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THE IMPACT OF HUMAN DEVELOPMENT INDEX (HDI), ELECTRICITY AND SANITATION INFRASTRUCTURE AVAILABILITY ON INCOME INEQUALITY IN SUMATERA ISLAND

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Abstract

This research aims to analyze the relationship between the Human Development Index (HDI), the availability of electricity and sanitation infrastructure on income inequality in the island of Sumatera. This research uses panel data from 10 provinces on the island of Sumatra in the 2011-2022 period. This research method used panel data regression analysis using the Random Effect Model (REM). Based on the results of research that has been conducted, it shows that HDI does not have a significant influence on income inequality, the availability of electricity infrastructure has a significant negative influence on income inequality, and sanitation has a significant negative influence on income inequality. The results of this study is expected to serve as a reference for the government in formulating policies aimed at reducing income inequality and improve equitable development on Sumatra Island.

Keywords: ***Income Inequality, Human Development Index, Electricity Infrastructure, Sanitation***

1. INTRODUCTION

A country's economic activities are developed through economic development, which leads to an increase in per capita income and a high level of prosperity. The existence of income inequality is one of the related development issues that cannot be separated from economic development. One of the challenges that Indonesia faces is income inequality. Income inequality in Indonesia has become one of the main problems in the country. First is the lack of fair opportunities that poor families face from the beginning. Second, there are inequalities in the labor market. Third, there are inequalities in the distribution of wealth. Inequality will be driven by communities that own a lot of assets, both now and in the future. Fourth, the poor will be hit hardest when there is a shock, and eventually the ability to earn money will decline (World Bank Group, 2015).

Income distribution inequality in Indonesia is related to the prosperity of people living below poverty and the differences in income per household. This problem is the main focus of Indonesia's economic development because it causes a gap between the low-income group and the middle-income group (Carla et al., 2023). Various factors contribute to income inequality within a region. These factors include variations in the availability of natural resources and variations in demographic conditions, centralized economic focus, mobility of goods and services, and uneven development in various regions. In Indonesia, inequality in the distribution of national income still occurs, and one of the causes is the geographical condition as an archipelago. As a result, many regions, especially remote ones, have not fully felt the impact of national development, thus contributing to national income inequality (Carla et al., 2023). Inequality often occurs in various provinces due to economic disparities Since development has been concentrated on one aspect or

another, various programs have been introduced to address problems such as income inequality and inter-regional inequality, but have not produced significant results in resolving them. In fact, policy designs to increase economic growth have also not yielded adequate results, as they have worsened income inequality and inter-regional inequality (Wahyuni et al., 2014). The island of Sumatra is the focus of the Indonesia, Malaysia, and Thailand Growth Triangle Cooperation (IMT-GT), through this collaboration, it is hoped that the island of Sumatra can become a growth engine for all islands in Indonesia. In the last 5 years, the Gini index in all Sumatra Island provinces has changed the Gini index. According to Badriah (2019) Inequality can arise in the development of a region because of variations in characteristics. and potential of human resources, natural resources, capital flows, development policies from the central government that may be detrimental to some regions, and inappropriate regional planning.

In Sumatra, the main focus is on facilities and infrastructure development. The presence of sufficient human resources, along with electricity and sanitation infrastructure, which are basic daily needs that are not yet affordable in some remote areas, which are factors that hamper the economic activities of local communities and contribute to exacerbating income inequality (Carla et al., 2023). According to Sugiyarto et al. (2015) income inequality and poverty have a clear relationship. This means that income inequality can have a major impact on poverty, and it can be said that inequality is one aspect of poverty. The main factor affecting economic development is human capital, which also impacts the income inequality of a region. The Human Development Index (HDI) assesses the magnitude of the impact. Inequality in HDI leads to income inequality where more developed regions have better quality human capital than less developed regions (Carla et al., 2023).

Infrastructure plays a crucial role as an indicator of economic growth, seen through the impact of infrastructure such as roads, irrigation, electricity, transportation, telecommunications, and water. However, inequality in the availability of adequate infrastructure in various regions also hinders economic development, such as low productivity, hampered social activities, lack of employment opportunities, and increased poverty. The availability of adequate human resources, electricity, and sanitation infrastructure for basic daily needs that cannot yet cover some remote areas is a barrier to people's economic activities and contributes to income inequality (Suparmoko, 2002).

Electricity is one of the most vital infrastructures, as it serves as an energy source for industrial activities involving production and consumption, commercial, and household sectors, thus having a major impact on the continuity of daily activities. When electricity cannot be used for a specific period, serious problems arise that can cause significant losses to a country's economic development (Carla et al., 2023).

The availability of proper sanitation infrastructure is a focus of attention because Mahendradhata et al. (2017) mentioned that one of the essential public health services the World Health Organization (WHO) defines it as access to proper sanitation. Increasing access to proper sanitation reflects an improvement in the quality of life and public health, where with more optimal health conditions and quality of life will provide higher opportunities to increase working time to increase income. Indirectly, this can affect income equality. Based on the above, income inequality seems to be correlated with the following factors: 1. human development index, 2. availability of electricity, and 3. good sanitation. Therefore, The study aims to gain a clearer understanding of the impact of these three factors on income inequality in Sumatra.

2. LITERATURE REVIEW

2.1 Income Inequality

According to Kuznets in Febrianto (2017), income inequality typically rises in the initial stages of development, but as development progresses and reaches more advanced stages, the distribution of income becomes more equitable. In simpler terms, income inequality typically increases during the initial stages of economic growth, but eventually improves. Kuznets explains this pattern using a curve called the Kuznets Curve, an inverted U-shaped curve that illustrates the connection between economic growth and income inequality, often referred to as the "inverted U" curve.

As stated by Todaro in Febrianto (2017), in the short run, the Kuznets Curve indicates a positive the link between economic growth and income inequality, meaning that economic growth leads to greater income inequality. However, over the long term, this relationship becomes negative, suggesting that as economic growth continues, income inequality decreases.

Income distribution shows how the economy is, how the results of the distribution of a country's development among its population whether experiencing inequality or evenness, differences in economic development among regions can lead to problems in their relationships (Reza et al., 2019).

2.2 Human Development Index (HDI)

The Human Development Index (HDI) is a measure used to assess human development in a way that is both measurable and representative. Introduced by the United Nations Development Program (UNDP) in 1990, the HDI provides a comparative evaluation of life expectancy, literacy rates, education, and living standards across different countries worldwide. (UNDP, 2013). The concept of human development is an approach that emphasizes human capital development along with economic growth. Human capital development, both physical and mental, means increasing the basic capacity of the population, which in turn will expand opportunities for participation in the ongoing development process. The Human Development Index (HDI) is an indicator used to evaluate the success of human development within a region (Mahroji, 2019).

The Human Development Index (HDI) serves as a measure of quality of life by using a three-dimensional approach to development, which includes health and longevity, education, and a satisfactory standard of living. These dimensions are crucial as they are associated with various factors. Life expectancy at birth is used as the indicator for the health dimension, while the knowledge dimension is assessed through a combination of average years of schooling and expected years of schooling. For the decent living dimension, the indicator is the purchasing power of individuals for basic food and non-food needs, which is reflected in the average expenditure per capita, serving as an income measure that indicates progress towards a decent standard of living (BPS, 2023).

Under Law No. 33 of 2004, the Human Development Index (HDI) is a measure that indicates the level of public welfare in fundamental services like education, health, and social welfare. The HDI is made up of four indicators: life expectancy, literacy rate, average years of schooling, and purchasing power. HDI can also be used as a reference to measure and evaluate the success of a country; the higher the HDI, the greater the welfare of the people achieved. By improving the quality of HDI, especially in education, a more advanced generation will be formed, and the unemployment rate will be reduced (Marhaeni, 2008).

2.3 Electricity Infrastructure

Electricity is crucial for the development of modern life, powering activities in both urban and rural areas. The demand for electricity continues to grow in line with the social growth of society. Adequate electricity supply is an important requirement for the implementation of economic activities because electricity is a basic necessity in daily life and almost all community activities depend on electricity (Arindini, 2018).

Electrical infrastructure includes all aspects related to power generation, energy transmission, electricity distribution, electrical substations, and other supporting facilities. With the development of the region and population growth, electricity needs are the main aspects that must be met, both in households and the economic sector, especially industry. The increasingly modern life of society makes the use of household appliances increase, office equipment, and community activities are highly dependent on electricity as a source of energy (Wahyuni, 2021).

2.4 Sanitation

Sanitation is an environmental health-oriented disease prevention effort. (Rejeki, 2015). Sanitation therefore refers to the efforts and actions of individuals to maintain a clean and healthy environment. A clean and healthy environment indicates freedom from disease. Thus, creating an environment that prevents the growth of harmful disease-causing bacteria is crucial for protecting

human health. In general, the science of sanitation is the application of principles that aim to improve, maintain, or restore optimal human health. As such, the application of sanitation is essential to have a positive impact on human health (Purnawijayanti, 2001).

Environmental sanitation is related to the high number of diseases that occur every year in the community, which shows that there is still a lot of pollution in the water used daily. (Suriawiria, 2008). Ehler and Steel state that sanitation is an effort to control environmental factors that can trigger the spread of disease. Meanwhile, Azawar states that sanitation is a public health effort that emphasizes technical supervision of every environmental factor that has an impact or potential impact on human health (Isnaini, 2014). According to Law No. 36 of 2009, a socially and economically productive life depends on mental, physical, spiritual and social health. Health affects the quality of human resources, so a person's quality of life can be measured through health aspects. Human resources are the potential within individuals in their role as adaptive and transformational social beings, who are able to manage themselves as well as utilize all natural capabilities in order to obtain prosperity in a balanced and sustainable manner (Masriah & Mujahid, 2011).

The quality of human resources is determined by their health, so if their health is low, it has an impact on low quality which has implications for low productivity. This is because sickness makes it difficult for individuals to focus. A person's economic situation can also be affected by poor health, where poor health can increase medical costs, and make it difficult for them to work effectively (Nadhir, 2017).

Relationship between Human Development Index and Income Inequality

According to research by Mopangga (2011), the Human Development Index (HDI) significantly impacts the source of inequality. Dumairy (2010) also supports this view, explaining that HDI affects regional inequality, with the quality of human development playing a critical role in regional advancement. The economic theory of human capital, developed by Nobel laureates such as Gary Becker, Edward Denison, and Theodore Schultz, suggests that individuals with higher education, measured by the length of schooling, are more likely to secure better jobs and higher salaries than those with lower levels of education. If salary is seen as an indicator of productivity, then individuals with higher education tend to have greater productivity, which ultimately contributes to economic growth (Jhingan, 2016).

Relationship Between Electricity Infrastructure and Income Inequality

Electricity infrastructure is an important energy used for various daily activities. Without electricity, activities can be hampered from an economic or social perspective. The more electricity that is connected, the better economic growth is expected to be, in turn increasing people's income and reducing income inequality. In terms of contribution to the economy, the production sector makes a significant contribution to regional economic activity, especially since agricultural products and plantations are spread across many villages, as well as MSME products that still do not use much technology, partly due to the lack of electricity infrastructure support. The impact is low community welfare and unequal distribution of development results, which in turn leads to high income inequality (Rosmeli, 2018).

Relationship between Sanitation and Income Inequality

Access to sanitation influences income inequality in both developed and developing countries. For numerous low-income households, particularly in developing countries, financial constraints are a key barrier to accessing safe sanitation facilities (Ikeda & Liffiton, 2019). In Indonesia, an increase in the number of households with access to improved sanitation can stimulate economic growth. Proper sanitation access is crucial for supporting a decent standard of living and enhancing public health quality, which in turn affects productivity and economic output in a region. Access to adequate sanitation impacts health conditions and plays a vital role in improving human life quality. This infrastructure is key to enhancing welfare and is an essential factor in reducing income inequality (Wahyuni, 2021).

3. IMPLEMENTATION METHOD

This study investigates the influence of the development index, availability of electricity, and sanitation infrastructure on income inequality on Sumatra Island. This study applies quantitative method by utilizing panel data from 10 provinces in Sumatra Island during 2011-2022.

Utilizing one or more of the input variables (predictor, regressor, independent, explanatory, and exogenous) to describe a response variable (output, dependent, or endogenous) Y is known as regression analysis. The resulting type of regression is called multiple regression if k>1, but simple regression if k=1 The initial equation in this study is:

$$\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e} \quad \text{.....(3.1)}$$

Description:
Y : Variable Y
β_0 : Constant
$\beta_{1\ \beta 2}$: Regression Coefficient for each Variable
X1 : Variable X 1
X2 : Variable X 2
X3 : Variable X 3
i : 10 Provinces on the Island of Sumatra
t : Year
e : Error

Based on equation 3.1 linear regression above, it is transformed into a research model written in equation 3.2 linear regression as follows:

$$\mathbf{KP_{it} = \beta_0 + \beta_1 IPM_{it} + \beta_2 Ls_{it} + \beta_3 Sn_{it} + e_t} \text{.....(3.2)}$$

Description:
KP : Income Inequality
β_0 : Constant
$\beta_{1\ \beta 2}$: Regression Coefficient for each Variable
IPM : Human Development Index
Ls : Electricity
Sn : Sanitation
i : 10 Provinces on the Island of Sumatra
t : 2011-2022
e : Error

4. RESULTS AND DISCUSSION

Descriptive Statistical Test Results

Descriptive statistics show the relationship between variables in a sample and are used to collect scattered data that is important for conducting research with inferential statistical comparisons. This study uses four variables with a total sample size of 120 data. Variable income inequality (KP) through the Gini ratio index, variable human development index (HDI) in percent, variable electricity infrastructure (Ls) in percent, and sanitation (Sn) in percent.

Table 1. Descriptive Statistics

	KP	IPM	Ls	Sn
Mean	0,332667	70,13108	92,32375	66,08917
Median	0,331000	70,00500	94,78000	68,00000
Maximum	0,437000	76,46000	99,69000	92,58000
Minimum	0,247000	64,20000	60,99000	32,37000
Std. Dev.	0,030438	2,475598	7,132833	15,53006
Observations	120	120	120	120

Source: Data results processed (2024)

According to Table 1, there are 120 valid data points for each variable in the income inequality sample. The maximum value is 0.437000, the minimum is 0.247000, and the average is 0.332667 for the period from 2011 to 2022. With a standard deviation of 0.030438, this indicates that the average value exceeds the standard deviation, suggesting a low degree of data variation and a fairly uniform distribution of values.

Chow Test

The Chow test is used to determine the next regression model by assessing whether the Chi-square value is below 0.05, which means the FEM model is accepted, or more than 0.05, which means the CEM model is accepted. The first step is to estimate both models, FEM and CEM, then perform a chow test regression to see which model is appropriate.

Table 2. Chow Test Results

Redundant Fixed Effects Tests
Equation: Untitled
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	19,981004	(9,107)	0,0000
Cross-section Chi-square	118,326903	9	0,0000

Source: Data results processed (2024)

Table 2 indicates that the chi-square probability value is 0.000, which is less than 0.05, meaning that FEM is considered a more suitable model than CEM. Since the Chow test supports FEM as the appropriate model, the next step is to perform the Hausman test.

Hausman Test

The Hausman test is a technique used to determine the most suitable regression model. If the Chi-square value is below 0.05, the FEM model is chosen, whereas if the Chi-square value exceeds 0.05, the REM model is preferred. Prior to performing the Hausman test, estimations are conducted using both FEM and REM.

Table 3. Hausman Test Results

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	2,610177	3	0,4557

Source: Data results processed (2024)

The Hausman test results in Table 4.3 indicate a probability value of 0.4557, which exceeds 0.05, suggesting that the Random Effect Model (REM) is the most suitable model according to the Hausman test. After selecting the REM model based on the Hausman test, the next step is to confirm it through the LM test stage.

Lagrange Multiplier Test

The LM test is used to confirm optimal estimation when applying the Common Effect Model (CEM) or Random Effect Model (REM). This test is crucial when the results from the fixed

effects and random effects models do not align. For instance, if the Chow test suggests the fixed effects model is appropriate and the Hausman test points to the random effects model, the Lagrange multiplier test is then used to determine the best model.

Table 4. Lagrange Multiplier Test Results

	Cross-section One-sided	Period One-sided	Both
Breusch-Pagan	202,3285 (0,0000)	0,640421 (0,4236)	202,9689 (0,0000)

Source: Data results processed (2024)

The Lagrange Multiplier test results in Table 4.4 show a probability value of 0.0000, which is lower than 0.05, suggesting that the Random Effect Model (REM) is the most appropriate model. Thus, the results of the Lagrange Multiplier test confirm that this study employs the Random Effect Model (REM).

Classical Assumption Test Results

Based on the LM test results, the Random Effect Model (REM) is selected for this study. When the REM is chosen, classical assumption tests are not required. The Random Effect Model (REM) uses the Generalized Least Squares (GLS) method for estimation, whereas the Common Effect Model (CEM) and Fixed Effect Model (FEM) rely on Ordinary Least Squares (OLS). A key benefit of the GLS method in the REM model is that it eliminates the need for classical assumption tests. However, if the Common Effect Model (CEM) or Fixed Effect Model (FEM) is used, classical assumptions must be tested (Gujarati, 2012).

Random Effect Model

This model is used to estimate panel data where disturbance variables may be correlated across both time and individuals. In the Random Effect model, differences in intercepts are incorporated through the error components of each entity. Heteroskedasticity is removed once the Random Effect model is applied.

Table 5. Estimation of the Random Effect Model Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0,534509	0,098812	5,409344	0,0000
IPM	-0,000882	0,001823	-0,483837	0,6294
Ls	-0,001021	0,000420	-2,431241	0,0166
Sn	-0,000692	0,000216	-3,209983	0,0017

R-squared	0,509307	Mean dependent var	0,062894
Adjusted R-squared	0,496617	S.D. dependent var	0,020948
S.E. of regression	0,014863	Sum squared resid	0,025624
F-statistic	40,13347	Durbin-Watson stat	1,577933
Prob(F-statistic)	0,000000		

Source: Data results processed (2024)

After processing the panel data, the values obtained from the panel data regression equation are as follows:

$$KP = 0{,}534509\ \alpha - 0{,}000882\ IPM - 0{,}001021\ Ls - 0{,}000692\ Sn$$

The constant value of 0.534509 in the model indicates that when the independent variables HDI, electricity infrastructure, and sanitation are 0 or remain constant, income inequality increases by 0.534509 percent. The coefficient of the HDI variable, -0.000882, shows that this variable has no significant impact on income inequality. The coefficient of the electricity infrastructure variable, -0.001021, suggests that a 1 percent increase in electricity infrastructure results in a 0.001021 percent reduction in income inequality. Additionally, the coefficient of the sanitation variable, -0.000692, implies that a 1 percent increase in sanitation leads to a 0.000692 percent decrease in income inequality.

The REM model shows a coefficient of determination (R^2) of 0.496617, indicating that approximately 49.66 percent of the variation in income inequality can be explained by HDI, electricity infrastructure, and sanitation. Consequently, the remaining 50.34 percent of the variation in income inequality is influenced by other factors, and the rest are influenced by other variables that allow for further study.

F test

The F-test is used to examine the relationship between the independent and dependent variables. The decision is based on the following criteria: If the F-statistic value exceeds 0.05, the independent variables do not significantly influence the dependent variable. However, if the F-statistic value is below 0.05, the independent variables have a significant impact on the dependent variable.

Table 6. F-Test Results

F-statistic	40,13347
Prob(F-statistic)	0,000000

Source: Data results processed (2024)

Based on the F-test, the probability value of the F-statistic is 0.000000, suggesting a significant collective effect of the independent variables on the dependent variable.

t test

The t-test is used to evaluate if the probability is below 0.05. If it is, the independent variable has a significant effect on the dependent variable. However, if the probability is above 0.05, the independent variable does not significantly influence the dependent variable.

Table 7. t-Test Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0,534509	0,098812	5.409344	0,0000
IPM	-0,000882	0,001823	-0,483837	0,6294
Ls	-0,001021	0,000420	-2,431241	0,0166
Sn	-0,000692	0,000216	-3,209983	0,0017

Source: Data results processed (2024)

The analysis of the HDI coefficient reveals that this variable does not influence income inequality in Sumatra. With a coefficient of -0.000882 and a probability value of 0.6294, which is higher than 0.05, it indicates that HDI does not significantly affect income inequality in the region. The panel data analysis reveals a coefficient of -0.001021 for electricity infrastructure, with a t-statistic value of -2.431241, indicating a negative correlation. The probability for electricity infrastructure is 0.0166, which is below 0.05, suggesting that electricity infrastructure significantly negatively impacts income inequality in Sumatra. Likewise, the panel data analysis shows a

coefficient of -0.000692 for sanitation, with a t-statistic of -3.209983, indicating a negative association. The probability for sanitation is 0.0017, which is less than 0.05, signifying a substantial negative effect of sanitation on income inequality in Sumatra.

Coefficient of Determination (R^2)

The coefficient of determination is a test used to measure the strength of the relationship between the independent and dependent variables. It represents the percentage of variation in the dependent variable that is explained by the independent variables.

Table 8. Coefficient of Determination (R^2) Results

R-squared	0,509307
Adjusted R-squared	0,496617

Source: Data results processed (2024)

Based on the coefficient of determination results presented in Table 4.8, the coefficient of determination, or Adjusted R-Square, is 0.496617. This means that HDI, electricity infrastructure, and sanitation together explain 49.66 percent of the income inequality in Sumatra. The remaining 50.34 percent is influenced by other factors not included in the model.

5. CONCLUSION

From the results of the tests and data analysis, it can be concluded that the Human Development Index does not influence income inequality in Sumatra, whereas electricity infrastructure has a significant negative impact on income inequality in the region, and sanitation also significantly reduces income inequality in Sumatra. Although HDI does not show a significant influence in this model, it is important to understand the context and other factors that may influence it. Additional research can be conducted to look for other variables or interactions that can increase the impact of HDI.

Based on the conclusions above, several recommendations can be considered. The government is anticipated to keep improving HDI-based programs in Sumatra by ensuring equal access to education, and providing education and healthcare services to support improvements in quality of life. This can provide long-term benefits in indirectly reducing income inequality. The government and policymakers in Sumatra are encouraged to continue developing and expanding the electricity network, especially in remote areas. The program to improve electricity access should be prioritized, with a focus on renewable energy use to support sustainability. The government is also expected to continue improving public access to adequate sanitation facilities through policies that encourage development in both physical and social infrastructure, primarily to achieve the Sustainable Development Goals In the 2022-2024 National Medium-Term Development Plan (RPJMN), which includes the target of ensuring access to proper sanitation.

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