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Contribution of Infrastructure Development to Gross Regional Domestic Product in All Provinces of Indonesia

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Abstract

Infrastructure development is a key factor in driving economic growth, particularly in developing countries like Indonesia, which face geographical challenges and regional disparities. This study aims to analyse the effect of road, electricity, and clean water infrastructure on Gross Regional Domestic Product (GRDP) across all provinces in Indonesia, with a focus on the dimensions of inclusiveness and spatial equity. The main issue raised is the inequality in infrastructure distribution between regions that hinders equitable economic growth. This study provides a new contribution through a multidimensional approach that not only assesses the economic impact of infrastructure but also takes into account social and sustainability aspects. In addition, the use of cross-section data from all provinces in 2023 and the application of multiple linear regression with classical assumption tests are methodological advantages that have not been widely used in previous studies. The method used is a quantitative approach with multiple linear regression analysis, using secondary data from BPS in 2023. The independent variables consist of road, electricity, and clean water infrastructure, while the dependent variable is GRDP. The classical assumption test was carried out to ensure the validity of the empirical model. The results of the study show that only the electricity infrastructure has a significant effect on GRDP, while road and clean water infrastructure do not have a statistically significant effect. However, all three remain strategically important in supporting long-term development. The conclusion of this study emphasises that infrastructure development must be inclusive and spatially equitable. The government needs to prioritise development in the 3T (frontier, outermost, and disadvantaged) regions and prioritise infrastructure quality, not just quantity, in order to encourage sustainable and equitable economic growth throughout Indonesia.

INTRODUCTION

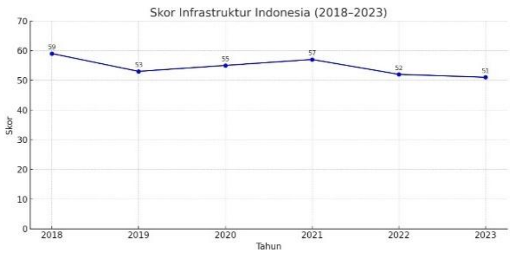
Infrastructure development is a crucial pillar in driving national economic growth. In Indonesia, infrastructure development continues to be a strategic agenda of the government to strengthen connectivity between regions, increase the efficiency of the distribution of goods and services, and strengthen national competitiveness amidst global economic dynamics. However, as an archipelagic country with a large geographical area and a spread-out population, Indonesia faces structural challenges in the equitable distribution of infrastructure development. Inequality between regions is still a central issue, where Java Island tends to get a larger portion of development compared to eastern Indonesia, such as Papua, Maluku, and Nusa Tenggara. This imbalance not only creates disparities in access to basic services and economic facilities but also widens the growth gap between regions, which can ultimately hinder national integration and create structural injustice in development. Therefore, a more inclusive and equity-based infrastructure development policy is needed, so that all regions of Indonesia can grow sustainably and equally (Seidel, 2023). Adequate infrastructure, such as roads, energy, and telecommunications, is believed to be able to encourage increased productivity, attract investment from various parties, and expand public access to essential basic services. Research by Nisa & Khalid (2024) shows that in developing countries, infrastructure investment significantly drives economic growth, especially through the transportation, energy and communications sectors.

In the macroeconomic context, infrastructure is classified as a public good that creates positive externalities for the private sector and households. This public good is non-rival and non-exclusive, meaning that it can be used by many parties without reducing its benefits for other users, and its use cannot be easily restricted (Quiroz Flores & Pfaff, 2021). The provision of infrastructure as a public good is often not properly valued by market mechanisms because its social benefits are not fully reflected in market prices (Czyżewski et al., 2021). Thus, the existence of optimal infrastructure not only provides direct benefits in supporting economic activities but also contributes indirectly to improving the quality of life of the community in general.

Infrastructure as a public good has two main characteristics, namely non-rival and non-excludable, meaning that its use by one party does not reduce its availability for other parties, and cannot be easily excluded from access. This makes the provision of infrastructure unable to be completely left to market mechanisms. In the World Bank Report (1994), infrastructure is classified into three main types. First, economic infrastructure includes physical assets such as roads, dams, irrigation channels, telecommunications, drinking water, and gas. Second, social infrastructure that supports aspects of public health and education, such as schools, hospitals, and parks. Third, administrative infrastructure related to the legal system, public administration, and culture. The Indonesian government also emphasised the types of priority infrastructure through Presidential Regulation Number 42 of 2005, which includes transportation infrastructure, roads, irrigation, drinking water, sanitation, telematics, electricity, and oil and gas transportation. By understanding the character of infrastructure as a public good and the potential to create positive externalities, state intervention in its provision becomes very important. Each user of the infrastructure generally does not pay directly, but still receives collective benefits from it.

In the context of Indonesia, according to data from the Central Statistics Agency (BPS), Indonesia's economic growth in 2023 will reach 5.05%. The transportation and warehousing sector is one of the sectors that experienced

the highest growth, namely 13.96%, which shows the importance of infrastructure in driving national economic activity. The Indonesian government also continues to increase the allocation of the infrastructure budget, with infrastructure spending in the 2024 State Budget reaching IDR 422.7 trillion, reflecting a major commitment to physical development as an economic driver. Infrastructure development has been a strategic priority for the government in recent decades. The government continues to increase investment in this sector, with the allocation of the infrastructure budget reaching more than IDR 400 trillion in 2022, occupying a large portion of the State Budget (APBN) (Reljic & Zezza, 2025). This strategy aims to drive national economic growth by increasing connectivity between regions, reducing logistics costs, and expanding access to basic public services. However, the effectiveness of infrastructure development on national economic growth does not always show consistent and uniform results. Differences in geographical, social, and economic conditions between regions also affect the extent to which infrastructure can drive economic growth. International studies also show that the impact of infrastructure is highly dependent on the type of infrastructure, the quality of implementation, and the local context behind it. For example, a study by Meka'a et al. (2024) in Cameroon revealed that investment in the road and telecommunications sectors contributed significantly to economic growth and private investment, while other infrastructure had limited effects. In contrast, a study in Brazil by Centurião et al. (2024) emphasised that although transport infrastructure can increase short-term GDP, its effects are highly dependent on spatial distribution and the type of policies implemented.
In practice, the value of infrastructure can be seen from the difference in income or costs between areas or economic activities supported and those not supported by the infrastructure. As explained in the Economic Rent Valuation (ERV) method, the provision of public goods such as roads and transportation facilities affects the productivity and income variables of the community endogenously. In this framework, the economic value of infrastructure is not only seen from the cost of providing it, but from the social surplus it generates (Widlak & Peeters, 2025).
As part of the quantitative approach, the following data summarises the basic infrastructure conditions and economic growth in each province of Indonesia in 2023, which will form the basis of the regression analysis in this study.



Source: World Economic Forum (WEF), 2023

Figure 1.
Trend of Indonesia's Global Competitiveness Index 2018–2023

Based on the graph, it can be concluded that the condition of infrastructure in Indonesia in the Global Competitiveness Index 2018-2023 has indeed fluctuated from year to year, but is still ranked 50th in the world with a score of 4.5 on a scale of 7.0. Meanwhile, if we look at the infrastructure quality ranking, Indonesia can be said to still be ranked lower when compared to several other countries in the world, namely Indonesia is ranked 51st in the world in the infrastructure category according to the IMD 2023, with a score of 34.6/100. This shows that in terms of quality and global competitiveness, Indonesia is still at a lower middle level, below developed countries such as Switzerland, Denmark, and Singapore, with a score of 88-100. However, in terms of public satisfaction, around 50% of the public are satisfied, which is a high level when compared to the G7 average (22-43%). In terms of digital connectivity, the 62nd position out of 79 countries reflects the challenges that still need to be overcome, especially in technology adoption and strengthening connectivity. Infrastructure also plays a role in driving economic growth by improving household welfare. A study of road transport infrastructure shows that productive infrastructure investment can simultaneously increase economic growth and welfare. In the Computable General Equilibrium (CGE) approach, effective road infrastructure development can increase GDP while reducing the impact of non-inclusive growth (Tchoffo et al., 2024). According to data from the European Space Policy Institute (ESPI) and Euroconsult cited in Morretta et al. (2023), government investment in high-tech infrastructure such as satellites and Earth Observation systems has experienced significant growth globally. By 2022, around 21% of the 5,467 satellites in orbit will be Earth observation satellites, most of which are funded by the public sector.

Although there have been many studies conducted globally, quantitative studies that examine the influence of infrastructure development on economic growth in Indonesia on a national scale are still relatively limited. In fact, with its broad and complex geographical characteristics and quite large disparities in development between regions, Indonesia has a unique, interesting, and important context for further analysis. In addition, to date, there has been no study that comprehensively discusses the role of infrastructure on economic growth in all provinces in Indonesia, so a study is needed that can provide a comprehensive picture of the contribution of infrastructure in the context of national development.

Based on this background, this study aims to quantitatively analyse the influence of infrastructure development on economic growth in all provinces of Indonesia by using national secondary data from official sources and applying appropriate analysis methods within a certain time span. This study has several novelties that distinguish it from previous studies. First, this study uses cross-sectional data from 2023 from all provinces in Indonesia to measure the relationship between three types of infrastructure and Gross Regional Domestic Product (GRDP). Second, this study integrates a multiple linear regression approach with classical assumption testing (normality, multicollinearity, heteroscedasticity, and linearity) to ensure the validity of the empirical model. Third, there is an emphasis on the dimensions of inclusiveness and spatial equity in infrastructure development, not just pursuing economic efficiency. Fourth, the approach used is multidimensional, not only assessing economic effects, but also considering the social impacts and sustainability of infrastructure development. It is hoped that the results of this study can provide a comprehensive picture of the strategic role of infrastructure in supporting national economic growth and provide a strong empirical contribution in supporting the formulation of more effective, inclusive, sustainable infrastructure development policies that can improve people's welfare in Indonesia. Therefore, it is important to conduct further quantitative analysis to empirically test the contribution of infrastructure to national economic growth. This approach can not only identify the magnitude of the influence of each type of infrastructure on GDP, but also open up space to understand the mediating and moderating variables that can strengthen or weaken the influence. Thus, the results of the study are not only descriptive but can also be used as a basis for formulating evidence-based policies to realise fair, equitable, and sustainable economic development throughout Indonesia.

Paul Romer (1990 stated that long-term economic growth not only depends on the accumulation of physical capital, but also on the role of government in providing public infrastructure, innovation, and improving the quality of human resources. Investment in the public sector, such as infrastructure, will create a multiplier effect that encourages private sector productivity and increases national output sustainably.(Ir and Tarumingkeng 2024). The following is the infrastructure data for each province in Indonesia and Indonesia's economic growth in 2023, which is the basis for the empirical analysis in this study. Infrastructure, according to the endogenous growth theory proposed by Romer (1990), is a key factor in driving increased productivity through the provision of public facilities that support economic activities. In addition, the positive externality theory states that the development of infrastructure such as roads, electricity, and clean water creates indirect benefits for the community and the private sector that are not fully reflected in market prices (Czyżewski et al., 2021). Infrastructure is also classified as a public good, as explained by Samuelson (1954), which is non-rival and non-exclusive, so its role is very vital in supporting equitable development between regions. Therefore, the availability and quality of infrastructure in each province can contribute significantly to regional economic growth.

Table 1
Basic Infrastructure Data and Economic Growth (Real GRDP) in Each Province of Indonesia in 2023

Province	X1_Road Infrastructure %	X2_Electricity Infrastructure %	X3_Clean Water Infrastructure%%	Y_Real GRDP %
ACEH	3.42	1.93	89.74	1.19
NORTH SUMATRA	5.77	5.01	92.19	4.87
WEST SUMATRA	3.25	1.9	85.59	1.54
RIAU	5.38	2.44	90.47	4.46
JAMBI	2.27	1.3	80.02	1.37
SOUTH SUMATRA	2.91	2.79	87.19	2.92
BENGKULU	3	0.74	73.08	0.42
LAMPUNG	3.25	2.96	82.78	2.18
BANGKA BELITUNG ISLANDS	1.63	0.63	81.64	0.49
RIAU ISLANDS	1.72	0.38	92.1	1.62
DKI JAKARTA	12.35	5.86	99.42	16.57
WEST JAVA	4.53	19	93.86	13.49
CENTRAL JAVA	4. 69	13.26	93.76	8.91
IN YOGYAKARTA	1.46	1.66	96.69	0.96
EAST JAVA	3.21	15.39	96.01	14.91
BANTEN	1.65	4.48	92.95	4.1
BALI	1.55	1.91	98.31	1.29
WEST NUSA TENGGARA	2.85	2.13	96.03	0.84
EAST NUSA TENGGARA	5.09	1.34	88.35	0.61
WEST KALIMANTAN	2.95	1.7	82.08	1.25
CENTRAL KALIMANTAN	2.44	0.92	77.72	0.92
SOUTH KALIMANTAN	1.78	1.65	76.29	1.21
EAST KALIMANTAN	1.8	1.4	87.9	4.34
NORTH KALIMANTAN	1.64	0.27	90.19	0.56
NORTH SULAWESI	1.92	0.91	94.37	0.82
CENTRAL SULAWESI	3.16	1.05	86.85	1.56
SOUTH SULAWESI	3.87	3.08	92.12	3.05
SOUTHEAST SULAWESI	2.07	0.89	94.8	0.87
GORONTALO	0.9	0.39	96	0.26
WEST SULAWESI	1.01	0.4	79.86	0.29
MALUKU	1.91	0.37	92.98	0.29
NORTH MALUKU	2.45	0.52	89.01	0.39
PAPUA	2.12	0.62	66.49	1.47

Source: Central Bureau of Statistics 2023

The data presented shows the development of national infrastructure in Indonesia in 2023, covering three main components, namely road infrastructure (X_1), electricity infrastructure (X_2), and clean water infrastructure (X_3), which are then compared with the national economic growth variable (Y). In general, the three infrastructure indicators show a relatively consistent upward trend, reflecting the government's long-term commitment to strengthening the physical foundation of national development. However, this development does not always correlate directly with economic growth trends, which instead show fluctuating dynamics due to the intervention of various external and structural factors. Previous research by Calderón and Servén (2010) showed that increasing the quantity and quality of infrastructure has a positive effect on long-term economic growth in developing countries. Furthermore, Shinta et al. (2019) found that electricity consumption as a representation of energy infrastructure has a significant effect on GDP growth in Indonesia, in line with the findings of Aginta et al. (2023) which showed that equitable electricity distribution increases regional economic added value. On the other hand, Cahyono (2012) stated that clean water infrastructure contributes to labor productivity although its impact is more pronounced in the long term. Meanwhile, Wibowo (2016) stated that road length does not have a significant effect on GRDP if it is not accompanied by an increase in quality, indicating that the effectiveness of infrastructure is highly dependent on its functional aspects and spatial equity.

The increase in road infrastructure, reaching 550,735 units in 2023, indicates a significant expansion of connectivity. This is seen as a strategic effort to facilitate the mobility of goods and services, accelerate logistics distribution, and open up isolated regions. Likewise, electricity infrastructure reached 288,435.75 in the same year. This increase reflects an increase in energy production and distribution capacity, which is a crucial element in driving industrial productivity and improving people's living standards, especially in underdeveloped areas.

Meanwhile, clean water infrastructure has also increased from year to year. In 2023, it reached 4,792,960 units, reflecting attention to basic public needs, both in terms of health and welfare. However, this increase in infrastructure is not directly proportional to economic growth. The economic contraction of -2.07% in 2020, for example, even though it occurred amidst a trend of increasing infrastructure, shows that physical development alone is not enough to guarantee economic resilience, especially when facing a crisis such as the COVID-19 pandemic. On the other hand, the economic recovery in 2022, which peaked at 5.31%, confirms that the impact of infrastructure on economic growth tends to be medium to long term, and is greatly influenced by macroeconomic stability, people's purchasing power, and investor confidence.

This fact shows that infrastructure development is a necessary but not sufficient condition to drive optimal economic growth. There needs to be policy integration involving other supporting factors such as bureaucratic reform, ease of doing business, human resource development, and strengthening fiscal and monetary institutions. In addition, the preparation of infrastructure priorities must be more sensitive to regional disparities. The disparity in development between the western and eastern regions of Indonesia can cause inefficiency in resource allocation and deepen the welfare gap, which in the long term can cause social instability and hinder inclusive growth.

METHODOLOGY

This study uses a quantitative approach with the aim of empirically testing the effect of infrastructure development on national economic growth in Indonesia. This approach was chosen because it is able to measure the relationship between variables objectively and systematically through numerical data and statistical analysis. The type of research used is causal-comparative research, where researchers analyze the causal relationship between independent and dependent variables. The independent variables in this study include road infrastructure (X_1), electricity infrastructure (X_2), and clean water infrastructure (X_3), while the dependent variable is national economic growth (Y) as measured by Gross Domestic Product (GDP). This study uses secondary data obtained from the official publication of the Central Statistics Agency (BPS) in 2023. In addition to GDP data, this study also involves poverty data and basic infrastructure data in all provinces in Indonesia. The methodology used in this study is multiple linear regression, which allows to measure the simultaneous effect of the three independent variables on the dependent variable. Regression analysis is complemented by classical assumption tests including normality tests, multicollinearity, heteroscedasticity, and linearity tests, to ensure the validity of the model used in this study.

The data used is secondary data of Multiple Linear Regression with cross-sectional data for the period 2023, obtained from official publications of the Central Statistics Agency (BPS) and related government sources. Data were collected and analysed using statistical software such as Stata to ensure the validity and reliability of the model.

The analysis model used is multiple linear regression with cross-sectional data. To ensure the validity and reliability of the model, a series of classical assumption tests were carried out including the normality test (Skewness Test) to test whether the data is normally distributed, the multicollinearity test (VIF) to ensure there is no high correlation between independent variables, the heteroscedasticity test (Breusch-Pagan Test) to check the stability of the residual variance, and the linearity test to test the linear relationship between variables. Furthermore, hypothesis testing is carried out through the F test to test the simultaneous effect of independent variables on the dependent variable, and the t test to see the partial effect of each independent variable. The coefficient of determination (R-squared) value is used to assess how much the independent variables are able to explain the variations that occur in the dependent variable.

Through this quantitative approach, the research is expected to provide a strong and accountable statistical picture of the contribution of infrastructure to national economic growth. The results of the analysis will be used to develop data-based policy recommendations in supporting inclusive, equitable, and sustainable infrastructure development.

RESEARCH AND METHOD

For the model using multiple linear regression using the classical assumption tests consist of normality, multicollinearity, heteroscedasticity, and linearity tests.

$$\boldsymbol{PDRB\ Rill_i = \alpha + \beta_1 Inf\ Jln_i + \beta_2 Inf\ Ltrk_i + \beta_3 Inf\ Air_i + \varepsilon_i}$$

$\boldsymbol{PDRB\ Rill_i} =$ *Gross Regional Domestic Product for unit i*

$\boldsymbol{Inf\ Jln_i}$ = *Road Infrastructure for unit i*

$\boldsymbol{Inf\ Ltrk_i}$ = *Electrical Infrastructure for Unit I*

$\boldsymbol{Inf\ Air_i}$ = *Later Infrastructure for unit i*

$\boldsymbol{\alpha}$ = *intercept or constant*

$\boldsymbol{\beta_i}$ = *Egression Coefficient for each variable Inf Jln, Inf Ltrk, and Inf Air.*

RESULTS AND DISCUSSION

RESULTS

Multiple Linear Regression Test

Source	SS	df	MS
Model	32.8673874	3	10.9557958
Residual	8.5108771	29	.293478521
Total	41.3782645	32	1.29307077

Number of obs	=	33
F(3, 29)	=	37.33
Prob > F	=	0.0000
R-squared	=	0.7943
Adj R-squared	=	0.7730
Root MSE	=	.54174

ln_y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_x1	.3608532	.2338884	1.54	0.134	-.1175024	.8392087
ln_x2	.6470391	.1734041	3.73	0.001	.2923878	1.00169
ln_x3	.1872034	.1396995	1.34	0.191	-.0985142	.4729209
_cons	-.3037963	.2169664	-1.40	0.172	-.7475425	.1399498

Table 1.1 Stata data processing results

Classical Assumption Test

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
ln_y	33	0.1945	0.7940	1.88	0.3898
ln_x1	33	0.1593	0.1848	3.97	0.1374
ln_x2	33	0.1546	0.7721	2.28	0.3198
ln_x3	33	0.5529	0.0713	3.86	0.1448

Table 1.2 Stata data processing results

Based on the results of the normality test, it shows that the probability value of all variables is greater than 0.05, so the data is normally distributed.

Variable	VIF	1/VIF
ln_x2	3.83	0.260989
ln_x3	2.86	0.350112
ln_x1	1.71	0.584033
Mean VIF	2.80	

Table 1.3 Stata data processing results

The results of the multicollinearity test show that the VIF value of variable X1 is 1.71 < 10, the VIF value of variable X2 is 3.83 < 10, and the VIF value of variable X3 is 2.86 < 10, so it can be concluded that there are no symptoms of multicollinearity or it passes the multicollinearity test.

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
        Ho: Constant variance
        Variables: fitted values of ln_y

        chi2(1)      =     0.46
        Prob > chi2  =   0.4991
```

Table 1.4 Stata data processing results

The results of the heteroscedasticity test show that the probability value is 0.4991 > 0.05, so it can be concluded that there are no symptoms of heteroscedasticity, or it passes the heteroscedasticity test.

```
Ramsey RESET test using powers of the fitted values of ln_y
      Ho:  model has no omitted variables
                F(3, 26) =      0.93
                Prob > F =      0.4420
```

Table 1.5 Stata data processing results

The results of the linearity test show that the probability value of the variable is 0.4420 > 0.05, so it can be concluded that the relationship between the variables is considered linear or passes the linearity test.

Cross-Section Data Regression Equation

$$\boldsymbol{PDRB\ Rill_i = -0,3037963 + 0,3608532 + 0,6470391 + 0,1872034}$$

The explanation is as follows

a. The Constant Coefficient Value of -0.3037963 or -0.30% indicates that if all independent variables (road infrastructure, electricity, and clean water) are zero, then the GRDP will decrease by 0.30%.
b. Road Infrastructure: The road infrastructure coefficient of 0.3608532 indicates a positive relationship. Every 1% increase in road infrastructure development can increase GRDP by 0.3608532.
c. Electricity Infrastructure: The Electricity infrastructure coefficient of 0.6470391 indicates a positive relationship. Every 1% increase in electricity infrastructure development can increase GRDP by 0.6470391.
d. Clean Water Infrastructure: The clean water infrastructure coefficient of 0.1872034 indicates a positive relationship. Every 1% increase in electricity infrastructure development can increase GRDP by 0.1872034.

Hypothesis Test Results

1. t-Test Results

ln_y	Coef.	Std. Err.	t	P>|t|
ln_x1	.3608532	.2338884	1.54	0.134
ln_x2	.6470391	.1734041	3.73	0.001
ln_x3	.1872034	.1396995	1.34	0.191
_cons	-.3037963	.2169664	-1.40	0.172

Table 1.6 Stata data processing results

Decision-making criteria

- $Jika\ t_{\text{hitung}} > t_{\text{tabel}}$ atau sig $<$ α, maka H_0 ditolak dan H_1 tidak di tolak.
- $Jika\ t_{\text{hitung}} < t_{\text{tabel}}$ atau sig $>$ α, maka H_1 ditolak dan H_0 tidak di tolak.

The influence of independent variables on the dependent variable partially is as follows.

a) The calculated t value of the Road Infrastructure variable (X1) is 1.54 < t table value of 2.04523 and the Prob. value is 0.134 > 0.05, so H1 is rejected and H0 is not rejected, meaning that Road Infrastructure has no effect on GRDP.
b) The calculated t value of the Electricity Infrastructure variable (X2) is 3.73>t table value of 2.04523 and the Prob. value is 0.001 <0.05, so H0 is rejected and H1 is not rejected, meaning that Electricity Infrastructure has an effect on GRDP.
c) The calculated t value of the Clean Water Infrastructure variable (X3) is 1.34 <2.04523 and the Prob. value is 0.001 <0.05. That is 0.191 > 0.05, then H1 is rejected and H0 is not rejected, meaning that Clean Water Infrastructure has no effect on GRDP.

2. F Test Results

Number of obs	=	33
F(3, 29)	=	37.33
Prob > F	=	0.0000
R-squared	=	0.7943
Adj R-squared	=	0.7730
Root MSE	=	.54174

Table 1.7 Stata data processing results

Decision-making criteria

- $Jika F_{\text{hitung}} > F_{\text{tabel}}$ atau sig $< \alpha$, maka H_0 ditolak dan H_1 tidak ditolak.
- $Jika F_{\text{hitung}} < F_{\text{tabel}}$ atau sig $> \alpha$, maka H_1 ditolak dan H_0 tidak ditolak.

The calculated F value is 37.33 > the F table value is 2.934030 and the significant value is 0.0000 <0.05, so H0 is rejected and H1 is not rejected. This means that the independent variable has an effect on the dependent variable.

3. Results of the Determination Coefficient Test R^2

Number of obs	=	33
F(3, 29)	=	37.33
Prob > F	=	0.0000
R-squared	=	0.7943
Adj R-squared	=	0.7730
Root MSE	=	.54174

Table 1.8 Stata data processing results

The Adj R-Squared value is 0.7730 or 77.30%. The coefficient of determination value shows that the independent variable is able to explain the dependent variable by 77.30%, while the remaining 22.70% is explained by other variables.

Analysis of the Influence of Road Infrastructure on GRDP

Based on the results of multiple linear regression data processing, it was obtained that the Road Infrastructure variable (X1) has a t-value of 1.54, which is smaller than the t table of 2.04523, and a probability value (p-value) of 0.134, which is greater than the 5% significance level ($\alpha = 0.05$). Thus, the decision taken is to reject H_1 and not reject H_0, which means that the road infrastructure variable does not have a significant effect on Gross Regional Domestic Product (GRDP) in the region and period studied.

This finding shows that increasing the length or number of road infrastructure does not necessarily have a direct impact on regional economic growth as reflected in the GRDP value. This is in line with the results of previous research by Wibowo (2016), which found that road length did not have a significant effect on GRDP. One of the reasons underlying this phenomenon is that road infrastructure has been relatively adequate quantitatively, especially in areas of economic growth centers. Thus, increasing the length of roads does not automatically increase economic activity if it is not accompanied by an increase in the quality and functionality of the road itself.

In the theory of development economics, especially in the infrastructure approach, government investment in transportation facilities such as highways is considered a form of public capital that can encourage market efficiency and facilitate the flow of goods, services, and labor. However, its effectiveness is highly dependent on the spatial allocation and technical quality of the infrastructure. Long but damaged, narrow, or congested roads will actually reduce economic productivity because they hinder the distribution process and increase logistics costs.

Therefore, these results provide important implications for policy makers: road development should no longer be focused on network expansion (quantity) alone, but rather directed at improving the quality of existing road infrastructure, including road surface improvements, traffic management, lighting, and safety facilities. With proper and well-maintained infrastructure, the flow of goods distribution and population mobility can take place more efficiently, which will ultimately support increased regional economic output.

Thus, it can be concluded that the insignificant influence of road infrastructure on GRDP in this study reflects the need for a more comprehensive development approach, which not only prioritizes quantity, but also functionality and real contribution to regional economic productivity.

Analysis of the Influence of Electricity Infrastructure on GRDP

The results of multiple linear regression analysis show that the Electricity Infrastructure variable (X2) has a t-value of 3.73, which is greater than the t table of 2.04523, with a probability value (p-value) of 0.001 which is much smaller than the significance level of 0.05. Thus, the decision taken is to reject H_0 and not reject H_1, which means that Electricity Infrastructure has a significant effect on Gross Regional Domestic Product (GRDP) in the studied area.

These results support the hypothesis that the availability and increase in electricity capacity as part of basic infrastructure has a direct impact on economic activity. In the context of endogenous growth theory, electricity is an important input in the production process that allows economic activities to run optimally. Without a reliable and adequate electricity supply, various economic sectors such as industry, trade, and services will experience serious obstacles, ranging from decreased productivity to distribution disruptions.

Empirically, this finding is in line with research conducted by Shinta et al., (2019) which shows that household and industrial electricity consumption contributes significantly to economic growth in Indonesia. Their research concluded that every increase in electricity infrastructure encourages the creation of business opportunities, efficiency of production processes, and acceleration of growth in strategic sectors. In addition, Aginta et al., (2023) also found that even distribution of electricity to all corners of the region plays a role in balancing regional economic growth, reducing inequality, and increasing the added value of regional GRDP.

Electricity infrastructure is not only a supporting facility, but has also become a major catalyst in economic transformation, especially in the era of digitalization and technology-based industries. Household industries, MSMEs, and even the informal sector are highly dependent on electricity for daily operations, from lighting, material processing, to information system-based distribution. Therefore, improving the quality and quantity of the electricity network, including efforts to expand electricity access to remote areas, will provide a multiplier effect on macro and micro economic growth.

Thus, these findings strengthen the argument that electricity infrastructure is a vital instrument in sustainable economic development, and needs to be a top priority in national and regional development planning. Investment in this sector will directly contribute to increasing GRDP, accelerating the transformation of productive sectors, and increasing regional competitiveness.

Analysis of the Impact of Clean Water Infrastructure on GRDP

Based on the results of multiple linear regression, it was obtained that the Clean Water Infrastructure variable (X3) has a t-value of 0.134, which is smaller than the t table of 2.04523, and a probability value (p-value) of 0.191, which is much greater than the significance level of 0.05. Thus, the decision taken is to reject H_1 and accept H_0, which means that Clean Water Infrastructure does not have a significant effect on Gross Regional Domestic Product (GRDP) in the period and region studied.

Theoretically, clean water infrastructure is one part of the basic infrastructure that supports the sustainability of life and public health, and contributes to labor productivity. In the framework of sustainable development theory, clean water is an important indicator in the Human Development Index (HDI) and the development of human resource quality. However, the insignificant effect of clean water on GRDP in this study indicates that the direct contribution of this sector to economic growth is not yet sufficiently visible in aggregate in economic output (GRDP).

This finding is in line with the results of research conducted by Cahyono (2012), which states that the influence of clean water infrastructure on economic growth tends to be indirect and requires time to show its impact quantitatively. They assert that clean water contributes more through improving the quality of life, reducing disease rates, and increasing healthy workforce participation. Indirect factors are reflected in the short-term GRDP. In some areas, access to clean water is still limited and has not been integrated with productive sectors, such as industry or agriculture. As a result, the contribution of this sector to economic growth is still potential, not actual.

Thus, although empirically this variable does not have a significant effect on GRDP, the development of clean water infrastructure still needs to be considered as part of a long-term strategy in building the quality of human resources and regional competitiveness. The government needs to encourage synergy between the development of clean water infrastructure and the productive economic sector so that the benefits are not only social, but also provide measurable economic impacts.

DISCUSSION

1. Analysis of the Role of Infrastructure in Driving Indonesia's National Economic Growth.

Infrastructure plays a fundamental role in supporting the economic growth of a country, including Indonesia. Adequate infrastructure, such as highways, electricity, ports, airports, energy, and clean water systems, is are important aspect in driving the smooth running of economic activities Agénor et al., 2025). Without efficient infrastructure, the distribution of goods and services is hampered, logistics costs increase, and national productivity decreases. In Indonesia, the role of infrastructure is becoming increasingly important given the geographical conditions consisting of thousands of islands, which require high connectivity between regions with adequate infrastructure (Sloan et al., 2018). National economic growth is not only determined by the amount of consumption and investment, but also by the availability of inclusive public infrastructure. Infrastructure encourages private investment, creates jobs, and accelerates the flow of trade between regions. When roads and ports are improved, for example, transportation time and costs can be reduced, allowing local products to compete better in national and international markets (Zulkarnain, 2025).

However, it is undeniable that infrastructure development faces challenges, such as disparities between regions. Java Island, as the centre of the national economy, has a much more advanced infrastructure than the Eastern Indonesia region. This inequality causes uneven economic growth. Therefore, infrastructure development must not only be oriented towards productivity, but also towards equitable development, which is not only centralised on one island.

Tsalidis et al.'s (2024) research highlights the importance of considering the social impacts of infrastructure development throughout the project life cycle. Infrastructure development, such as factories and industrial facilities, has a significant impact on local job creation, worker health, and the well-being of surrounding communities. Therefore, infrastructure development must pay attention to the sustainability dimension, not only economic, but also social and environmental (Tsalidis et al., 2024). The importance of a sustainability approach is also reflected in projects that adopt the principles of a circular economy. For example, a desalination plant built in Lampedusa in Tsalidis' case study showed that the construction and operation of infrastructure can contribute up to 75% of a given social impact. This shows that infrastructure development must be planned by taking into account its entire life cycle, not just the operational phase.

On a micro scale, community-based infrastructure interventions or self-built infrastructures, as studied by Nieto-Combariza et al. (2025), show that communities are able to independently create infrastructure that is adaptive to local needs, such as road repairs, lighting, and pedestrian facilities. This complements the absence of the state in providing basic infrastructure in marginal areas (Galeano-Duque, 2024). suburban areas of large cities, where residents often create local solutions to the lack of public infrastructure. This activity can be considered a form of urban improvisation that shows the importance of bringing infrastructure policies closer to the aspirations and needs of the community directly (Purnamasari et al., 2025). This shows how democratisation in local elections and the presence of civil society organisations strengthen the provision of public goods, including basic infrastructure. In the case of slums in Argentina, infrastructure provision is better in areas with a high level of social organisation and democratically elected local representatives (Paniagua, 2022).

An important lesson from this fact is that infrastructure development cannot be separated from the local socio-political context. In areas with high community participation and strong civil society organisations, local governments will be more motivated to provide public infrastructure fairly (Lestari et al., 2025). In other words, good governance is a prerequisite for infrastructure development to have a significant impact on economic growth. The role of infrastructure is also closely related to the development of the industrial sector and national economic competitiveness. Transportation and energy infrastructure, for example, greatly determine production and distribution costs. When infrastructure is poor, logistics costs can reach 23–24% of Indonesia's GDP, much higher than in other countries in ASEAN. Infrastructure improvement is an important path to national economic efficiency (Hartono et al., 2025).

In the tourism sector, the existence of international airports, access roads, and public facilities is are important factor in attracting tourists. Indonesia, which is rich in tourism potential, must rely on infrastructure development to boost the sector's contribution to GDP. Bali, for example, would not have become a major world tourist destination without massive infrastructure development since the 1970s (Yang et al., 2024). Furthermore, infrastructure development also drives digital transformation. The provision of telecommunications networks and broadband internet is crucial to driving an inclusive digital economy. The 3T (frontier, outermost, lagging) regions must be prioritised in digital infrastructure development to reduce the national digital divide (Hakam & Jumayla, 2024).

However, there is a risk that infrastructure development can lead to social exclusion and environmental degradation if not planned properly.

This often happens in toll roads, dams, or industrial area projects that ignore the rights of local communities (Nugroho et al., 2025). Therefore, a participatory approach in infrastructure planning is very important to ensure social justice. Returning to the sustainability framework, infrastructure built with the principles of energy efficiency, minimal emissions, and long-term orientation will create green growth, which is the direction of Indonesia's future economic policy. Investment in environmentally friendly infrastructure, such as renewable energy and low-carbon public transportation, is a strategic step towards Indonesia Emas 2045.

2. The Impact of Inequality in Infrastructure Development Between Regions on Economic Disparities in Indonesia.

The disparity in infrastructure development between regions in Indonesia, especially in terms of roads, electricity, and clean water, is one of the structural problems that is still a major challenge in realizing equitable national development. As an archipelagic country with more than seventeen thousand islands, the disparity in the provision of basic infrastructure contributes significantly to increasing social and economic disparities between regions (Permana et al., 2025).

Infrastructure development focused on certain areas, especially Java Island as the centre of economic and administrative activities, has created a striking gap in inequality with other regions, especially in eastern Indonesia. This inequality is visible from the quality and quantity of the road network, the availability of a stable electricity supply, and access to clean water (Abstracts, 2021).

Adequate road infrastructure plays a vital role in connecting production areas with consumption markets. In areas with developed infrastructure, connectivity between regions runs smoothly, distribution of goods becomes efficient, and logistics costs can be reduced. Conversely, in areas with damaged, unpaved, or even non-existent roads, economic activities are hampered. Difficult access reduces the competitiveness of local products, increases production costs, and limits investment flows and labor mobility (Wang et al., 2025).

The availability of electricity is also a primary prerequisite for the development of small industries, services, and the household sector (Wilson, 2025). Areas with good access to electricity tend to have higher productivity and are able to attract more formal economic activities. On the other hand, remote and underdeveloped areas that have not been evenly electrified experience economic stagnation because business activities are limited to the informal sector or on a subsistence scale (Graham, 2025). The same thing happens with access to clean water, which is not only an indicator of welfare but also has a direct impact on population productivity. Lack of clean water worsens public health conditions and increases the cost of living, which ultimately reduces labour productivity and widens socio-economic disparities.

This infrastructure inequality also exacerbates the migration of people from villages or underdeveloped areas to economic centres. Uncontrolled urbanisation causes high pressure on city infrastructure, such as traffic jams, clean water crises, and slum explosions. Meanwhile, villages or areas of origin experience decreased productivity due to the loss of potential labour (Rediansyah et al., 2023).

From a national development perspective, the disparities in roads, electricity, and clean water create serious obstacles to inclusive and sustainable development (Nalle, 2022). When most of the budget and infrastructure projects are concentrated in areas with high political and economic bargaining power, other areas with low fiscal capacity are marginalised. This indicates an imbalance in the allocation of public budgets that needs to be immediately addressed through reform of the central-regional financial balance system (Tulchinsky et al., 2023).

The long-term impacts of this inequality are very serious: regional economic stagnation, increasing poverty rates, and a low Human Development Index (Siti Kharisatul Ulya et al., 2025). Regions that are not adequately served by basic infrastructure will continue to lag and rely on central fiscal transfers, creating an unhealthy pattern of structural dependency (Uzar & Eyuboglu, 2025).

The inequality of basic infrastructure, such as roads, electricity, and clean water, also has a geopolitical dimension. Border areas and outer islands with minimal access to infrastructure are very vulnerable to the threat of disintegration, smuggling, and illegal exploitation of resources (Ariansyah et al., 2023). Therefore, equitable infrastructure development must also be seen as a national resilience strategy.

To address this challenge, it is necessary to integrate basic infrastructure development with strengthening the local economy. Roads built must open market access for local products. Electricity distributed must support productive activities, not just household consumption. Clean water must reach areas that have previously experienced sanitation vulnerabilities (Wiratama et al., 2023). Development planning also needs to actively involve local governments and communities so that infrastructure projects truly address local needs, not just symbolic projects from above (Hutabarat & Shields, 2024).

In addition, synergy between the central government, state-owned enterprises, the private sector, and public-private partnership (PPP) schemes can accelerate the distribution of infrastructure. However, in its implementation, regulations that favour the public interest and the principles of transparency and accountability must be the main foundation so that development is not only fast but also equitable.

3. Inclusive Infrastructure Development Policy: Challenges and Opportunities in Realising Equitable Social Welfare

Inclusive infrastructure development is an important strategy in realising equitable social welfare amidst Indonesia's geographic and demographic complexity (Al-Zu'bi et al., 2025). In this context, road, electricity, and clean water infrastructure are not just technical facilities, but important instruments to bridge social gaps, strengthen social cohesion, and open access to a decent life for all citizens, especially for groups that have been marginalised (Yeboah et al., 2024).

These three types of basic infrastructure play a key role in addressing inequality. Roads open up regional connectivity, connecting disadvantaged areas with economic centres and public services. Electricity enables productivity and access to information and technology (Lipper & Cavatassi, 2024). Clean water is a fundamental need that is directly related to the health and quality of life of the community. Therefore, inclusive infrastructure development policies must ensure that access to roads, electricity, and clean water is available fairly, especially for the poor, people with disabilities, indigenous groups, women, and residents in disadvantaged, outermost, and frontier (3T) areas (Harahap et al., 2025).

However, the implementation of inclusive basic infrastructure development still faces major challenges. One of the main challenges is the inequality in infrastructure distribution between regions (Susilowati et al., 2025). Developed areas tend to get priority for development, while remote areas are often left behind. This inequality is evident from the condition of damaged or unbuilt roads, areas that are still dark without stable electricity, and limited access to clean water in many villages and poor settlements. This inequality has a direct impact on mobility, economic productivity, and the quality of life of the community (Sha & Taeihagh, 2024).

Another challenge is the lack of community participation in the planning and implementation of infrastructure projects (Spencer et al., 2023). Many village roads, electricity installations, or clean water supply projects are built without dialogue with residents, so they do not address real needs and even risk causing social conflict. Top-down approaches often ignore the local social, cultural, and ecological context, resulting in unsustainable projects (Shobande et al., 2025).

In urban areas, basic infrastructure development also often triggers social exclusion. Road widening projects or the construction of new water and electricity networks sometimes displace poor people's settlements without fair compensation (Yeboah et al., 2024). As a result, vulnerable groups are increasingly excluded from access to basic infrastructure and the economic opportunities that come with it.

Therefore, inclusive infrastructure development policies must be based on the principles of spatial and social justice. This means that road, electricity, and clean water infrastructure must be a priority in areas that have been marginalised. Equal access is not just technical justice (Triono, 2024). But also a form of recognition of the basic rights of citizens. Indicators of development success are no longer measured by the length of roads or the number of electricity connections, but by how much the community's quality of life has improved due to the presence of this infrastructure (Spencer et al., 2023).

The great opportunity to realise inclusive infrastructure lies in technological advances and strengthening data-based information systems. The government can utilise digital technology, such as geographic information systems (GIS) and big data, to map areas that lack roads, electricity, and clean water more accurately (ELVIANDRI, 2019). This will facilitate budget allocation that is right on target and based on the actual needs of the community.

In addition, multi-party cooperation schemes are key to expanding the scope and increasing the sustainability of basic infrastructure development. Collaboration between central and regional governments, the private sector, civil society organisations, and local communities can accelerate the construction of village roads, electricity connections per household, and community-based clean water projects. The community-based infrastructure model has been proven to be able to encourage a sense of community ownership and ensure sustainability because it is built based on local needs (Zulaika & Trisakti, 2022).

Institutionally, various national policies such as the Village Law, Special Allocation Fund (DAK), and national strategies related to the development of 3T regions can be used as a legal and fiscal framework to encourage inclusive basic infrastructure development. However, realisation in the field still requires strict supervision, budget transparency, and political commitment from stakeholders (Rothenberg et al., 2025).

Affirmative policies must also be strengthened so that vulnerable groups are no longer spectators of development. Examples include prioritising the development of clean water and electricity networks in customary areas or disaster-prone areas, building disability-friendly roads in rural areas, and improving roads and drainage in densely populated urban poor areas.

From a sustainable development perspective, the construction of roads, electricity, and clean water must also meet the principles of environmental friendliness and climate resilience. Roads built must consider disaster risks, electricity networks must

encourage renewable energy, and clean water projects must maintain the sustainability of local water sources (Suryawan et al., 2025).
Indonesia has great potential to be a pioneer in inclusive basic infrastructure, in line with its commitment to the Sustainable Development Goals (SDGs), especially goals 6 (access to clean water), 7 (clean energy), 9 (infrastructure), and 10 (reduced inequality). With the right approach, the development of basic infrastructure such as roads, electricity, and clean water will not only increase economic growth but also strengthen social justice and national integration.

CONCLUSION

Infrastructure development plays an important role in driving regional economic growth in Indonesia. This study found that of the three types of infrastructure studied, roads, electricity, and clean water, only electricity infrastructure has a significant effect on Gross Regional Domestic Product (GRDP). Meanwhile, road and clean water infrastructure have not shown a statistically significant effect, although theoretically they remain important in supporting economic resilience and community welfare. Overall, the infrastructure variables in this study are able to explain most of the variation in regional economic growth, although there are still other factors such as governance, investment climate, and institutional efficiency that also need to be considered. Other findings show that there is an imbalance in the distribution of infrastructure between regions, especially between the western and eastern regions of Indonesia, which can widen the development gap and hinder inclusive growth. Therefore, future infrastructure development policies need to emphasize the principles of spatial justice, community participation, and data-based planning and local needs. Inclusive infrastructure, especially in the 3T (frontier, outermost, and disadvantaged) regions, is expected to not only increase connectivity and productivity, but also strengthen social and national integration. This research provides an empirical contribution in supporting the formulation of evidence-based infrastructure development policies to encourage fair, equitable, and sustainable economic growth throughout Indonesia.

Thus, this study provides an important empirical contribution in supporting the formulation of evidence-based infrastructure development policies to encourage fair, equitable, and sustainable economic growth throughout Indonesia.

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