42,000,000
	Mechanic	2	Person	IDR 6,400,000	IDR 12,800,000
	Worker	9	Person	IDR 4,000,000	IDR 36,000,000
	Driver	3	Person	IDR 3,500,000	IDR 10,500,000
	Field Officer	2	Person	IDR 5,000,000	IDR 10,000,000
3	Houling				
	Operator	2	Person	IDR 6,000,000	IDR 12,000,000
	Worker	6	Person	IDR 4,000,000	IDR 24,000,000

### 3.1. Cash flow

Data processing is carried out using a *spreadsheet* program, so that cash inflow and outflow data can be compiled in a cash flow table to facilitate the calculation of feasibility analysis.

**Table 3. Cashflow period 0 and 10**

No	Description	Year	
		0	10
<b>I</b>	Cash In		
	Sales:		
	AC base / ATB	0	IDR 3,959,503,761.67
	AC binder	0	IDR 15,234,007,621.98
	ACWC	0	IDR 21,013,814,647.79
	HRS	0	IDR 3,531,974,105.10
	Sand sheet	0	IDR 3,627,352,423.24
	Sum of I	0	IDR 47,366,652,559.79
<b>II</b>	Cash Out	0	
	Employee Salaries	0	IDR 180,300,000.00
	Depreciation	0	IDR 2,539,582,500.00
	AMP Maintenance and Maintenance Costs	0	IDR 570,046,536.62
	Cost of Capital and Raw Materials		
	AC base / ATB	0	IDR 1,861,519,524.26
	AC binder	0	IDR 7,123,860,433.65
	ACWC	0	IDR 9,752,312,048.07
	HRS	0	IDR 1,647,139,221.89
	Sand sheet	0	IDR 1,742,592,180.15
	Initial Investment Cost	IDR 36,279,750,000.00	0
	Office Operating Costs	0	IDR 492,096,940.02
	Pph	0	IDR 947,333,051.20
	Sum of II	IDR 36,279,750,000.00	IDR 26,856,782,435.87
<b>III</b>	Net Cash Flow $\Sigma(I - II)$	-IDR 36,279,750,000.00	IDR 20,509,870,123.92

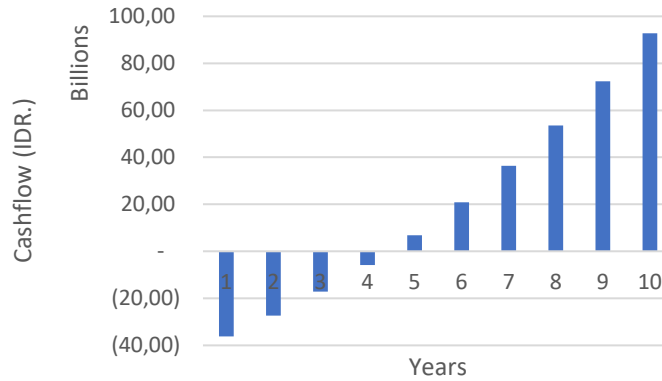
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Cash Flow Cummulative	-IDR 36,279,750,000.00	IDR 92,788,570,532.40
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Source: Data Processing

AMP's industry cash flows over a 10-year period can be seen in figure 1 of cumulative cash flows below.



**Figure 2. Cummulative cash flow**

Based on the calculation of cash flows that occur for 10-years period, It is possible to gauge the viability of an investment. The following table shows the results of the feasibility analysis.

**Table 4. Feasibility Analysis Results**

No	Analysis	Value
1	NPV	IDR 30,777,082,259.61
2	BCR	1.39
3	PP	4.16 Years
4	IRR	30%

From the cash flow calculation, NPV value of IDR 30,777,082,259.61 is obtained or NPV provides a value greater than zero ( $NPV \geq 0$ ) then the investment is feasible, BCR is obtained at 1.39 ( $BCR \geq 1$ ) then the investment is feasible, PP occurs in the 4.16th year and the IRR value is obtained at 30% giving a number higher than the MARR ( $IRR \geq MARR$ ) then the investment can be made.

Based on the results of the analysis, the  $NPV > 0$  indicates a positive value. When the NPV value is greater than 0, it is the right time to invest because the NPV value describes the financial condition at the time of the projection year. Meanwhile, the BCR value exceeds the value of 1, indicating that the profit value is greater than the costs incurred, so the greater the BCR value that exceeds 1, the investment is considered better. In the PP value, the analysis results show a significant number, considering that the investment life is 10 years and the value of the payback time is 4.16, so that the time required for payback is shorter than the investment period. The IRR value obtained from the analysis is quite high, so it illustrates the ability of the business to offset business interest rates by up to 30%.

### 3.2. Sensitivity analysis of investment value

Investment sensitivity analysis was done by operating the parameters of sensitivity that engaged in analysis. The sensitivity of an investment's value can be discovered by setting the  $NPV=0$ , thus the other parameters engaged the cashflow can also affect the sensitivity. The parameters of sensitivity as follow.

**Table 5. Sensitivity analysis parameters**

Description	Value
Investment	IDR 36,279,750,000.00
Annual Benefit	IDR 181,143,974,389.96
Annual Cost	IDR 130,614,045,192.88
Residual value	IDR 22,856,242,500.00
Investment Life	10 Years
Interest Rate (i)	12%

Investment sensitivity when  $NPV = 0$  or  $\sum^n t = 0$   $CF_t (FBP)_{t=0}$  is calculated as follows.

$$NPV = -I + Ab (FBP) + S (FBP) - Ac (FBP)$$

$$0 = -I + Ab (FBP) + S (FBP) - Ac (FBP)$$

$$I = Ab (FBP) + S (FBP) - Ac (FBP)$$

$$I = IDR 73,386,171,697.09$$

The analysis' findings indicate that the investment value will be susceptible to IDR. 73,386,171,697.09. This shows that an investment is no longer worth it when it exceeds that value. The investment value of the AMP industry of IDR 36,279,750,000.00 is considered to have a high feasibility value compared to the investment figure based on the results of the analysis.

The investment value of the sensitivity analysis results is obtained by assuming the  $NPV = 0$ , so that other variables that make up the equation are taken into account to obtain the value of the investment variable in accordance with the compiled cash flow. When the variables that make up the cash in and cash out are involved in the calculation, a positive investment value is obtained as a measure of investment sensitivity. Based on this, if the value of money invested exceeds the results of the analysis, then the investment is declared not in accordance with the cash flow.

### 3.3. NPV analysis with Monte Carlo

The simulation is carried out on cash flow with changes in value on the constituent factors of cash flow. Simulations are carried out to determine the value and probability of NPV which is influenced by the factors that make up the simulated cash flow. Simulation with changes in sales value with two scenarios where the first scenario is sales revenue of 100%, the second scenario is HRS and SS sales of 10%. This takes into account road conditions with light loading. According to Sukirman (2010), HRS and SS are used on pavement layers with light loading. [20] Additionally, simulations are run to determine the project's feasibility value, or NPV.

**Table 6. Simulation results of scenario 1**

Probability R, (R=1-pf)	0.99960
Probability pf, (pf=NPV<0)	0.00040
NPV (simulation)	
Min	-IDR 6,121,303,285.13
Max	IDR 29,038,021,003.87
Mean	IDR 14,433,294,717.60
Stdev	3913161120
NPV ( R )	IDR 27,553,320,897.33

Based on simulation and calculation results, the NPV value of each is obtained as in table 6 above. The probability value R ( $R = 1 - pf$ ) is the probability value of a non-negative NPV event on a normal distribution curve, which is the probability value obtained from subtracting the probability of NPV events below zero (pf). The R probability value of 0.99960 is depicted on the normal distribution curve of NPV, so that the NPV value can be calculated based on the probability value



of 0.99960 (99.96%). The NPV value is IDR. 27,553,320,897.33 based on Monte Carlo simulation results.

**Table 7. Simulation results of scenario 2**

Probability R, (R=1-pf)	0.9997
Probability pf, (pf=NPV<0)	0.0003
NPV (simulation)	
Min	-IDR 2,452,041,588.12
Max	IDR 24,818,565,279.67
Mean	IDR 11,961,302,115.06
Stdev	3426313313
NPV ( R )	IDR 23,719,088,232.49

The simulation results in the form of NPV values and probabilities in scenario 2 can be seen in table 7 above. The minimum and maximum NPV values from the simulation results are -IDR. 2,452,041,588.12 and IDR. 24,818,565,279.67 while the average NPV value is IDR. 11,961,302,115.06. The probability value of NPV<0 is 0.0003 (0.03%). This value is a negative NPV value based on simulation results with 3 events. The percentage value is obtained by comparing 3 samples by 10,000 samples conducted in the simulation. This shows that the probability value of R (R=1-pf) has a value of 0.9997 or 99.97% so that the NPV value can be found on the normal distribution curve. NPV value at R=0.9997 is IDR. 23,719,088,232.49 and those values are only a small difference compared to scenario 1. Based on this, the investment value and hotmix sales income with the two scenarios mentioned above do not have a high value difference so that investment by applying both scenarios can be said to be feasible.

Based on the simulation results using Monte Carlo for the two scenarios, it can be illustrated that there is no significant difference between the two scenarios. Based on this, other alternatives are needed, including the addition of other scenarios where the variation in profit value between different scenarios is quite large or other variations in the variables that make up the cash out. Furthermore, for similar research, the addition of sufficient scenarios should be sought so as to illustrate the sensitivity of the overall investment value.

#### 4. CONCLUSION

Considering what was discovered via study and discussion, following are some examples of inferences that can be drawn:

1. The investment value in the *asphalt mixing plant* industry is IDR. 36,279,750,000.
2. Based on the analysis, the NPV (*Net Present Value*), BCR (*Benefit Cost Ratio*), PP (*Payback Period*), and IRR (*Internal Rate of Return*) values were IDR. 30,777,082,259.61, 1.39, 4.16 years, and 30%.
3. Sensitivity to investment factors obtained a value of IDR.73,386,171,697.09.
4. The NPV value based on monte carlo simulation in scenarios 1 and 2 is IDR. 27,553,320,897.33 and IDR. 23,719,088,232.49.

#### REFERENCES

- [1] R. Sulistyorini, "Peran Infrastruktur Transportasi dalam Pengembangan Provinsi Lampung," *Jurnal Transportasi*, vol. xxi, no. 1, pp. 55-62, 2021.
- [2] R. Kristiano, Suryana and S. U, "Perkembangan Sarana dan Prasarana Transportasi dalam Hubungannya Dengan Tingkat Perekonomian Masyarakat Di Desa Kolang Kecamatan Kuwus

- Barat Kabupaten Manggarai Barat Provinsi Nusa Tenggara Timur," *Jurnal Geografi Gea*, vol. 19, no. 2, pp. 131-140, 2019.
- [3] Kemenhub, "Transportasi Sebagai Pendukung Sasaran Pembangunan Nasional," kemenhub, 03 10 2017. [Online]. Available: <https://dephub.go.id/post/read/transportasi-sebagai-pendukung-sasaran-pembangunan-nasional>. [Accessed 26 04 2023].
- [4] Dinaspupr, "Dinas PUPR Kota Banda Aceh," 12 07 2020. [Online]. Available: <https://dinaspupr.bandaacehkota.go.id/2020/07/12/asphalt-mixing-plant/>. [Accessed 25 04 2023].
- [5] F. Rahmansyah, "Evaluasi Investasi Asphalt Mixing Plant," Universitas Islam Indonesia, UII, Yogyakarta, 2002.
- [6] D. I. Anggraeni and S. Wibowo, "Evaluasi Investasi Asphalt Mixing Plant (Kasus Pada C.V. Ratna Base Camp Pacitan Jawa Timur)," Jurusan Teknik Sipil, Fakultas Teknik Sipil dan Perencanaan, Universitas Islam Indonesia, Yogyakarta, 2001.
- [7] M. Giatman, *Ekonomi Teknik*, Jakarta: PT. Raja Grafindo Persada, 2006.
- [8] J. Tjakra and J. B. Mangare, "Analisa Kelayakan Investasi Asphalt Mixing Plant (Studi kasus : PT. Lumbang Berkat Indonesia base camp Molobok)," *TEKNO SIPIL*, vol. 12, no. 61, pp. 40-47, 2014.
- [9] J. Fernando, "Investopedia," 24 May 2023. [Online]. Available: <https://www.investopedia.com/terms/n/npv.asp>. [Accessed 26 October 2023].
- [10] M. Girardin, "Theforage," 17 March 2023. [Online]. Available: <https://www.theforage.com/blog/skills/npv>. [Accessed 26 October 2023].
- [11] B. Putranto, D. Trijanto and M. Efendi, "Kelayakan Finansial Proyek Pembangunan Perumahan The City Inside Kota Malang," *Prokons*, vol. 12, no. 2, pp. 73-78, 2019.
- [12] A. Hasugian. I, F. Ingrid and K. Wardana, "Analisis Kelayakan dan Sensitivitas : Studi Kasus UKM Mochi Kecamatan Medan Selayang," *Buletin Utama Teknik*, vol. xv, no. 2, pp. 159-164, 2020.
- [13] W. Kenton, "Investopedia," 26 May 2023. [Online]. Available: <https://www.investopedia.com/terms/s/sensitivityanalysis.asp>. [Accessed 26 October 2023].
- [14] E. T. Indeed, "Indeed," 11 March 2023. [Online]. Available: <https://www.indeed.com/career-advice/career-development/sensitivities-analysis>. [Accessed 26 October 2023].
- [15] T. Vipond, "Corporate Finance Institute," 26 September 2020. [Online]. Available: <https://corporatefinanceinstitute.com/resources/financial-modeling/what-is-sensitivity-analysis/>. [Accessed 26 October 2023].
- [16] GoCardless, "GoCardless," December 2020. [Online]. Available: <https://gocardless.com/en-us/guides/posts/what-is-sensitivity-analysis/>. [Accessed 26 October 2023].
- [17] IBM, "What is Monte Carlo simulation?," IBM, [Online]. Available: <https://www.ibm.com/topics/monte-carlo-simulation>. [Accessed 27 April 2023].
- [18] AWS, "aws amazon," amazon, [Online]. Available: <https://aws.amazon.com/id/what-is/monte-carlo-simulation/>. [Accessed 28 April 2023].
- [19] M. Stanojev and D. Stojic, "Reliability Analysis of Structures ," *Architecture and Civil Engineering*, vol. xii, no. 3, pp. 265-272, 2014.
- [20] A. Prayogo, H. Suprayitno and H. Budianto, "Penentuan Kriteria dalam Pemilihan Jenis Perkerasan pada Dataran Tinggi di Kabupaten Trenggalek," *ITS JOURNAL OF CIVIL ENGINEERING*, vol. 33, no. 1, 2018.
- [21] M. Priyo, "Studi Kelayakan Investasi Proyek Perumahan pada Proyek Pembangunan Perumahan Aura Tirta Graha Banjarnegara," *Jurnal Ilmiah Semesta Teknika*, vol. 15, no. 2, pp. 120-132, 2012.