International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 03 March 2024
DOI: 10.47191/ijcsrr/V7-i3-34, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

Nickel Price Projection Using Multivariate Regression Method and Investment Feasibility Analysis of Nickel Mining in Indonesia with Sensitivity Analysis and Monte Carlo

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ABSTRACT: Nickel is one of the metals commonly used in various industries. Indonesia is one of the countries that has the largest nickel reserves in the world. Nickel prices will be formed through an equilibrium mechanism between production supply and nickel demand. This study will analyse the relationship between nickel price formation, supply, and demand. Nickel prices will also affect the feasibility of nickel mining investment in Indonesia. The data used in this study consists of market data derived from historical reports of the last 5 – 12 years (2010 – 2022) and mining plan assumptions derived from benchmarks with similar industries. The methods used in this analysis are multivariate regression, discounted cash flow, sensitivity analysis, and Monte Carlo simulation. The results of the analysis that have been carried out show the relationship between nickel supply and demand with prices, with estimated nickel price projection ranging from $16,750 / Ton - to $18,927 / Ton. The factors that most influence the feasibility of mining investment are nickel price, sales realization, water content, contractor costs, and fuel costs. The risk of nickel mining investment in Indonesia based on Monte Carlo simulations is estimated at around 11.36%. This shows that nickel mining investment in Indonesia is still very attractive.

KEYWORDS: Indonesia, Mining, Monte Carlo, Nickel, Price.

1. INTRODUCTION

Nickel is one of the metals commonly used in various industries. Some useful properties of nickel include having a high melting point (1453º C) (Haynes, 2016), being resistant to corrosion, and being able to be combined as alloy metals. The use of nickel in the market is very important as a raw material for the manufacture of stainless steel and electric vehicle batteries. Indonesia is one of the countries that has the largest nickel reserves in the world (Kadarusmam, 2013). The need for nickel is currently increasing significantly, mainly due to the development of electric cars where almost 80% of the composition of electric car batteries is made of nickel. The increase in demand does not necessarily cause nickel prices to rise, since the downstream program is carried out in Indonesia, causing nickel production to be abundant. Nickel prices will be formed through an equilibrium mechanism between production supply and increased nickel demand. Thus, in this study, an analysis will be carried out on the relationship between nickel price formation and nickel supply and demand.

The feasibility of a nickel mine investment will be influenced by nickel commodity prices. The feasibility study will be assessed by projecting the current value of the cash flow that will be obtained by the project in the future. The future cash flow projections are estimated by making financial models. Volatile variables that affect the feasibility of the mine will be tested by sensitivity analysis and Monte Carlo simulation to measure the level of risk in nickel mining investment in Indonesia. This research will use one of the case studies of nickel mining in North Maluku to assess the feasibility and attractiveness of investing in the nickel mining sector in Indonesia.

2. DATA

The data collection used in this study came from secondary data and simulation processes at one of the mining sites in the North Maluku region. The secondary data used is historical market data over the last 5 to 12 years. While the mining plan data is simulated by the author based on historical data and mining rules which will not be detailed explained in this study.

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2.1 Market Data

Market data consists of historical data on nickel price movements, supply, demand, Indonesian composite stock price (JCI) movements, company financial statements, and PT Vale Indonesia Tbk. (IDX: INCO) stock price movements as a comparison,

2.2 Mining Plan

The mining plan was made by the author's technical team and will not be detailed in this study. A resume of the mining technical plan used for the simulation of this research is addressed in the table below.

Table 1. Mining Parameter of Financial Modelling

Ore Specification	Value
Saprolite Reserves (Mill. WMT)	120
Limonite Reserves (Mill. WMT)	30
Saprolite Sales (Mill. WMT)	10
Saprolite Grade (Ni%)	1.90
Limonite Sales (Mill. WMT)	2.50
Limonite Grade (Ni%)	1.42
Stripping Ratio	1.67
Capital Expenditure	**Value**
Infrastructure (Mill. USD)	175.20
Building (Mill. USD)	17.39
Equipment (Mill. USD)	97.07
Operational Expenditure	**Value**
Contractor Cost/Total Material (USD/Ton)	7.91
Owner Cost / Total Material (USD / Ton)	1.10
Fuel Consumption/Total Material (USD/Ton)	2.10

3. METHOD

3.1 Discounted Cash Flow Analysis

Mining feasibility analysis of an investment is calculated using the discounted cash flow (DCF) approach (VALMIN, 2015), the premise of the discounted cash flow method is the current value of estimated cash flow or assets that will be obtained in the future (Damodaran, 2006). DCF is used to evaluate the current value of an investment.

Based on the theory of the time value of money, the money we invest today has a greater value than the money we will receive tomorrow. Therefore, DCF analysis is very important for an investor who uses his money at the moment and hopes to gain acceptance in the future. The calculation of discounted cash flow is done with the following equation:

$$DCF = \frac{CF1}{(1+r)^1} + \frac{CF2}{(1+r)^2} + \cdots + \frac{CFn}{(1+r)^n}$$

CF1 = Cash Flow Year 1
CF2 = Cash Flow Year 2
CFn = Nth Year Cash Flow
R = Discount Rate

3.2 Sensitivity Analysis

Sensitivity analysis was conducted to test the variables that most influence the feasibility of the mining project (Rudenno, 2012). This test is carried out by changing volatile variables in the range between -20% to +20%. The variables tested in the sensitivity

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analysis consisted of inflation, nickel price, cobalt price, HGSO sales realization, LGSO sales realization, limonite sales realization, fuel prices, contractor costs, debt interest, and water content in the ore. The variable that gives the most deviation is the factor that most affects the feasibility of the mine project.

3.3 Monte Carlo Simulation

Monte Carlo simulations are carried out to measure the uncertainty of the project value caused by variable volatility. Monte Carlo simulation is performed by changing variables with random combinations assuming the distribution of changed variable values is normally distributed. Monte Carlo simulations in this study were carried out as many as 2000 simulations with variables consisting of nickel prices, sales realization, contractor costs, fuel costs, long-term loan interest, and inflation.

4. ANALYSIS

4.1 Price Projection

The global nickel price to be used for the price benchmark (*Harga Mineral Acuan*/HMA) is highly volatile. Therefore, projections are needed to determine the global nickel price used in financial modelling. Global nickel price projections are carried out with a multivariable regression analysis approach to nickel supply and demand which greatly affects prices. The multivariable regression equation for nickel price projections is as follows:

$$P(Ni) = I + (Cd \times D) + (Cp \times P)$$

Where:
I = Intercept
D = Demand Cd = Coefficient Demand
P = Production Cp = Coefficient Production

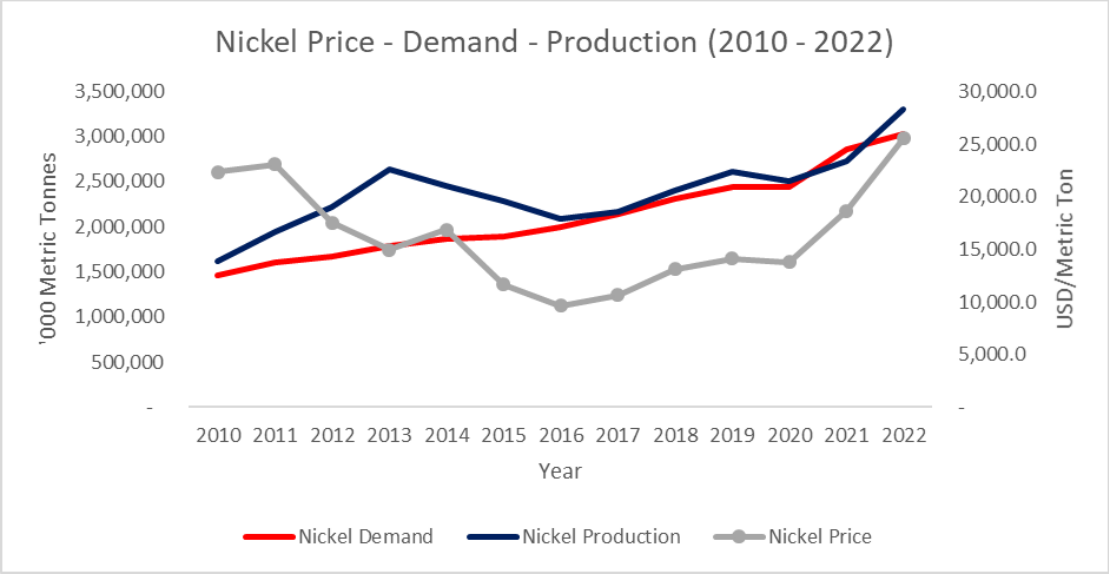

Figure 1. Nickel Price, Production, and Demand 2010 – 2022

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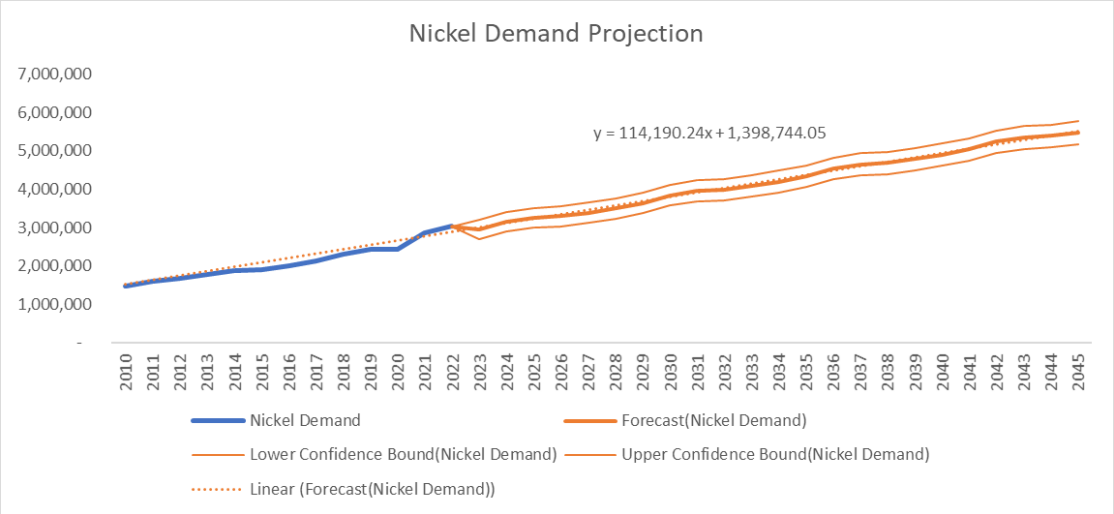

Figure 2. Nickel Demand Projection

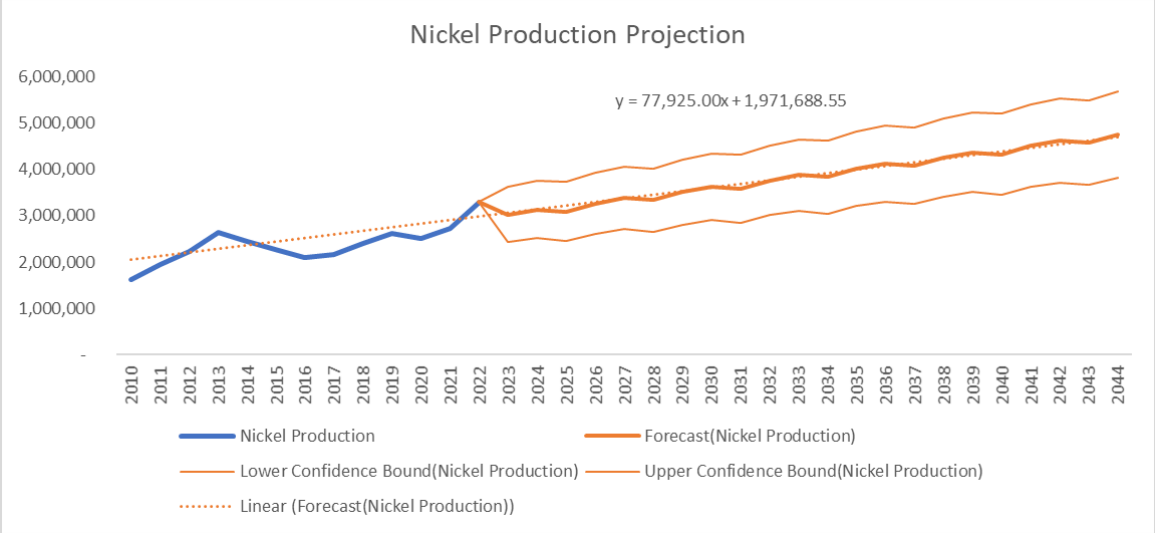

Figure 3. Nickel Production Projection

The results of multivariate regression analysis between production, demand, and nickel prices obtained an intercept value of 11,258.3, a regression coefficient for demand of -0.002, and a regression coefficient for production of 0.0039157. So the price equation in the X year after 2022 is as follows:

$$Price\ Ni(X) = 11{,}258.3 + \left(-0.002\ \times D(X)\right) + (0.0039157 \times P(X))$$

Based on the regression analysis, nickel price projections between 2023 and 2045 will tend to range between $16,750 / Ton and $18,927 / Ton (Appendix 1). If demand and production trends follow the trends predicted in this study.

4.2 Feasibility Analysis

The capital structure in this study uses a proportion of 79.87% capital in the form of equity, and 20.13% capital in the form of long-term loans. The cost of equity is determined at 13.69% based on capital asset pricing model analysis (Damodaran, 2023), and the cost of debt after tax of 7.55%. So, the weighting average cost of capital (WACC) is 12.45%.

The results of the feasibility analysis (Appendix 2) show that nickel mining investment in North Maluku in a mine with reserves of 120 million wmt saprolite, 30 million wmt limonite, and 14 years of life of mine, would obtain an NPV value of $863 million. The mining payback period is estimated to be obtained within 3 years, and the profitability index is 9.23.

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4.3 Sensitivity Analysis

The results of sensitivity analysis testing on the feasibility model of nickel mining in the North Maluku region showed that the price, realization of saprolite sales, moisture content in ore, contractor trade, and fuel costs affected the feasibility value by 10% – 38% of the model sieve value. This needs to be a special concern for investors in assuming prices, sales realization, and mining costs in detail before investing in the nickel mining sector.

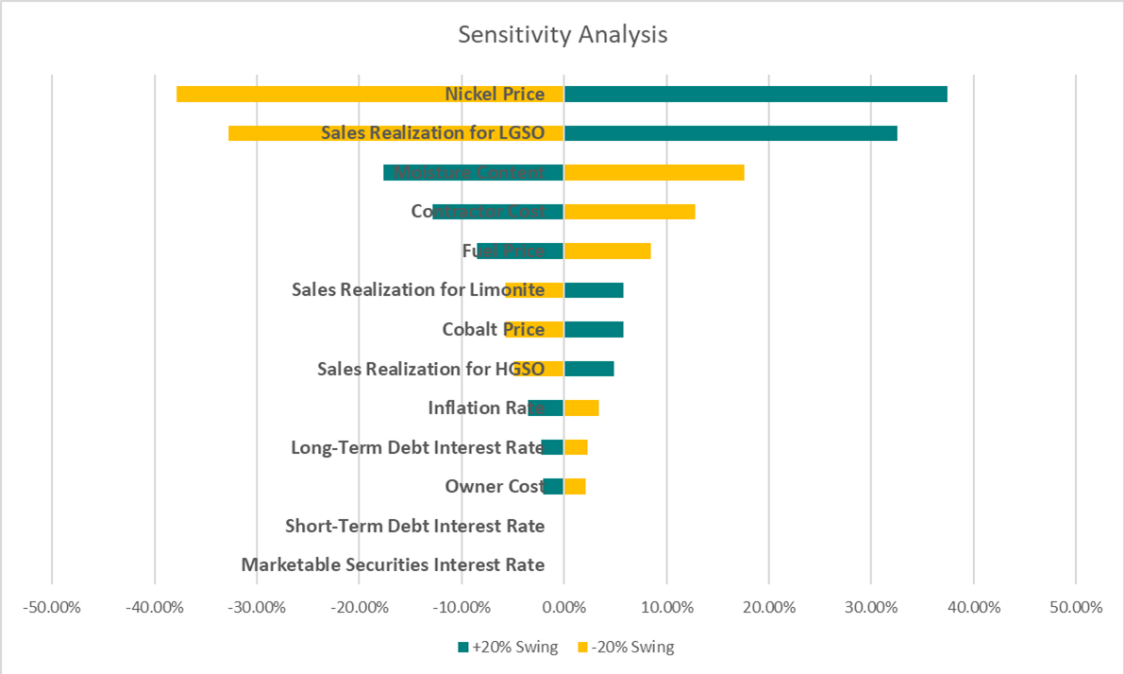

Figure 4. Tornado Diagrams of Sensitivity Analysis

4.4 Monte Carlo Simulation

Monte Carlo analysis is conducted to test the feasibility value of volatile variables contained in financial models. The simulation was carried out 2000 times with random combinations that have been normally distributed in the standard deviation range of each parameter.

Table 2. Standard Deviation in Monte Carlo Simulation

Variable	% Std. Dev
Nickel Price (USD)	33%
Cobalt Price (USD)	36%
Sales Realization HGSO (WMT)	23%
Sales Realization LGSO (WMT)	23%
Sales Realization Limonite (WMT)	23%
Realization Contractor Cost (USD/WMT)	14%
Realization Fuel Price (USD)	28%
Longterm Debt Interest Rate	19%
Inflation Rate	37%

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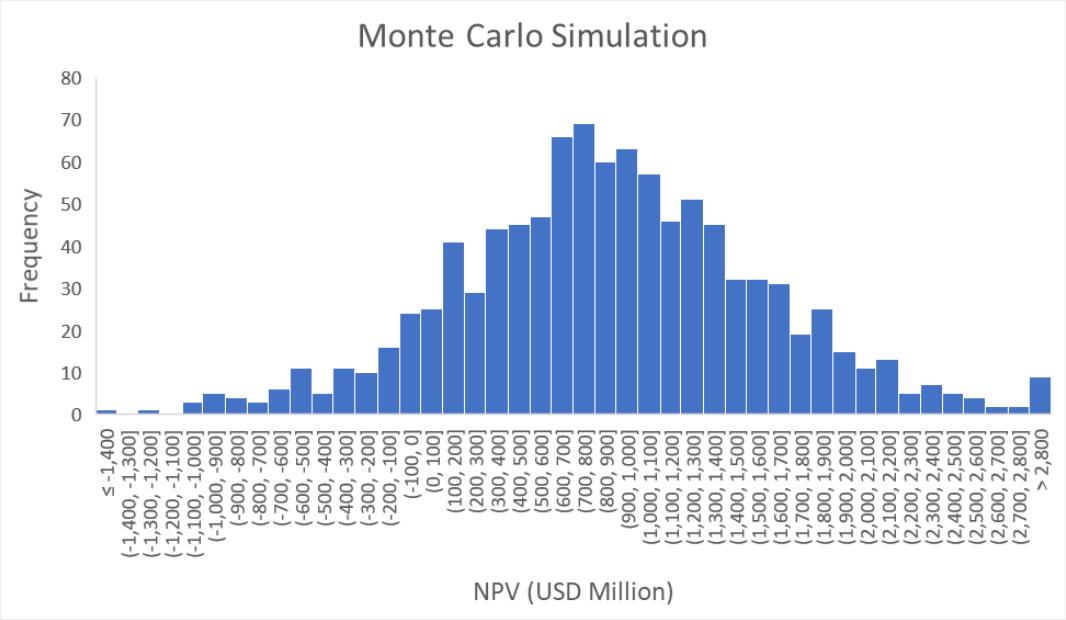

Figure 5. NPV Distribution of Monte Carlo Simulation

Table 3. Descriptive Statistics of Monte Carlo Simulation

Descriptive Statistics	
Min	(1,626.80)
Max	3,282.61
Mean	861.78
Standard Deviation	713.52
Median	827.48
Kurtosis	0.34
Skewness	0.10
Prob NPV<0	11.36%

Based on Monte Carlo simulations, the average feasibility value is $861.78 million. The average feasibility value of the results of the simulation is almost the same as the financial model that has been made, this shows that the assumptions made in the financial model are quite representative assumptions with values similar to Monte Carlo simulations. The feasibility value distribution in the simulation has shown a normal distribution, with a low skewness value. The simulated standard deviation of $713 million shows a high variation in the feasibility value due to high parameter volatility.

DISCUSSION

Based on the analysis that has been done, the multivariate regression method, the price of nickel resulting from projected demand and production ranges from $16,750 / Ton to $18,927 / Ton. The projected price range will result in the feasibility of mining investment in Indonesia with an investment feasibility value of $863 million in mines with reserves of 120 million wmt saprolite and 30 million wmt limonite. The most influential factors that affect the investment feasibility value of nickel mining in Indonesia are price, sales realization, water content, contractor costs, and fuel costs. The risk of failure of nickel mining investment in Indonesia based on Monte Carlo simulations is estimated at only 11.36%.

CONCLUSION

Based on the analysis that has been done, supply and demand have a strong relationship in the formation of nickel prices, so nickel price projections can be determined by multivariate analysis of nickel supply and demand. The projected nickel price range in

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Indonesia in the future is estimated to range from $16,750 / Ton to $18,927 / Ton. This price range makes nickel mining investment in Indonesia still very feasible. The most influential factors on the feasibility of nickel mining investment in Indonesia besides price are sales realization, water content, contractor costs, and fuel costs. Investors in the mining business must pay attention to these factors so that the value of investment feasibility is still maintained. Nickel mining investment in Indonesia is still very interesting because based on Monte Carlo simulations the risk of investment failure ranges from 11.36%.

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APPENDIX 1: Nickel Price Projection Results

Year	Demand ('000 MT)	Global Production ('000 MT)	Price (USD/MT)
2023	3,030,000	3,300,000	18,029
2024	2,942,549	3,019,930	17,110
2025	3,147,453	3,134,277	17,142
2026	3,258,132	3,090,759	16,747
2027	3,294,186	3,267,484	17,365
2028	3,389,016	3,381,831	17,621
2029	3,502,200	3,338,312	17,221
2030	3,641,087	3,515,037	17,631
2031	3,845,992	3,629,384	17,662
2032	3,956,671	3,585,866	17,267
2033	3,992,724	3,762,591	17,886
2034	4,087,555	3,876,938	18,141
2035	4,200,739	3,833,419	17,741
2036	4,339,626	4,010,144	18,151
2037	4,544,530	4,124,491	18,183
2038	4,655,210	4,080,973	17,788
2039	4,691,263	4,257,697	18,407
2040	4,786,094	4,372,044	18,662
2041	4,899,277	4,328,526	18,262
2042	5,038,165	4,505,251	18,672
2043	5,243,069	4,619,598	18,704
2044	5,353,748	4,576,079	18,309
2045	5,389,801	4,752,804	18,927

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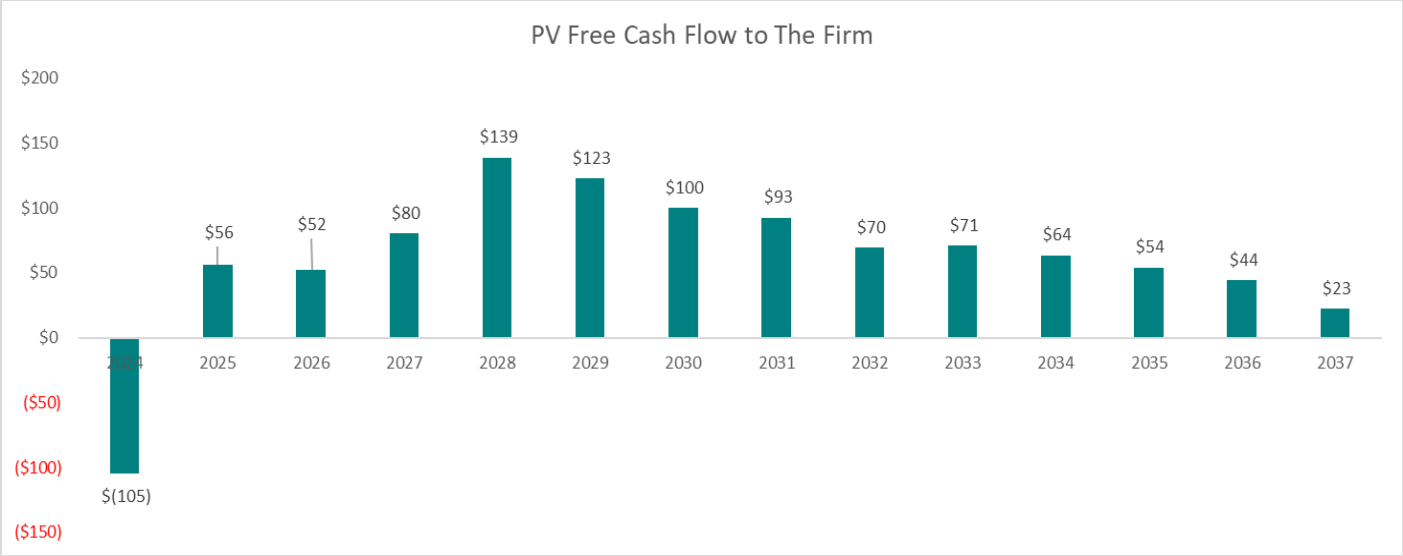
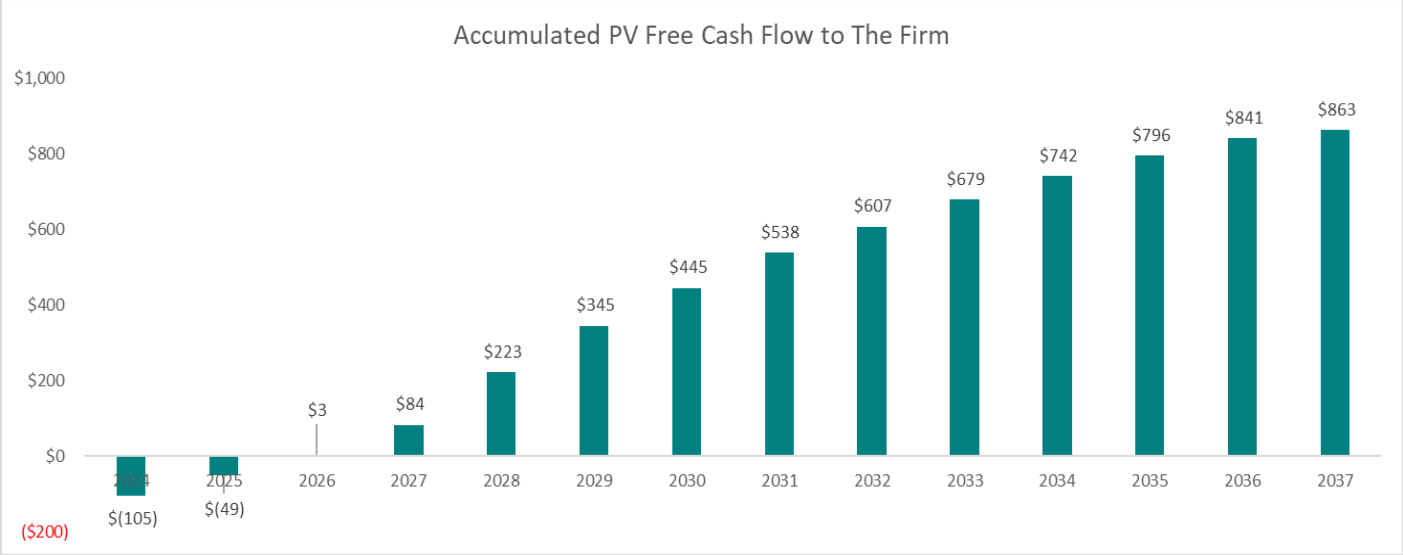
APPENDIX 2: Capital Budgeting Analysis





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APPENDIX 3: Financial Ratio of Analysis

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
LIQUIDITY RATIOS													
Current Ratio	3.24	3.48	3.57	3.47	3.43	3.41	3.34	3.32	3.29	3.41	3.43	3.13	3.42
Quick (Acid-Test) Ratio	2.53	2.79	2.90	2.77	2.73	2.70	2.64	2.60	2.59	2.69	2.69	2.30	2.65
ACTIVITY RATIOS													
Average Age of Inventory	78.32	78.32	78.32	78.32	78.32	78.32	78.32	78.32	78.32	78.32	78.32	78.32	78.32
Average Collection Period	68.14	68.14	68.14	68.14	68.14	68.14	68.14	68.14	68.14	68.14	68.14	68.14	68.14
Average Payment Period	57.51	57.51	57.51	57.51	57.51	57.51	57.51	57.51	57.51	57.51	57.51	57.51	57.51
Total Asset Turnover	0.87	1.34	1.22	0.91	0.76	0.66	0.58	0.54	0.46	0.41	0.35	0.10	0.38
DEBT RATIOS													
Debt Ratio	0.23	0.24	0.19	0.15	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.02	0.05
Times Interest Earned Ratio	31.46	79.18	95.39	89.22	95.87	106.83	119.89	106.32	122.72	160.57	230.74	40.25	521.12
Debt to Equity Ratio	19.7%	14.5%	14.7%	10.4%	6.0%	4.1%	2.8%	2.0%	1.9%	1.3%	0.7%	0.4%	0.3%
PROFITABILITY RATIOS													
Gross Profit Margin	54.25%	60.25%	63.01%	59.60%	58.67%	58.09%	56.69%	55.73%	56.12%	56.46%	55.50%	40.04%	52.80%
Operating Profit Margin	35.33%	43.94%	46.97%	43.44%	42.48%	41.74%	40.32%	39.14%	39.35%	39.58%	38.36%	16.38%	36.12%
Net Profit Margin	25.08%	31.81%	34.08%	31.49%	30.82%	30.32%	29.31%	28.43%	28.62%	28.84%	28.01%	11.71%	26.43%
Return on Assets	21.82%	42.74%	41.51%	28.79%	23.52%	20.04%	16.94%	15.49%	13.24%	11.82%	9.69%	1.18%	10.12%
Return on Equity	28.43%	56.54%	51.40%	33.80%	26.77%	22.32%	18.69%	16.91%	14.21%	12.53%	10.17%	1.20%	10.67%

Cite this Article: Muhammad Chandra R.M. (2024). Nickel Price Projection Using Multivariate Regression Method and Investment Feasibility Analysis of Nickel Mining in Indonesia with Sensitivity Analysis and Monte Carlo. International Journal of Current Science Research and Review, 7(3), 1728-1737