An Indonesian Economic Policy: The Poverty Impact of Nickel Downstream in Mining Regions

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Abstract

This study analyzes Indonesia's nickel downstream policy, examining its impact on poverty in mining regions and the challenges associated with implementing it. This study was conducted to address claims that economic improvement stems from the downstream processing of nickel in mining regions. This study uses a mixed-method approach with a sequential explanatory design, combining quantitative and qualitative research. In the quantitative analysis, a panel-data regression with a Random Effects Model is applied, using Cluster-Robust Standard Errors. Meanwhile, in the qualitative analysis, data were analyzed thematically using manual coding of interview transcripts to identify key patterns. The findings indicate that the estimated panel-data regression model shows a relationship between the dependent variable (poverty) and three independent variables: Industrial Management, Life Expectancy, and Literacy Rate. The findings suggest a relationship between the dependent variable (poverty) and three independent variables: industrial management, life expectancy, and literacy rates related to poverty, so that the downstream contribution of nickel from the mining sector is high or positively influential through industrial management aspects; its benefits do not reduce poverty in nickel mining regions.

Keywords Economic Policy, Nickel Downstream, Poverty, Mining Regions

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1. Introduction

In 2021, Indonesia's poverty rate peaked at 10.14% due to widespread job losses caused by the COVID-19 crisis. Meanwhile, the Indonesian government claims that its nickel downstream policy has contributed to a 21.2–21.6% increase in national economic output and has generated approximately 13.83 million jobs over the past decade. However, findings from a study conducted by the Indonesia Coalition reveal a significant disparity between national-level claims and local realities. Poverty rates in key nickel-producing regions have remained stagnant, and in two regions, South Halmahera and Konawe, they have even increased. These facts raise critical questions about the distribution of benefits from the downstream policy and its actual effectiveness in alleviating poverty in communities directly affected by mining and nickel processing activities (Djailani, 2025).

Poverty can be defined on an economic (purchasing power) basis using the International Poverty Line or the National Poverty Line, which sets the threshold at households spending less than IDR 350,000 per month or less than US$2.20 per day, depending on country differences in the cost of living (World Bank, 2019). The problem of poverty in Indonesia is a sustainable government problem. This is based on uncertainty about the government's effective strategy in reducing poverty in Indonesia. One of the government's strategies for economic growth is the downstream of nickel, which is included in the national strategic project (Sara, 2024).

Adding value to raw materials, such as nickel, is a downstream strategy to increase income and economic independence, thereby creating a multiplier effect in the national economy (Putra et al., 2024). Moreover, this includes significant investment in smelters, boosting local economies, double-digit growth rates in 2021 in Maluku and Central Sulawesi, job creation, and increased export earnings (Gupta, 2023; Sasongko, 2024). Nickel that has been processed and refined into finished or semi-finished goods will often have an economic value that increases. Showing that nickel downstream is part of Indonesia's nationalistic economic policy implemented since 2000 in the natural resources sector (Kim, 2023).

In 2021, Indonesia accounted for 30% of the world's nickel production (IndoCommodities, 2024), and by 2023, according to S&P Global Market Intelligence, Indonesia produced about 40.2% of the world's nickel, and Indonesia's production acceleration is faster than China, Australia, and other countries (Chan, 2023; Silva, 2024) it is even predicted to supply 85% of global nickel intermediates by 2027 (Shanghai Metals Market, 2024). At the same time, unemployment and poverty rates in nickel-producing provinces remain high, and the promised economic benefits have not been equitably distributed to local communities. For instance, Southeast Sulawesi recorded a poverty rate of 11.43% in March 2023—higher than the national average. Furthermore, a majority of the provinces within the nickel mining zones rank among the highest on the Multidimensional

Poverty Index (MPI). For example, Papua holds the highest MPI at 69.65%, followed by North Maluku in third place with 45.92%, West Papua in fourth with 41.65%, and Maluku in fifth with 40.83% (The Prakarsa, 2024).

Indonesia's share of the world nickel production market increased from 16.1% in 2019 to 38.3% in 2022 (Silva, 2024). Nickel ore that has undergone downstream processing (manufacturing to increase added value) can take the form of products such as ferronickel, nickel pig iron (NPI), stainless steel, mixed sulfide precipitate (MSP), mixed hydroxide precipitate (MHP), and nickel matte (IndoCommodities, 2024). Semi-finished nickel products include ferronickel, nickel matte, MHP, MSP, and Nickel Sulfate, which, if the end-user goods are batteries and ferronickel, can also be stainless steel (Chan, 2023).

Indonesia's production of stainless steel, a refined product from nickel, is the second largest in the world, with an estimated production capacity of 7 million metric tonnes per year by 2027, driven by abundant nickel resources that are poised to have implications on global market and supply trends (Shanghai Metals Market, 2024). In 2022, Indonesia exported Flat-Rolled Stainless Steel for $37.5 million, ranking it 22nd globally. These exports went to the United States, the United Kingdom, Canada, Turkey, and Vietnam (The Observatory of Economic Complexity, 2023). By 2023, Indonesia will be the world's largest stainless-steel exporter, accounting for 54% of global stainless-steel exports and earning US$2.8 billion from them (Workman, 2024). At least by 2024, Indonesia will have produced around 900,000 tonnes more, according to research by Macquarie Bank, Australia (Jain, 2024). If Indonesia commits to improving nickel downstream processing and converting raw nickel ore into manufactured products, it will become a global 'economic player' in nickel products.

The Indonesian government's nickel downstream policy is the main reason for the boom in downstream nickel production, as the government's policy has seen entrepreneurs shift their investment focus to domestic nickel processing so that exports of processed commodities such as stainless steel, ferronickel, and other nickel semi-finished goods have generated US$30 billion by 2022 (Chan, 2023). Indonesia is also a significant producer of mixed hydroxide deposits, in addition to nickel pig iron and nickel matte, which are then exported (Jain, 2024; Perry, 2023). That production growth is expected to accelerate, with production capacity in 2027 forecast at nearly 1 million tonnes of mixed sulfide precipitate (Perry, 2023).

Economic growth, claimed to be driven by downstream nickel processing carried out by the government, can address the problem, alleviating the poverty experienced by people in Indonesia's nickel mining regions. An indicator of the regional economy's improvement is GRDP. Gross Regional Domestic Product (GRDP) is a fundamental indicator of a region's economic performance over a given period. GRDP reflects the total value of goods and services produced by the region's factors of production, including those used for final consumption by the community (Supartoyo et al., 2014). The calculation of GRDP is essential for development planning because it can identify inter-regional economic disparities and the distribution of welfare. In addition, governments often use GRDP data to formulate fiscal and monetary policies to promote inclusive and sustainable economic growth (Hill, 1997).

Although Indonesia's nickel downstream has boosted national economic indicators, few studies have assessed whether regional economic growth in the nickel sectors reduces poverty in local communities. This study addresses this gap (Wang et al., 2022). In the global market, nickel products are highly competitive. Putra & Samputra (2023) emphasized that changes are needed to the Minister of Energy and Mineral Resources Regulation Number 11 of 2019, emphasizing special attention to environmental aspects and national resilience. Penelitian yang dilakukan oleh Putra & Samputra (2023) dan Wang et al. (2022) hanya berfokus pada analisis kebijakan ekspor dan pengelolaan downstream nickel untuk persiapan kebutuhan energi masa depan, dengan fokus pada studi literatur. In addition, it is limited to analyzing the availability of nickel resources in the industry to mitigate the risk of resource shortages. Thus, neither empirically examines poverty outcomes in producing regions, which this study addresses.

The principle of utilitarianism, commonly encapsulated in the phrase "the greatest happiness for the greatest number," serves as a foundational rationale for both the formation and reform of legal systems. At the same time, it is essential for citizens not only to understand the law but also to recognize their responsibility to uphold it. Legal provisions must therefore be communicated clearly and thoroughly so that the public can fully understand their content and implications. Only through such clarity can the law effectively serve as a guide for society in realizing the public interest and maintaining social order (Songbes, 2023). "The greatest happiness of the greatest number" has long served as the foundational principle for justifying the utility of a policy framework grounded in utilitarianism. Drawing upon Jeremy Bentham's concept of utilitarianism, this approach broadly explains the fundamental purpose of policy. Bentham also proposed several postulates to assess norms. His evaluation method relies on two key elements: pleasure—which encompasses utility, satisfaction, enjoyment, and happiness—and pain, which encompasses fear, discomfort, and suffering. Bentham's analytical strategy involves weighing the number of legal provisions that generate pleasure against those that result in pain. Through this comparative assessment, one can determine which policy products are beneficial and which are detrimental (Pratiwi et al., 2022).

The difference between this study and others is that it employs a mixed-methods approach with a Sequential Explanatory design. Previous research was unable to demonstrate the effectiveness of nickel downstream policy that could impact poverty in nickel mining regions. Therefore, this study aims to analyze in greater depth using six variables: the research variables are the Human Development Index X_{1it}, Industrial Processing X_{2it}, Mining X_{3it}, Life Expectancy X_{3it}, Literacy Rate X_{4it}, and Gross Regional Domestic Product at Current Prices

X_{6it}. It applies a panel data regression with a Random Effects approach and uses Cluster-Robust Standard Errors. Hypothesis testing is conducted at a 5% significance level (α = 0.05) to deepen the analysis and create new findings to review whether there is an influence of the nickel downstream policy on the poverty rate in each area of the nickel downstream region in Indonesia, which includes several districts/cities, namely Morowali, Konawe, Kolaka, East Halmahera, Central Halmahera, North Halmahera, Bantaeng Regency, and East Luwu.

2. Objective Study

Based on this simple background, this study seeks to determine;

(1) The effect of nickel downstream on poverty in mining regions

(2) To understand the challenges of Nickel downstream policy implementation

This study uses a mixed-methods approach, where the hypotheses in the quantitative approach of this study are;

H_1 : The nickel downstream significantly influences poverty in mining regions.

H_0 : There is no significant effect of nickel downstream on poverty in mining regions.

3. Methodology

This study adopts a sequential explanatory mixed-methods design, starting with a quantitative analysis of nickel downstream and poverty indicators across seven nickel-producing districts. This is followed by qualitative interviews to explore contextual explanations for the statistical findings. The data source for this study is primary data collected through semi-structured interviews with policymakers and academics selected for their expertise in AM & AAC. Meanwhile, the secondary data pertains to the Poverty Rate from the Central Bureau of Statistics (BPS). This study includes eight regencies with observations covering 5 years from 2019 to 2023. The variables used in this research include one response variable and six predictor variables, as listed in Table 1.

Table 1: Research Variable

Variable	Information	Definition	Unit
Y	Poor Population by District/City	A value that measures the proportion of the population living below the poverty line.	Percent (%)
X_1	Development Index	A measure used to assess the quality of life and human development in a country.	Index
X_2	Industrial Processing	Output value or output generated from industrial processing activities, covering the value of goods produced, electricity used in the production process, and other services related to industrial processing.	Percent (%)
X_3	Mining	The output value generated from mining activities, namely the process of extracting valuable minerals from the earth, is either mechanical or manual.	Percent (%)
X_4	Life Expectancy	The average age that an individual can expect to live to at birth, reflecting the health and quality of life in a region.	Years
X_5	Literacy Rate	Percentage of the population aged 15 years and above who can read and write and understand a simple sentence in their daily lives.	Percent (%)
X_6	Gross Regional Domestic Product at Current Prices	Gross value added of all goods and services calculated using prices prevailing in the current year in a region.	Million (Rupiah)

Source: adapted from Putnam (1993, 2000), Cigler (2007), and Kusumasari et al. (2010)

In the quantitative analysis, this study employs a panel-data regression with a Random Effects approach and Cluster-Robust Standard Errors. Hypothesis testing is conducted at a significance level of 5% ($\alpha = 0.05$). The steps of data analysis in this research are described as follows;

(1) Conduct data exploration on the percentage of the poor population data (Y) to obtain data characteristics.

(2) Estimate the panel data regression model using the Random Effect Model. In this panel data regression model, error terms are included due to individual and observation time changes, which can cause differences in intercepts between individuals and between times. The formula is as follows:

$$Y_{it} = \beta_{0i} + \sum_{k=1}^{K} \beta_k X_{kit} + u_i + \varepsilon_{it}; \quad i = 1,2,\dots,N\,; t = 1,2,\dots,T\,; k = 1,2,\dots,K$$

(3) Conduct testing for classical regression assumptions.

A. Test the normality of residuals using the Jarque-Bera Test. This test combines information on skewness and kurtosis of residual data to assess the suitability of the data for a normal distribution. The hypothesis and formula are as follows:

H_0: Residuals are normally distributed

H_1: Residuals are not normally distributed

$$JB = 102 \times \left[\frac{Skewness^2}{6} + \frac{(Kurtosis - 3)^2}{24}\right] \sim \chi^2$$

The decision is made by comparing the JB statistical value with the critical chi-square value. In addition, if the $p - value > 0.05$, then H_0 is accepted, meaning that the residuals are considered normal. If the $p - value \leq 0.05$, H_0 is rejected, and the residuals are not normal.

B. Test for homoscedasticity by applying the Breusch-Pagan Test. This test is conducted to determine whether the residual variance is constant (homoscedasticity) or varies (heteroscedasticity) in the regression model. If heteroscedasticity occurs, it makes the estimation of the regression parameter variance inefficient and invalidates the hypothesis test. The hypothesis and formula are as follows:

H_0: Residual variance is constant (homoscedasticity)

H_1: Residual variance is not constant (heteroscedasticity)

$$BP = \frac{1}{2}\boldsymbol{f}^{\mathrm{T}}\mathbf{Z}(\mathbf{Z}^{\mathrm{T}}\mathbf{Z})^{-1}\mathbf{Z}^{\mathrm{T}}\boldsymbol{f} \sim \chi^2$$

With vector $\boldsymbol{f}$ is $f_i = \left(\frac{e_i^2}{\sigma^2} - 1\right)$. While f^T is $(f_1, f_2 \dots f_n)$, Z is a standardized X matrix, of size n × (p + 1), and e_i^2 is the residuals for the i-th observation from the regression estimation results. The decision-making in this test is to reject H_0 if the value of $BP > \chi^2_{a,p}$ or if the $p - value < \alpha$ where p is the number of predictor variables.

C. test for residual autocorrelation with the Breusch-Godfrey Test (Lagrange Multiplier Test). This test is used to detect residual autocorrelation, especially higher-order autocorrelation, in regression models. Autocorrelation indicates that residuals are correlated, violating the assumption of residual independence and potentially affecting the validity of statistical inferences. The hypothesis and formula are as follows:

H_0: There is no residual autocorrelation.

H_1: There is residual autocorrelation.

$$\lambda_{LM} = T\sum_{i=1}^{N-1}\sum_{j=1+1}^{N}\hat{\rho}_{ij}^{2} \sim\chi^2$$

If the $p-value > 0.05$, then fail to reject H_0 and there is no autocorrelation. Conversely, if the $p-value$ is less than or equal to 0.05, the null hypothesis is rejected, indicating the presence of autocorrelation in the residuals.

D. Identify multicollinearity among independent variables by checking the Variance Inflation Factor (VIF). The VIF value indicates how much the variance of the regression coefficient increases due to correlation with other independent variables. If a variable's VIF is 1, it means there is no correlation with the other independent variables. A VIF value between 1 and 5 indicates moderate correlation, and a value greater than 10 indicates a serious multicollinearity problem that needs to be addressed. The VIF formula for the jth independent variable is:

$$VIF_j = \frac{1}{1-R_j^2}$$

Where R_j^2 is the coefficient of determination of the regression of the jth independent variable against all other independent variables.

(4) Estimating Random Effect Model parameters using Cluster Robust Standard Error (CRSE). This estimate is used because the assumptions of heteroscedasticity and autocorrelation are violated. The CRSE formula is as follows:

$$\hat{\boldsymbol{V}}[\hat{\boldsymbol{\beta}}] = \boldsymbol{c}(\boldsymbol{X}'\boldsymbol{X})^{-1}\left(\sum_{g=1}^{G}\boldsymbol{X}_g'\hat{\boldsymbol{u}}_g\,\hat{\boldsymbol{u}}_g'\boldsymbol{X}_g\right)(\boldsymbol{X}'\boldsymbol{X})^{-1}$$

(5) Evaluate regression model parameters through R- square value calculation and parameter significance testing.

(6) Interpret the regression model based on statistically significant parameters.

As for the second phase, after conducting a quantitative analysis, the researcher will proceed to the second stage, namely a qualitative study. Qualitative data were analyzed thematically using coding of interview transcripts to identify key patterns related to policy distribution, environmental impact, and perceived inequality. Thematic interpretation was informed by Bentham’s utilitarian lens, focusing on whether policy outcomes maximized collective welfare in affected regions.

4. Result and Discussion

4.1 The Effect of Nickel Downstream on Poverty in Mining Regions

The 2020 nickel downstream policy led to an explosion in refined nickel production, coinciding with the world's surge in electric car sales over the past decade amid challenges posed by climate change. Exports of nickel-containing metals continued to rise in line with foreign direct investment in the metals industry (Kim, 2023). Mixed sulfide and mixed sulfide precipitate are among the primary components used to produce lithium batteries for electric cars (Chan, 2023; IndoCommodities, 2024). It is suitable for Indonesia, which wants downstream nickel resources with regulations and investment to develop the domestic electric vehicle battery industry (Chan, 2023; Gupta, 2023). Indonesia has four of the largest nickel-producing provinces: Central Sulawesi, South Sulawesi, Southeast Sulawesi, and North Maluku. The following are some of the nickel-producing districts/cities in some of these provinces;

Table 2: Descriptive Statistics

District/Cities	2019	2020	2021	2022	2023
Morowali	13.75	13.43	13.75	12.58	12.31
Konawe	12.34	12.2	13.03	12.57	13.02
Kolaka	11.92	11.6	12.43	11.51	11.8
East Halmahera	15.39	15.45	15.04	13.14	12.47
Central Halmahera	14.12	13.56	13.52	12	11.44
North Halmahera	4.55	4.45	5.22	4.58	4.62
Bantaeng	9.03	8.95	9.41	9.07	9.18
East Luwu	6.98	6.85	6.94	6.81	6.93

According to the percentage Table of the poor population in eight regions during the period 2019 to 2023, there is variation in patterns between regions. Some regions show a declining trend, while others experience an increase or remain relatively stable. The most significant decline occurred in East Halmahera, from 15.39% in 2019 to 12.47% in 2023, a drop of about 2.92 points. Significant declines also occurred in Central Halmahera, from 14.12% to 11.44%, and in Morowali from 13.75% to 12.31%. These three regions have seen improvements in poverty conditions over the last five years. On the other hand, two regions experienced a slight increase in the percentage of the poor population: Konawe (from 12.34% to 13.02%) and Bantaeng (from 9.03% to 9.18%). Meanwhile, Kolaka and East Luwu tend to be stable, with minimal year-to-year changes.

Compared with other regions, East Halmahera consistently had the highest poverty rate in 2019 and 2020. However, its position has continued to decline until 2023. On the other hand, North Halmahera has had the lowest poverty rate for five consecutive years, ranging from 4.45% to 5.22%. Thus, although there is generally a trend of poverty reduction across most regions, some regions still show increases or stagnation that require attention.

A. Estimation of Panel Data Regression Model

The panel data regression model can be estimated using three tests: the Chow Test, the Lagrange Multiplier Test, and the Hausman Test. The results of each of these tests are shown in Table 3 below;

Table 3: The Result of Chow, Lagrange Multiplier, and Haussman Test

Test	Hypotheses	Statistical Test	Decision
Chow	$H_0: CEM$ $H_1: FEM$	$p-value < 0.001$	Reject H_0
Lagrange Multiplier	$H_0: CEM$ $H_1: REM$	$p-value < 0.001$	Reject H_0
Haussman	$H_0: REM$ $H_1: FEM$	$p-value = 0.992$	Fail to reject H_0

Based on Table 3, the best-estimated model is the Random Effect Model (REM). The next step is to perform modeling using the REM approach.

B. Normality Test

Normality tests are conducted using the Jarque-Bera test with the following hypotheses:

H_0: Errors are normally distributed
H_1: Errors are not normally distributed

Table 4: The Result of Normality Test (Jarque-Bera)

Jarque-Bera Value	$\boldsymbol{p-value}$	$\boldsymbol{\chi^2_{0,05;2}}$
2.032	0.362	5.991

Based on Table 4, the value of Jarque-Bera is known = 2.032 $< \chi^2_{0.05,2}$ table $= 5.991$ and $p-value = 0.362 > \alpha_{0.05}$, so it can be concluded that H_0 is fail to rejected, which means there is enough evidence to state that the error is usually distributed.

C. Homoscedasticity Test

The homoscedasticity test used in this study employs the Breusch-Pagan (BP) test. The hypotheses in the Breusch-Pagan test are as follows:

H_0 : $\sigma_1^2 = \sigma_2^2 = \cdots = \sigma_{40}^2$ (There are no signs of heteroscedasticity)
H_1 : At least one $\sigma_i^2 \neq \sigma^2$ (There are signs of heteroscedasticity)

Table 5: Test for Heteroscedasticity using the Breusch-Pagan test (BP)

Nilai *Breusch-Pagan*	$p - value$	$\chi^2_{0,05;6}$
28.525	<0.001	12.592

Based on Table 5, the results of the homoscedasticity test show a Breusch-Pagan (BP) value of 28.525, which is greater than the Chi-square table value ($\chi^2_{0.05,6}$) of 12.592. This is also confirmed by a $p - value$ of 0.000, which is less than the significance level (α) of 0.05. Therefore, the null hypothesis (H_0) is rejected, indicating heteroskedasticity in the data.

D. Autocorrelation Test

The autocorrelation test used in this research employs the *Breusch-Pagan* (BP) test. The hypothesis in the *Breusch-Pagan* test is as follows:

H_0 : $\sigma_1^2 = \sigma_2^2 = \cdots = \sigma_{40}^2$ (There are no signs of autocorrelation)
H_1 : At least one $\sigma_i^2 \neq \sigma^2$ (There are no signs of autocorrelation)

Table 6: Autocorrelation Test of Breusch-Pagan (BP)

Nilai *Breusch-Godfrey*	$p - value$	$\chi^2_{0,05;6}$
31.059	<0.001	12.592

Based on Table 6, the results of the autocorrelation test show a Breusch-Godfrey (BP) value of 28.525, which is greater than the Table *Chi-square* value ($\chi^2_{0.05,6}$) of 12.592. In addition, the obtained $p - value$ is less than 0.001, which is smaller than the significance level of 0.05. Thus, the null hypothesis (H_0) is rejected, and it can be concluded that the data exhibit autocorrelation.

E. Multicollinearity Check

One assumption that must be met before performing panel data regression analysis is that there is no multicollinearity among the independent variables.

Table 7: Multicollinearity Check

Variable	VIF Value
X_1	2.682
X_2	2.505
X_3	2.288
X_4	3.914
X_5	1.425
X_6	1.358

Based on Table 7, all variables have a VIF value below 10. Thus, there is no indication of multicollinearity in the REM model.

A. Modeling Using Random Effect Model

Furthermore, the data are modeled using a random-effects panel regression, resulting in an R-square of 55.294%. Thus, it can be concluded that the independent variables explain 55.294% of the variation in the percentage of the poor population (Y), with the remaining variation explained by other factors. The results of the partial tests obtained are as follows;

Table 8: Random Effect Model

Variable	Coefficient	Standard Error	$t_{statistics}$	$p-value$	Decision
X_1	0.416	0.218	1.903	0.057	Fail to reject H_0
X_2	0.001	0.001	0.766	0.443	Fail to reject H_0
X_3	-0.0005	0.002	-0.250	0.802	Fail to reject H_0
X_4	-2.113	0.533	-3.959	0.000	Reject H_0
X_5	-0.187	0.101	-1.853	0.064	Fail to reject H_0
X_6	-0.000005	0.000	-1.198	0.231	Fail to reject H_0

B. Cluster Robust Standard Error (CRSE)

Based on the results of the panel-data regression assumption tests using a random-effects approach, it was found that the assumptions of homoskedasticity and autocorrelation are violated. Although this violation does not affect the unbiased and consistent nature of the model estimates. it causes the standard errors to be biased. As a result, the validity of the model testing. whether simultaneous or partial. is reduced. Therefore, it is necessary to adjust the standard error by applying CRSE. where individual units or districts/cities (i) are used as cluster variables in the calculations. The estimated results of the panel data regression model with random effects using CRSE are presented in the following table;

Table 9: The Result of Cluster Robust Standard Error (CRSE)

Variable	Coefficient	Standard Error	$t_{statistics}$	$p - value$	Decision
X_1	0.416	0.289	1.439	0.159	Fail to reject H_0
X_2	0.001	0.0004	2.469	0.018	Reject H_0
X_3	-0.0005	0.0007	-0.811	0.422	Fail to reject H_0
X_4	-2.113	0.451	-4.686	<0.000	Reject H_0
X_5	-0.187	0.042	-4.460	<0.000	Reject H_0
X_6	-0.000005	0.000	-1.8148	0.078	Fail to reject H_0

After re-estimating using CRSE, the standard errors of the regression parameters changed. This change indicates that the correction has been successfully applied to address heteroskedasticity and autocorrelation, resulting in more accurate standard error estimates. In addition, there is an adjustment in the t-statistic and p-value, which shows a direct relationship with changes in the standard error. The estimated parameters from the best corrected model are presented as follows;

$$\hat{y}_{it} = \beta_{0i} + 0.001X_{2it} - 2.113X_{4it} - 0.187X_{5it} \quad (?)$$

Furthermore, the estimated value of β_{0i} obtained for each district/city of the best model is as follows:

Table 10: Estimated Values for Each Region

Regency/City	β_{0i}
Morowali	148.265
Konawe	148.963
Kolaka	149.386
East Halmahera	150.977
Central Halmahera	139.617
North Halmahera	142.323
Bantaeng Regency	145.853
East Luwu	143.623

Based on the equations in Table 10, the estimated panel-data regression model shows the relationship between the dependent variable y_{it} and three independent variables: X_{2it}, X_{4it}, and X_{5it}. The estimation results show that the coefficient for X_{2it} is 0.001. This means that every increase of 1 unit in industrial processing will increase the percentage value of the poor population by 0.001 units, assuming other variables remain constant. Meanwhile, X_{2it} has a negative coefficient of -2.113, indicating that a 1-unit increase in life expectancy reduces the percentage of the poor population by 2.113 units. Similarly, the variable X_{5it} also negatively affects the percentage of the poor population, with a coefficient of -0.187. This means that an increase of 1 unit in the literacy rate will decrease the percentage of the poor population by 0.187 units.

Given the nickel industry's significant adverse impact, it can eliminate thousands to tens of thousands of fishermen and farmers, leaving them without livelihoods. Given the increase in the poverty index in 3 provinces in Indonesia. the largest producers of nickel, it is argued that nickel downstream cannot create new jobs to end poverty. Fundamentally, fishermen and farmers experience job losses when the nickel industry undermines environmental conditions that support local communities' livelihoods (Litha, 2023).

The activities of the nickel downstream industry have minimal implications for reducing the unemployment rate and regional inequality, and they only negatively affect ecological and public health. The narration regarding nickel downstream can improve local communities' welfare by recruiting labor and increasing wages, which can be denied. The cumulative number of workers in several fields during vulnerable times over 15 years reached US$14.71 billion, or Rp. 228 trillion. The BAU plan for labor projections during a relatively long. vulnerable period results in lower income. Nickel downstream activities initiate this. As experienced by farmers and fishermen, nickel downstream has led to a negative impact on several sectors, especially agriculture and fisheries. This is based on losses incurred by Indonesia's three largest nickel-producing provinces. totaling US$387.10 or Rp. 6 trillion. Explicitly, fishermen and farmers will suffer losses of US$234.84 million, or Rp3.64 trillion. over the next 15 years (Syahni, 2024).

4.2 The Challenges of Nickel Downstream Policy Implementation in Indonesia

Nickel mining in Indonesia has drawn global attention for its crucial role in supplying raw materials to the global electric vehicle (EV) battery industry. As one of the world's largest nickel producers, Indonesia leverages this resource through aggressive policies to maximize its economic benefits. By focusing downstream, the Indonesian government hopes to create high-value products, such as EV batteries, domestically, which is critical to the world's energy transition towards greener technologies (Kranenburg, 2024; Putra & Samputra, 2023). However, there are enormous social and environmental costs behind this economic success.

Human rights violations in the mining or nickel smelter (refining) sector are prevalent in Indonesia (Djamhari et al., 2024). For example, around 200 farming families are threatened with losing their jobs, and communities whose lives are disrupted by environmental damage stemming from nickel mining company activities and land exploitation in South Konawe Regency. Southeast Sulawesi Province, which began in 2000 (Peribadi et al., 2015). The way the state carries it out in a repressive manner is undoubtedly contrary to human rights. The state must protect its citizens in accordance with the principle of "Salus Populi Suprema Lex Esto" (Holqi et al., 2024).

Similar cases also occur in the form of health losses, such as potential deaths due to exposure to toxic air originating from the coal-based nickel industry in nickel-rich areas, such as Central Sulawesi, Southeast Sulawesi. South Sulawesi, and North Maluku, have also continued to increase since nickel downstream began in 2020 (Myllyvirta et al., 2024; Syarifuddin, 2022). Melky, Campaign Chair of the Mining Advocacy Networkม found a land grab by a nickel company against the Tobelo Dalam tribe in the forest of North Halmahera, North Maluku, to build a company distribution road. Likewise, the findings and reports of several international media outlets since March 2021 about criminalization and violence against peasant residents during land and environmental struggles against mining companies on Wawoni Island, Konawe Regency, Southeast Sulawesi, and in several places in North Maluku and Central Sulawesi (Korteweg & Kranenburg, 2024).

Land and environmental exploitation is a form of human rights violation when, according to the Universal Declaration of Human Rights, it concerns adequate living standards and circumstances that make it impossible to make a living (Article 25, Paragraph 1, Universal Declaration of Human Rights, 1948). The conception of human rights includes recognition, protection, and respect for human dignity. The conceptual development of human rights after World War 2 also emphasized protecting society from governments that sought to 'wage war' against certain groups (Sabine et al., 2010).

This emphasis can also relate to people directly dealing with governments or companies that are in conflict of interest. Not only the government but also companies, especially nickel companies, are economic actors that often come into conflict with citizens due to nickel business negotiations that affect the socioeconomic life of the community (Putra & Samputra, 2023). For example, several nickel refining companies in Bantaeng Regency, South Sulawesi, have failed to fulfill their Corporate Responsibility to Respect Human Rights (Aulia et al., 2020). It is a long historical record that mining interests in Indonesia, as in other countries. are shrouded in socioeconomic, Cultural, and environmental conflicts between mining operators and local or Indigenous communities (Resosudarmo et al., 2009).

Progressive growth, such as the expansion of mining regions by companies in Indonesia, has been evident since the late 2020s but has not been matched by significant ecological rehabilitation or the restoration of the spatial impacts of mining and industry, and still ignores the pressures of socio-ecological issues (Heijlen & Duhayon, 2024). However, the nickel downstream policy since 2020 has been heavily scrutinized for its role as a Green Crime, i.e. adverse impacts on the environment (deforestation and greenhouse gas emissions). human rights. Health, and livelihoods (Heijlen & Duhayon, 2024; Rynaldi et al., 2024).

Still, in South Konawe Regency, research conducted on residents of Wonua Kongga Village provides empirical evidence that deforestation, pollution from mining, water pollution, agrarian damage, landslides, road damage, and other impacts are due to nickel mining activities (Korteweg & Kranenburg, 2024; Surdin et al., 2022). Deforestation and pollution of marine ecosystems (including mangroves) also occur in the Indonesia Morowali Industrial Park in Morowali Regency, Central Sulawesi, where more than 20 nickel mining and downstream companies operate (Korteweg & Kranenburg, 2024; Syarifuddin, 2022).

The current nickel mining industry has yet to fulfill its goals for people's welfare and ecological sustainability, despite the social injustice and forest destruction experienced by local communities, such as Morowali and Central Halmahera. Deforestation, as part of environmental degradation, is the conversion of forested areas to non-forested areas (direct land use and land cover), such as mining, urban, vacant land, or agricultural areas, which degrade ecosystems and biodiversity (Heijlen & Duhayon, 2024; UN Environment Programme, 2004). The trail of deforestation in Indonesia since the New Order cannot be explained solely by political factors, especially the roles of policymakers and political forces, with support from the international community. During the New Order era. policymakers who prioritized industrialization for economic growth and development, without considering environmental consequences, contributed to deforestation and forest exploitation in Indonesia (Dauvergne, 1993), a trend that persists today (2020-2024).

However, factually, Indonesia is one of the world's largest nickel producers (Heijlen & Duhayon, 2024; Kranenburg, 2024). Empirical research found around 32 nickel product projects or companies in operation and 20 more under development in Indonesia from 1976 to 2024. The progressive growth of nickel industrialization since 2020 above is due to the policy of banning nickel ore exports to ensure the continuity of industrial raw materials (processing and refining) of nickel, economic growth, employment, and resource sovereignty in Indonesia (Putra & Samputra, 2023).

The policy is outlined in the Minister of Energy and Mineral Resources (ESDM) Regulation Number 11 of 2019 concerning the Second Amendment to the Minister of ESDM Regulation Number 25 of 2018 concerning the Mineral and Coal Mining Business. In the global economic competition, a nickel downstream policy is also urgently needed to support the production of electric car batteries (Korteweg & Kranenburg, 2024). It is a futuristic, renewable transportation technology, and the President Joko Widodo administration has sought to process nickel rather than mine it and sell raw materials at low prices. Therefore, this nickel downstream policy is to advance the circle of industrial and technological economic progress in Indonesia toward becoming a developed country. However, the socio-ecological record of human rights violations and deforestation is a big note in reforming this policy.

The expansion of the nickel industry has caused significant environmental damage. Nickel-rich regions in Indonesia, such as Central Sulawesi. Southeast Sulawesi, and North Maluku, have experienced massive deforestation, soil erosion, and water pollution. Mining processes involving extensive land clearing and nickel extraction from laterite deposits have destroyed essential ecosystems, including rainforests and mangroves (Surdin et al., 2022). In Morowali, for example, extensive deforestation and water pollution have damaged local biodiversity and disrupted the livelihoods of coastal communities dependent on fishing and agriculture.

The environmental impact of nickel mining is also reflected in its contribution to greenhouse gas emissions. Extracting and processing nickel requires enormous energy, thereby increasing carbon emissions. This creates a paradox in which a resource essential for EV battery production, intended to reduce global carbon emissions, contributes to environmental degradation and climate change (Rynaldi et al., 2024). Such contradictions highlight the importance of more sustainable mining practices and stricter environmental regulations. In addition, the social impacts of the nickel industry boom are also of great concern. Local communities, particularly indigenous groups in regions such as South Konawe and North Halmahera, have been forced off their ancestral lands to make room for nickel mines. These communities often experience land displacement without adequate compensation, leaving them economically vulnerable and disconnected from their traditional ways of life. In addition, many of these areas are subject to agrarian exploitation, where mining companies take over agricultural land, exacerbating food insecurity and poverty among the local population.

Health issues are also a significant concern. Communities living near nickel smelting facilities, particularly in Central Sulawesi and Southeast Sulawesi, report increased respiratory illnesses, skin problems, and other health disorders due to the release of toxic chemicals into the air and water. Air pollution from smelting operations, which release sulfur dioxide and other harmful substances. has created a public health crisis in these regions. Residents often lack access to adequate health services and are most affected by these health risks. Despite these issues coming to the fore, efforts to protest the environmental and social damage caused by nickel mining are often met with resistance. Activists and local communities who express their concerns usually face intimidation and legal challenges, with some being criminalized for defending their rights and the environment. This highlights the broader problem of political implications and corruption in the industry, which means that powerful business interests often trump the voices of affected communities (Myllyvirta, 2024).

From a legal perspective, Indonesia's nickel industry has also been criticized for failing to meet corporate social responsibility (CSR) standards. While Indonesia's economic policies are geared towards maximizing profits from its natural resources, there are significant gaps in ensuring that companies operating in the nickel sector respect human rights and mitigate environmental damage. Critics argue that the government's focus on industrial growth has prioritized short-term economic gains over long-term sustainability and the Well-being of local communities (Aulia et al., 2020). In this context, "green crime" emerged to describe illegal and unethical practices in the industry, including deforestation, pollution, and violations of environmental laws (Rynaldi et al., 2024).

The environmental and human rights violations associated with nickel mining are not only a national but also a global problem. As the world shifts to more environmentally friendly technologies, the demand for nickel will continue to increase. This creates a moral dilemma for countries and companies that depend on nickel for EV production. While nickel is essential for reducing carbon emissions and promoting renewable energy, its extraction and processing contribute to environmental damage and social injustice. This underscores the need for a global framework that ensures sustainable, ethical nickel production, balancing economic growth with environmental protection and human rights (Heijlen & Duhayon, 2024).

Strategic economic programs such as nickel downstream need to take into account Article 4 Paragraph (4) of the Fourth Amendment of the 1945 Constitution of the Republic of Indonesia, which states that 'the national economy is based on economic democracy with the principles of togetherness, efficiency, Justice, sustainability, environmentally sound...'. These principles mean that public projects should not externalize costs onto any party; instead, public projects should be run with the principles of togetherness, discussion with all parties, and, most importantly, environmental sustainability. Public policies, such as national strategic projects, may be top-down. Still, the process and objectives must be inclusive, minimizing losses and negative impacts on affected parties while increasing the number of beneficiaries. Labor absorption and industrialization benefits are positive realities of the nickel downstream policy. However, this does not mean ignoring the socio-ecological aspects that are directly affected; the idea and policy of nickel downstream must consider various aspects related to this policy (Baraputri, 2023; Kamarudin, 2018).

Table 11: Analyzing Nickel Downstream through Utilization Theory as Justice

Nickel Downstream Policy with Utilization Theory	Explanation
Provide Subsistence	In providing subsistence, policies must guarantee the protection of the community as an agenda for sustaining life (Bentham, 1914). Increasing the added value of nickel ore or the manufacturing industry's output into finished or semi-finished goods can enhance the economic value (selling value) of nickel ore as a quality export commodity. Smelters are industries that manage nickel ore before it can be reprocessed, but many smelter industries are still entirely dependent on government policy commitments (AA, Interview, 2024). This policy aims to use resources efficiently through value-added programs for processed goods. Technocratic considerations for downstream nickel and a vision of profitable industrialization are underway. Despite plans to utilize deposit nickel to provide a broad chain effect (strategic and complex aspects), this still needs to be resolved. There must be a more measurable and robust plan to maximize the added value in this nickel downstream policy while preventing and minimizing environmental impacts (AAC, Interview, 2024).
Provide Abundance	Policies are required to provide guarantees to the community to create welfare. This is based on the view that human nature is dynamic, so life's needs always arise. Welfare can be created by the efforts to produce a source of livelihood. So, legal products must provide certainty so people can make a living and support themselves (Halevy, 1934). Rivers and beaches indicate whether an industrial activity considers its impact on the surrounding environment. If rivers and streams (upstream or downstream) are polluted, such as changing colour, then industrial management can be considered damaging to the environment due to poor ecological management. Good mining management should not disturb the river or the environment (AAC, Interview, 2024). Waste management (negative externalities) must be implemented to reduce impacts on human health and marine animals. Downstream is a public project that the state must implement to stimulate production. It should not be based solely on short-term gains but should provide the broadest

Nickel Downstream Policy with Utilization Theory	Explanation
	possible benefit to society, the environment, and justice (AA, Interview, 2024).
Attain Equality	The law must be social, cultural. and egalitarian to attain Equality. The principle of Equality is oriented towards Equality of opportunity, not Equality of conditions. The Equality principle can have implications for justice (Schofield, 2009). The downstream policy remains quite exclusive and elitist in its approach to the political process. It does not involve parties representing the scientific community and the general public providing input on the broadest possible benefits and preventing negative externalities (AAC, Interview, 2024). The political process is also biased toward business groups and their relationships with policymakers. Due to the lack of Criticism of Mineral Policy Supervision, the Legislative Body (DPR-RI) is also in a grey area. The implementation of the nickel policy should also ideally be carried out by state-owned companies rather than the private sector, which is the dominant party (AA, Interview, 2024). Compensation should aim to prevent and solve environmental problems affected by nickel industry activities. Corporate social responsibility is not just about compensating for problems or making amends, but also about taking on additional roles or social missions to provide other benefits to society (AAC, Interview, 2024).
Security	Policies need to provide guarantees of security and public order. These two aspects are the ideals of the law itself. Without a security policy, public order cannot be created. Thus, it has consequences for low wealth and no source of livelihood (Bentham, 1914). There is a need for law enforcement (police and prosecution) and a firm overhaul of rules. Environmental pollution and human rights violations can occur due to weak enforcement of corporate accountability rules or because laws do not adequately regulate this accountability (AAC, Interview, 2024). Rules governing the implementation of nickel downstream in the field must be synchronized (not conflicting) and consistently enforced by law enforcement (AA, Interview, 2024).

Source: Author Interview, AA & AAC (2024)

To formulate a fair policy, it is necessary to build a strong relationship between the government and civil society. one that is also oriented toward preventive efforts to reduce conflicts. Suitable policy formulation must be bottom-up (Holqi et al., 2024). The downstream activities of the nickel industry have not considered the adverse impacts and have become part of the ‘structural victimization’ of communities in the Sulawesi and North Maluku regions, especially issues of deforestation, environmental damage, public health, human rights violations, deprivation of living space, and marginalization of women. That nickel refining is highly carbon-intensive (Chan, 2023). Nickel mining can contribute to deforestation or water pollution through improper tailings disposal, especially in Sulawesi and Maluku, where there have been indications of adverse health impacts due to increased ecotoxicity and land being sold without the consent of local communities (Sasongko, 2024).

Labengki Island has not escaped the socio-ecological impacts of the approximately 50 nickel companies operating nearby in North Konawe Regency. Water becomes murky. The ocean is polluted, forests are cleared (for open-pit mining), and marine biota such as coral reefs are threatened, forcing fishermen to sail further to catch fish. Tourism potential is fading, though some residents also receive compensation from the company. However, residents consider that the compensation provided is not proportional to the more significant environmental damage that could persist in the long term. The company's environmental obligations agreed in the Work Plan and Budget with the Ministry of Energy and Mineral Resources still raise questions for residents regarding their implementation (Baraputri, 2023). From the above cases, the issue of nickel downstream policy at the conceptual stage concerns social and ecological justice and must be addressed through several reforms.

5. Conclusions

Based on the results of the above analysis, the researcher concluded that the estimated panel data regression model shows a relationship between the dependent variable (poverty) and three independent variables: Industrial Management. Life Expectancy, and Literacy Rate. The findings suggest a relationship between the dependent variable (poverty) and three independent variables: industrial management, life expectancy, and literacy rates. An increase of 1 unit in industrial processing will increase the percentage of the poor population by 0.001 units, an increase of 1 unit in life expectancy will decrease the percentage of the poor population by 2.113 units, and an increase of 1 unit in literacy rates will decrease the percentage of the poor population by 0.187 units. The results show that although the downstream contribution of nickel from the mining sector is high and positively influential through industrial management, its benefits do not reduce poverty in nickel mining regions. This is due to limited local job opportunities and uneven income distribution. This is motivated by several factors; instead of improving the economy of the surrounding community, downstream actually has negative implications, namely causing farmers and fishermen to lose their livelihoods.

The challenges of nickel downstream policy implementation in Indonesia are that the production boom of processed nickel should ideally 'trickle down', but this project has not successfully addressed poverty. Local resources should be managed with the welfare of the surrounding community in mind, especially at the national level. They should at least help overcome poverty so that it is not just an economic surplus machine 'above the clouds'. Public policies that are supposed to provide aggregate social justice benefits should require evaluation of the allocation of economic benefits from nickel downstream to local communities and of the fulfillment of local communities' rights to the environment affected by the externalities of nickel industry activities. Nickel downstream policies need to minimize environmental impact; they are not based solely on short-term benefits but must provide the broadest possible benefits for society, the environment, and justice. The nickel downstream policy is still elitist, demanding law enforcement (police and prosecution) and firm rule overhaul. The limitation of this study is the continued need for in-depth exploration related to downstream nickel product data (from trade scale) in the GRDP within the nickel production and manufacturing blocks. A deeper understanding of the downstream nickel profit flow in general is still needed to assess the extent of capital surplus in downstream nickel projects. The economic impacts of downstream nickel can flow to local communities and people experiencing poverty, enabling them to accumulate significant income and allocate it to fund economic development.

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