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Assessing the Quantitative Relationship between Economic Infrastructure and Economic Expansion

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Abstract:
Economic growth is a crucial pillar of regional development and serves as an indicator of how well development is going, as well as a tool for future planning. Development will not proceed easily if the infrastructure is poor, and a nation or region's economic activity will not be sufficient if the infrastructure is insufficient. Throughout the years 2018 to 2023, Probolinggo Regency's economic growth rate had erratic variations. Therefore, the purpose of this study is to ascertain how Probolinggo Regency's road network, access to clean water, and availability of power affect economic growth. This study's methodology was quantitative and deductive in nature. The information used is secondary data, specifically time series data from the Central Bureau of Statistics. Using multiple linear regression analysis and the OLS (Ordinary Least Squares) data analysis method, SPSS 24 was utilized to conduct the study's data analysis. Where the value is significant > 0.05, the study's findings show that infrastructure for roads, water, and power has no bearing on economic growth.

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INTRODUCTION

Regional inequality and underdevelopment are structural challenges that significantly impact national development goals. The government places a strong emphasis on this to promote inclusive and sustainable growth. Accelerating the restoration of basic health services, education, and infrastructure is one program aimed at restoring economic growth through the serious development of agropolitan, minapolitan, tourism, industrial, and creative economy areas (Alexandro & Basrowi, 2024; Deng et al., 2021; Sain, 2025). Through social protection, this program also aims to reduce disparities between regions and poverty. Based on Presidential Regulation no. 42 of 2005, a Committee for the Acceleration of Infrastructure Provision was formed, which lists various forms of infrastructure, including roads, irrigation systems and drinking water, as well as oil and gas infrastructure, electricity and sanitation, the provision of which is regulated by the government (Setiawan et al., 2024; L. Wang et al., 2024). Currently, 122 districts in Indonesia are still considered underdeveloped, most of which are located outside Java.

To date, the Ministry of Public Works and Public Housing (PUPR) has continued its work program by spending its budget on PUPR infrastructure, such as dams, roads, bridges, irrigation, and sanitation, infrastructure in strategic tourism areas, regional organizations, and drinking water systems. In response to the COVID-19 pandemic, low-income housing was built to increase competitiveness and support the National Economic Recovery (PEN) (Getachew et al., 2024). This program focuses on infrastructure development by involving local communities as actors, particularly in simple non-technical work or small-scale infrastructure. P3TGAL, OP, and swamp irrigation,

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routine road and bridge maintenance, road drainage revitalization, and Islamic boarding schools are examples of such projects (Alexandro, 2024; Tampekis et al., 2023). Economists argue that the most effective strategy for reversing economic decline is to increase the rate of economic growth, also known as gross domestic product growth, to a level higher than the rate of population growth. This would increase per capita income, thereby improving people's living standards. Therefore, achieving a high rate of economic growth is the primary goal of economic development (Aziz, 2024). For the benefit of the people, continuous infrastructure improvements and bureaucratic reform are necessary.

The Probolinggo Regency Government will, among other things, strengthen sustainable infrastructure by continuing to empower and build long-term infrastructure such as roads. In addition, several targets to be achieved by 2023 include a community peace index of 1.36 percent, a maternal development index (HDI) of 67.83 percent, and a reduction in the open subscription rate to 2.75 percent. The poverty target was then lowered to 16.21 percent, economic growth to 3.67 percent, and infrastructure service affordability to 67.76 percent. Infrastructure is seen as a critical component in the process of achieving high economic growth, given Probolinggo Regency's long history of economic growth. Therefore, additional efforts are needed to ensure that infrastructure development continues to increase annually. The development of roads, water, electricity, and GRDP is outlined in Table I below.

Table 1. Development of Roads, Water, Electricity, GRDP in Probolinggo Regency 2019-2021

Gross Domestic Product	**Economic Growth by Business Sector (Percentage)**		
Business Sector	2019	2020	2021
Roads	4.47	-6.11	2.07
Water	4.02	3.24	0.99
Electricity	5.18	0.72	1.85
Gross Regional Domestic Product (GRDP)	4.56	-2.12	3.35

It can be seen that the GRDP in Probolinggo Regency reached 4.56 million people per capita in 2019, and decreased by -2.12 million people in 2020. In 2021, the GRDP increased again to around 3.35 million people per capita. This was due to the COVID-19 outbreak, which resulted in a decline in national income in 2020. Furthermore, with the stabilization of national income in the following year, the GRDP was increased to aid government policy formulation and to periodically compare economic conditions between regions or provinces.

GRDP is part of the overall regional development, including infrastructure. This is because infrastructure is one of the investments or sources of regional income. Table 1 shows that road infrastructure is always changing. Compared to the previous year, roads experienced a -6.11 percent decline in 2020. Then, roads experienced a 2.07 percent increase in 2021. Water infrastructure in Probolinggo Regency also experienced a decline annually (Bai et al., 2022). It decreased by 3.24 percent in 2020 and 0.9 percent in 2021 between 2019 and 2021. The electricity infrastructure in Probolinggo Regency experienced a decline. The increase in the number of customers has not been able to driven an increase in electricity sales. Electricity sales in 2019 were 5.18% and 1.85% in 2021 (Xia et al., 2023; Yang et al., 2023). This decline in sales was due to the PSBB policy, which was extended several times, and the implementation of strict health protocols by the Government, resulting in depressed electricity sales figures for industrial and business customers until the end of the year.

In general, the significant increase in public spending on infrastructure indicates that the various effects of infrastructure on the economy have a multiplier effect, driving high growth. Both directly and indirectly, infrastructure plays a significant role in various economic, social, and political spheres. By providing necessities such as roads, water, electricity, and so on, infrastructure also improves socioeconomic conditions (Carvalho et al., 2022). The creation or expansion of household, business, and government activities, as well as the availability of adequate infrastructure, are expected to drive economic growth. To help improve the welfare of the people of Probolinggo Regency,

research is needed on the impact of economic infrastructure, such as roads, electricity, and clean water, on GRDP (Gross Regional Domestic Product).

Infrastructure development is a key factor in driving economic growth, particularly in areas like Probolinggo Regency, where sectors such as roads, air transportation, and electricity directly contribute to Gross Regional Domestic Product (GRDP). The decline in GRDP in 2020 due to the COVID-19 pandemic demonstrated the vulnerability of the regional economy to external crises. However, the recovery in 2021 demonstrates that appropriate infrastructure investment can accelerate economic recovery. This study seeks to delve deeper into the relationship between infrastructure development and GRDP in Probolinggo, providing insight into the multiplier effects that infrastructure can generate in supporting economic growth. The originality of this study lies in its specific focus on the economic conditions of Probolinggo and its contribution to understanding how infrastructure investment can drive sustainable economic growth in the region.

RESEARCH METHOD

This research uses a quantitative research design with a case study approach (Stefan et al., 2022). The quantitative approach was chosen because the primary objective of this study is to measure the relationship between economic infrastructure (roads, water, electricity) and economic growth, as represented by the Gross Regional Domestic Product (GRDP) of Probolinggo Regency. The case study approach was chosen to provide an in-depth analysis of the dynamics occurring in the region from 2018 to 2022, as well as to understand the specific impact of infrastructure development on local economic growth. This design also allows for the collection of numerical data that can be statistically analyzed to obtain more objective and measurable results.

The location of this research is Probolinggo Regency, East Java, which was chosen due to its challenges in infrastructure and economic development, particularly post-COVID-19 pandemic. This location was also chosen because of the importance of understanding how infrastructure development in the region directly impacts economic growth. Probolinggo has significant potential in economic sectors such as agriculture, tourism, and industry, which are highly dependent on basic infrastructure like roads, water, and electricity. Furthermore, Probolinggo is a region that still experiences development inequality, making it a relevant location for analysis of the relationship between infrastructure and economic growth.

The data collection technique used in this study was secondary data obtained from various reliable sources, including the Central Statistics Agency (BPS), PLN (State Electricity Company), PDAM (Regional Drinking Water Company), and other official publications (Abigail Soesana, 2023). The data collected included economic infrastructure indices, such as roads, water, and electricity, as well as data related to Probolinggo Regency's Gross Regional Domestic Product (GRDP) for the period 2018 to 2022. This data was obtained by downloading annual reports and statistical data published by these institutions, providing valid and up-to-date information for analysis purposes.

Data analysis was conducted using multiple linear regression, t-test, F-test, and coefficient of determination (R^2) using SPSS version 24 software. This analysis process involved several stages: first, data condensation, which involved summarizing the raw data for easier analysis; Second, data reduction, which filters the data to focus only on relevant variables such as economic infrastructure (roads, water, electricity) and GRDP; third, data display, which presents data in tables and graphs to visualize the relationships between variables; and fourth, data verification, which aims to test the accuracy of the data by comparing existing data with other sources and conducting statistical tests to ensure data consistency.

Data validity will be checked through several checking techniques, including triangulation, which involves comparing data from various sources to ensure consistency, and secondary data checking, where data from the Statistics Indonesia (BPS) and related agencies will be checked for consistency with existing data (Ratna, 2021). Furthermore, statistical validity will also be tested using validity and reliability testing techniques to ensure the data used is reliable and consistent in the regression analysis. With these steps, this research aims to produce valid and accountable findings

that illustrate the relationship between infrastructure development and economic growth in Probolinggo Regency.

RESULT AND DISCUSSION

Result

Classical Assumption Test

Normality Test

Before proceeding with the regression analysis, it is important to ensure that the data used meets the basic assumptions of regression analysis, one of which is the normal distribution of residuals. Therefore, a normality test is performed to verify whether the residual data from the regression model is normally distributed. This test aims to ensure that the model's prediction errors have an appropriate distribution, ensuring reliable regression analysis results.

Table 2. Normality Test Results

	Unstandardized Residual
Asymp.Sig. (2-tailed)	0.200

Source: Data Processed by SPSS 24, 2023

Before proceeding with the regression analysis, it is crucial to ensure that the data meet basic assumptions, one of which is the normal distribution of residuals. A normality test is conducted to verify whether the residuals generated by the regression model are normally distributed. This normality assumption is crucial because if the residuals are not normally distributed, the results of the regression analysis can be biased and unreliable. Therefore, a normality test is a necessary initial step to ensure the regression model produces valid results. Below are the results of the normality test conducted in this study to ensure the feasibility of further analysis.

The results of the normality test show a significance value (Asymp.Sig.) of 0.200, which is greater than 0.05. This value indicates that the residuals from the regression model are normally distributed, indicating no violation of the normality assumption. Therefore, we can conclude that the data used meet the requirements for further regression analysis. Meeting this normality assumption is important because it ensures that the model can produce more accurate and accountable estimates. This strengthens the validity and reliability of the research results.

Multicollinearity Test

Before proceeding with further regression analysis, it is important to ensure that the model is free from multicollinearity, which can affect the stability of the regression coefficient estimates. A multicollinearity test is performed to check for strong relationships between independent variables in the model that could distort the analysis results. This test uses two main indicators: the tolerance value and the Variance Inflation Factor (VIF), to ensure that multicollinearity is not present. The following presents the results of the multicollinearity test performed on this regression model to evaluate the feasibility of further analysis.

Table 3. Multicollinearity Test Results

Model	Collinearity Statistics	
	Tolerance	VIF
Road	.655	1,526
Water	.702	1,424
Electricity	.769	1,301

Source: SPSS Processing Data 24, 2023

The multicollinearity test results show a tolerance value greater than 0.10 and a VIF (Variance Inflation Factor) value less than 10.00. This indicates that there are no multicollinearity issues in this regression model. Multicollinearity occurs when there is a very strong relationship between independent variables, which can affect the stability of the regression coefficient estimates. With a high tolerance value and a low VIF, it can be concluded that there is no excessive correlation between the independent variables in this model, allowing for more reliable regression analysis.

Successfully avoiding multicollinearity issues is crucial because it ensures that each independent variable can contribute significantly to the model without influencing the others. When multicollinearity is avoided, regression coefficient estimates will be more accurate, allowing the model to provide clear and valid interpretations. Therefore, this multicollinearity test showing good results confirms that the regression model used has a sound structure and is not distorted by the relationships between the independent variables.

Heteroscedasticity Test

Before proceeding with the regression analysis, it is important to verify that the model meets the assumption of homoscedasticity, meaning that the error variance remains constant across all observations. To achieve this, a heteroscedasticity test is performed to identify any inconsistencies in the error variance. If heteroscedasticity is present, the regression analysis results may be distorted, invalidating the conclusions. This test uses chi-square to assess whether the error variance fluctuates significantly. The following are the results of the heteroscedasticity test conducted in this study to ensure the feasibility of the regression model used.

Table 4. Heteroscedasticity Test Results

R Square	0.999
chi-squarecount	4,995
chi-square table	5,991

Source: SPSS Processing Data 24, 2023

The heteroscedasticity test results showed an R-square value of 0.999 and a calculated chi-square value of 4.995, while the table chi-square value was 5.991. Based on the comparison between the calculated chi-square value and the table chi-square value, it can be concluded that there is no heteroscedasticity problem in this model. Heteroscedasticity occurs when the error variance is not constant across observations, which can affect the accuracy of the regression model's estimates. Since the calculated chi-square value is smaller than the table chi-square value, this indicates that the regression model used does not experience heteroscedasticity.

With the absence of heteroscedasticity problems, the results of this regression analysis are reliable. This ensures that the error variance in the model remains constant, which is an important assumption in regression. A model that does not experience heteroscedasticity will produce more accurate and reliable coefficient estimates, making the interpretation of the regression analysis results more valid and accountable in the research context.

Autocorrelation Test

Before proceeding with further regression analysis, it is important to check for autocorrelation issues in the model used. Autocorrelation refers to the relationship between residuals (prediction errors) from one period and residuals from another period, which can affect the reliability of the regression results. An autocorrelation test is performed to ensure that model errors are not influenced by previous values, which can lead to biased or unstable estimates. The following are the results of the autocorrelation test conducted in this study to verify the feasibility of the regression model before proceeding with further analysis.

Table 5. Autocorrelation Test Results

	Unstandardized Residual
Asymp.Sig. (2-tailed)	.913

Source: Data Processed by SPSS 24, 2023

The autocorrelation test results showed a significance value (Asymp.Sig.) of 0.913, which is greater than 0.05. This indicates that there is no autocorrelation problem in this regression model. Autocorrelation occurs when residuals (prediction errors) from one time period are related to residuals from another time period, which can undermine the validity of the regression model. The absence of autocorrelation ensures that the model's residuals are unaffected by previous values, resulting in more stable and accurate regression coefficient estimates.

By meeting the assumption of no autocorrelation, subsequent steps in the regression analysis can be performed with greater confidence. This strengthens the validity of the model, as low or no autocorrelation means the regression model can provide more reliable predictions. Therefore, the results of this autocorrelation test provide a strong basis for continuing the regression analysis and drawing more accurate conclusions from the analyzed data.

Regression Multiple Linear

Before proceeding with further analysis, a multiple linear regression test was conducted to identify the relationship between the independent variables, namely water and electricity infrastructure, and the dependent variable representing economic growth. This test aims to determine the extent to which each independent variable simultaneously influences the dependent variable. Using data processed using SPSS version 24, the results of this multiple linear regression test provide insight into the contribution of each infrastructure factor to economic growth. The following are the results of the multiple linear regression test conducted in this study.

Table 6. Multiple Linear Regression Test Results

Water	34,158	11,444	1,128	2,985	.206
Electricity	31,037	51,082	.198	.608	.652

Source: Data Processed by SPSS 24, 2023

The regression equation obtained from this analysis is Y = 106664335.800 (a) - 14.885 (X1) + 34.158 (X2) + 31.037 (X3). The constant value of 106664335.800 indicates that if independent variables such as road, water, and electricity infrastructure are held constant, then economic growth, represented by the symbol Y, is 0.0106664335.800 percent. In other words, even if there is no change in these variables, economic growth can still be influenced by other factors, which can be explained by the constant value in the regression equation.

In this analysis, variable X1 (road infrastructure) has a negative regression coefficient of -14.885, indicating that if road infrastructure increases, economic growth (Y) will decrease, and vice versa. Meanwhile, variable X2 (water infrastructure) has a positive regression coefficient of 34.158, meaning that improvements in water infrastructure will also increase economic growth. Meanwhile, variable X3 (electricity infrastructure) has a positive regression coefficient of 31.037, indicating that improvements in electricity infrastructure will contribute to increased economic growth. However, if X3 decreases, Y will also decrease.

Hypothesis Testing

F Test

Before proceeding with further analysis, an F-test was conducted to determine whether the overall regression model was significant in explaining data variability. This F-test aims to simultaneously evaluate the relationship between the independent variables (road, water, and electricity infrastructure) and the dependent variable (economic growth). Using data processed through SPSS version 24, the F-test indicates whether the regression model can effectively predict the dependent variable. The following are the results of the F-test conducted to test the significance of this regression model.

Table7. F Test Results

Mode	l	Sum of Squares	df	MeanSquare	F	Sig.
1	Regression	2840868762000	3	9469562540000	3,040	.394
		00,000		0.000		
	Residual	3115033041000	1	3115033041000		
		0.000		0.000		
	Total	3152372066000	4			
		00,000				

Source: Data Processed by SPSS 24, 2023

It is known that the significance value (sig.) of the F test is 0.0394, which is greater than 0.05. This indicates that the independent variables (road, water, and electricity infrastructure) simultaneously do not have a significant effect on the dependent variable (economic growth). In other words, although these variables have a relationship with economic growth, their influence is not strong enough overall to explain the variability of economic growth in this regression model. Therefore, these results suggest that factors other than infrastructure need to be considered to significantly influence economic growth.

Test t

Test Analysis T

Based on the t-test results, variable X1 (road infrastructure) does not have a significant effect on variable Y (economic growth) because the significance value (sig.) is 0.303, which is greater than 0.05. This indicates that changes in road infrastructure do not directly affect economic growth in this regression model. Although road infrastructure is important for supporting economic activity, in this study, its influence is not significant enough to be a major determinant of economic growth.

The t-test results also show that variables X2 (water infrastructure) and X3 (electricity infrastructure) have significance values of 0.206 and 0.652, respectively, both greater than 0.05. This means that neither water nor electricity infrastructure has a significant effect on economic growth (Y) in this model. Although both sectors are important for supporting the economy, these results indicate that their influence on economic growth is not statistically strong enough. Therefore, other factors may need to be considered to explain the improved economic growth.

X1 has a significant effect on variable Y because of its significance. Value is 0.303 > 0.05.

X2 has a significant effect on variable Y because of the significance. Value is 0.206 > 0.05.
X3 has a significant effect on variable Y because of its significance. Value is 0.652 > 0.05.

Coefficient of Determination Test (R2)

Before proceeding with further analysis, a coefficient of determination (R^2) test was conducted to evaluate the extent to which the independent variables (road, water, and electricity infrastructure) could explain variations in the dependent variable (economic growth). This test is important for assessing the suitability of the regression model in describing the relationship between the tested factors and economic growth. Using data processed through SPSS version 24, the results of the coefficient of determination test provide an overview of the model's strength in explaining economic changes in Probolinggo Regency. The following are the results of the coefficient of determination test conducted in this study.

Table9

Results of the Coefficient of Determination

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate
1	.949[a]	.901	.605	5581248.105

Source: Data Processed by SPSS 24, 2023

The coefficient of determination. The results showed an R-square value of 0.901, indicating that this regression model can explain 90.1% of the variation in the dependent variable (economic growth) based on the independent variables (road, water, and electricity infrastructure). This high R-value indicates a strong relationship between the independent and dependent variables, and the regression model can provide accurate predictions of economic growth.

However, the adjusted R-squared value of 0.605 indicates that only 60.5% of the variation in the dependent variable can be explained by the independent variables simultaneously. This indicates that while this model has a significant contribution, 39.5% of the variation in economic growth is influenced by other factors not included in this model. Thus, factors other than infrastructure may have a significant influence on economic growth, which needs to be considered in further analysis.

Discussion

Based on the results of this study, it was found that road infrastructure did not significantly influence economic growth in Probolinggo Regency. This aligns with the findings of Tong (2023), who stated that although road infrastructure is crucial for supporting economic growth, the large number of damaged roads that are not promptly repaired in both urban and rural areas hinders optimal development. Furthermore, the inability to build roads of good quality and at an appropriate cost has the potential to burden the regional economy. These findings indicate that the success of road development in Probolinggo depends not only on the quantity of construction but also on the quality and ongoing maintenance, as stated by Krasnoperova (2023), who emphasized the importance of efficient road infrastructure management to support the regional economy.

Furthermore, research on water infrastructure also indicates that this variable does not significantly impact economic growth. This finding aligns with the findings of Velde (2024), who explains that a lack of funding often hinders public access to health services, clean water, and adequate waste management. Although water infrastructure in Probolinggo is better than the average in East Java, with 70% of the population having access to clean water, numerous challenges remain

related to equitable distribution. Xu (2024) also noted that the lack of adequate water resources can reduce economic productivity and increase health risks, such as waterborne diseases. Therefore, further development of the water infrastructure sector is essential to support sustainable economic growth in Probolinggo.

Regarding electricity infrastructure, this study's findings indicate that electricity infrastructure does not significantly influence economic growth in Probolinggo. Despite the presence of the Paiton Steam Power Plant (PLTU) in the area, many remote villages remain without electricity, hampering the region's economic development. This aligns with the findings of Garia (2024), who emphasized the importance of equitable electricity access to support economic activity. In Probolinggo, frequent power outages and the lack of electrification in mountainous areas such as Lumbang, Sukapura, and Tiris hinder the region's economic potential. The practical implication of these findings is the importance of accelerating electricity infrastructure development throughout the Probolinggo region to create economic equality and reduce inequality between urban and rural areas.

The theoretical implication of these findings is the importance of considering factors other than infrastructure to explain economic growth. Although infrastructure plays a crucial role, the results of this study indicate that its impact on the economy is significantly influenced by its quality, maintenance, and equitable distribution (Surya et al., 2023; D. Wang et al., 2024). This enhances our understanding of the role of infrastructure in economic development theory, which often emphasizes the quantity of development while underestimating factors of quality and equity. Furthermore, this study reminds us that economic development depends not only on physical development but also on social development and the equitable distribution of resources.

Practically, the results of this study provide recommendations for local government policies to focus attention on the maintenance and improvement of existing infrastructure, while also ensuring equitable distribution between urban and rural areas. Furthermore, more efficient allocation of funds for the water and electricity sectors can accelerate economic development in less developed regions. In this regard, policies that include equal distribution of infrastructure and improving quality, especially in remote areas, are crucial to support sustainable economic growth in Probolinggo Regency.

CONCLUSION

Based on the analysis, the key finding of this study is that economic growth in Probolinggo Regency is not significantly influenced by road, water, or electricity infrastructure. Despite the importance of these infrastructures in supporting economic activities, the study found no direct and significant impact of these variables on economic expansion. This highlights the complexity of economic growth, suggesting that other factors, such as institutional support, human capital, or regional policies, may play a more significant role in driving growth. A major lesson from this research is that infrastructure alone is insufficient to ensure economic progress without complementary efforts in other areas.

This study contributes scientifically by providing valuable insights into the relationship between infrastructure and economic growth in a specific regional context. It also serves as a reference for policymakers in understanding the need for more comprehensive development strategies beyond just infrastructure investment. However, the research has limitations, particularly in its focus on a limited set of infrastructure variables and geographic scope. Future research could explore additional factors that may influence economic growth, such as digital infrastructure, education, or governance, and include a broader range of regions for more generalizable conclusions.

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