

Infrastructure Divergence And Its Impact On Economic Growth In West Nusa Tenggara

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Abstract

Infrastructure growth in West Nusa Tenggara (NTB) has shown uneven development at both the regional and sectoral levels in the last 10 years. This study examines how road, electricity and water infrastructure across the regions of NTB affect the economic growth considering interregional development divergence. An empirical approach was taken through panel data regression estimation with Random Effects specification, covering 100 observation units. Results indicate that there is a positive but insignificant relationship between that water infrastructure and economic growth, while road and electricity infrastructure have a positive and significant relationship. Although the models ability to explain variations in economic growth is relatively limited, the simultaneous effect of the three types of infrastructure remains significant. Overall, these findings that infrastructure contribution to the economic growth does not have a homogenous effect on the growth of regions. The results suggest the need for integrated infrastructure development policies that focus on improving service quality and road network connectivity need to be considered.

INTRODUCTION

Economic development refers to the process of raising living standards through increased incomes, reduce poverty and unemployment, and greater social welfare (Aprilia & Astuti, 2025; Otchere et al., 2025; Wang et al., 2025). The development and economic growth complementary relationship indicate that planned development can be used to promote sustainable economic growth through provision of a conducive environment, which in the long term will support inclusive development (Sipota et al., 2024). The economic growth is already one of the primary indicators to evaluate the effectiveness of development and projected future development improvements (Made et al., 2024; Oktaviana et al., 2026).

At the regional level, economic growth is generally measured using Gross Regional Domestic Product (GRDP) that is the summation of the value of goods and services manufactured in an area during a specified period (Aris et al., 2025; Syahputra et al., 2021). GRDP not only provides an overview of the scale of economic activity but also serves as the basis for formulating and analyzing regional development policies (Badan Pusat Statistik Indonesia, 2024).

Infrastructure is regarded as the main aspect in facilitating economic growth since it can lead to an increase in accessibility, lower transaction costs, and strengthens interregional networks (Chin et al., 2021; Große, 2024). According to Solow neoclassical theory of growth, the dynamics of economic growth are fundamentally based on three long-term factors; physical capital accumulation, labor development, and technological progress (Laird & Johnson, 2021). The physical capital that includes infrastructure is a significant requirement in facilitating the process of production and distribution (Rediansyah et al., 2023). Also in the endogenous theory of growth

Barrow and Lucas, focuses on the fact that the use of public infrastructure may lead to spillover effects which will contribute to long term productivity and stresses on the fact that the quality of human capital is important and it also depends on the access of basic services (Lestari et al., 2025). Therefore road, electricity and water infrastructure are strategic in enhancing sustainable and fair economic development.

According to the World Bank in Latuconsina et al. (2024) economic infrastructure is defined as various physical assets that facilitate the production and distribution processes, such as the provision of basic public services (electricity, communications, clean water, and waste disposal), the existence of public facilities that support connectivity and resource management, and transportation systems that strengthen inter-regional connections by land, water, and air.

West Nusa Tenggara (NTB) is a province comprising of two big islands namely Lombok and Sumbawa further subdivided into ten regencies and cities with diverse characteristics and regional resource bases. This variation is felt in the regional economic foundation, where Lombok Island is more inclined towards the tourism and service sectors compared to Sumbawa Island, which is more dependent on agriculture and mining. The conditions also determine the requirements and successes of the infrastructure development within any region. The NTB regional government and the central government still encourage the development of infrastructures via various policies out of which is the Regional Medium-Term Development Plan (RPJMD) which is a guideline to quicken the process of developing the infrastructure and stimulate the economic growth in the major sectors.

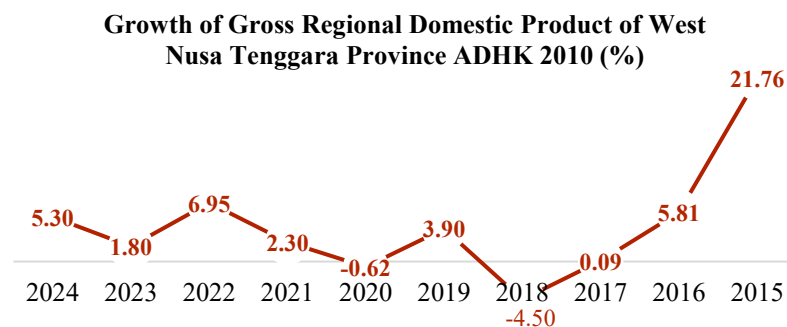


Figure 1. NTB Province GRDP Growth Rate 2015-2024

Figure 1 shows fluctuations in the economic growth in West Nusa Tenggara Province (NTB) between the year 2015-2024 based on the indicator of the GRDP growth rate at constant prices with the 2010 base year. At the beginning of the observation period in 2015, the NTB economy recorded a very high growth rate of 21.76 percent, which was mainly driven by a surge in metal ore concentrate production. Subsequently, a sharp decline occurred, resulting in a contraction of -4.50 percent in 2018, which was triggered by an earthquake. The economy started recovering in 2019 with the growth rate of 3.90 percent, but the pressure returned in 2020 when the coronavirus pandemic caused the decline of the economy of -0.62 percent. The increase was sluggish until it reached 6.95 percent in 2022, and decreased to 5.30 percent in 2024.

The economic development cannot be separated from the contribution of infrastructure as a driver of economic activity. In the last ten years, infrastructure in the fields of roads, electricity, and water has developed as shown in the following graph:

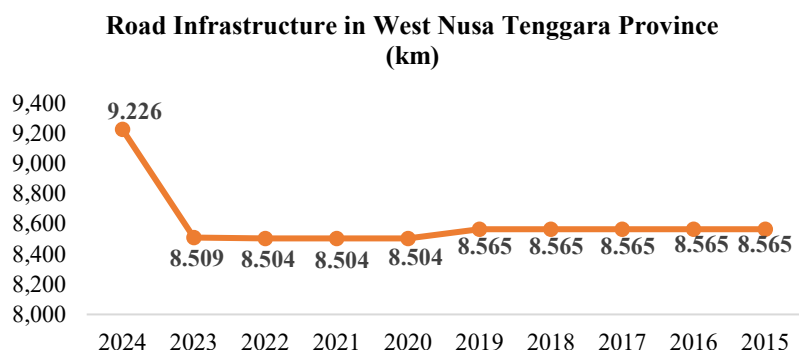


Figure 2. Length of Road Network in NTB by Authority 2015-2024

Figure 2 shows the development of road infrastructure for the period 2015-2024 in the West Nusa Tenggara region. Overall, the length of roads in NTB stagnated at around 8.565 km during the 2015-2019 period, followed by a slight decrease and a drastic increase to 9.226 km in 2024. The difference in road network length does not fully reflect the addition of new physical road networks, but is likely influenced by road reclassification, changes in jurisdiction, and changes in recording methods (Kundiharto, 2023). These results show that road infrastructure development in NTB over the last ten years has tended to be low and has not experienced stable growth.

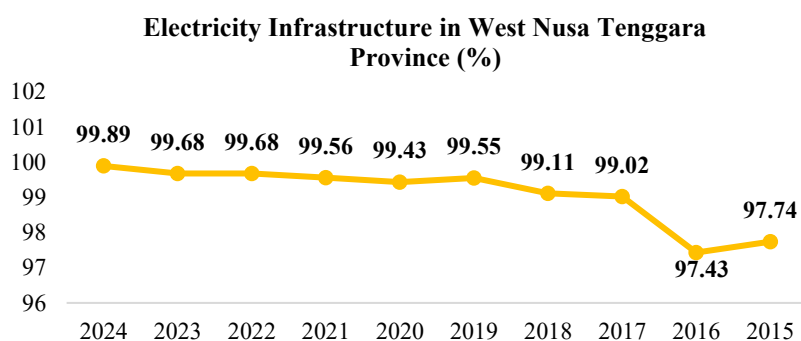


Figure 3. Households Using PLN Electricity in NTB 2015-2024

Figure 3 shows electricity infrastructure in NTB, measured by the proportion of households using PLN electricity. In general, the household electrification rate shows a stable upward trend, starting from 97.74 percent at the beginning of the observation period and reaching its peak at 99.89 percent in 2024. A significant increase occurred in 2017, reflecting the government's success in expanding electricity access to the community.

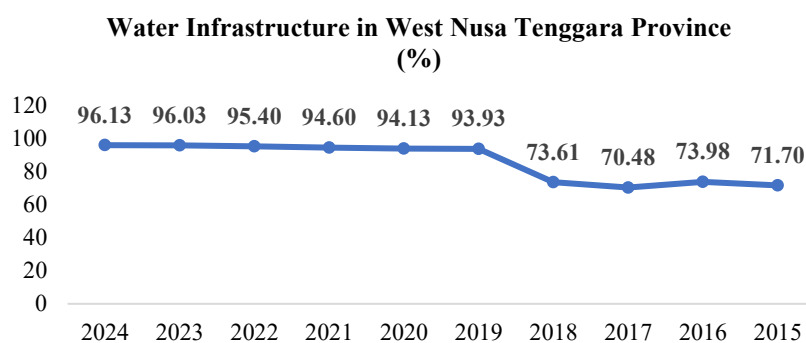


Figure 4. Accessibility of Proper Drinking Water Sources for Households in NTB Province 2015-2024

Figure 4 shows that access to proper drinking water in NTB Province has increased significantly, from 71.70 percent in 2015 to 96.13 percent in 2024. The most substantial change occurred in 2019, indicating improvements in basic infrastructure services that contributed to the enhancement of the community's quality of life.

Basic infrastructure development in NTB has shown uneven trends over the past ten years. Electricity and water infrastructure has grown comparatively fast whereas the road infrastructure has been inclined to remain stagnant. Moreover, there also exist discrepancies between regions in that the Lombok Island region appears to enjoy a more access to infrastructure than several regions in Sumbawa Island. These disparities suggest that there might be a divergence in infrastructure that would result in various regions being able to facilitate economic activity and the growth of the GRDP.

Empirical studies by different researchers indicate that the correlation between infrastructure and economic growth does not always take the same pattern. Despite the overall positive impact of infrastructure on the economic growth, the extent of this impact depends on the type of infrastructure, quality of service, and regional features (Afriyana et al., 2023; Alawi et al., 2025; Bahari et al., 2025; Rediansyah et al., 2023; Wahyunadi et al., 2021). The results of the studies conducted in different countries also demonstrate a variety of findings on the relationship between infrastructure and economic growth (Nenavath, 2023; Park & Yi, 2026; Sajjad & Dar, 2025).

Yet, the major part of past research so far has been the aggregate form of analysis and has not particularly looked at regional differences in the development of infrastructure (divergence) and its influence on economic growth, especially on the regencies/city level in West Nusa Tenggara Province. This implies that there is a research gap that needs further study.

The urgency of this study is on the fact that there is still a gap in the development of the infrastructure between regions in NTB that can increase the gap in economic growth. In the absence of an empirical knowledge on the contribution of each infrastructure impact, the development policies risk being misdirected and ineffective to enhance fair economic growth. It is on this basis that the current research will analyze the impact of road, electricity and water infrastructure on economic growth in NTB Province over the period 2015-2024 with the consideration of the aspect of the infrastructure development divergence amongst regions.

Road infrastructure is the primary source of facilitating the mobility of the factors of production, the economic accessibility, and interregional connection (Law et al., 2022; Mohmand

et al., 2021; Rehman et al., 2023; Rehman & Noman, 2021; Sobieralski, 2021). Therefore, the development of road infrastructure will promote more inclusive economic development.

H1: The economic growth in regencies/cities in West Nusa Tenggara Province is a major influence of road infrastructure.

Availability of sufficient electricity is also a key element in facilitating economic activity, particularly within the industrial sector and the household sector. With access to electricity, more productivity is made possible, costs become efficient, and more people shall have jobs. In rural areas, strengthening electricity infrastructure has the potential to encourage a more even distribution of economic activities across regions (Asaleye et al., 2025; Avordeh et al., 2024; Fried & Lagakos, 2021; Gizaw et al., 2025; Lee, 2022; Tiwari et al., 2021). Therefore, improvements in electrical infrastructure are expected to drive regional economic growth.

H2: Electrical infrastructure has a significant impact on the economic development of regencies/cities in West Nusa Tenggara Province.

Water infrastructure plays an important role in improving the quality of life of the community, as well as economic productivity due to better health and efficiency of economic activities (Barbier, 2024; Li et al., 2024; Prabowo & Makrufan, 2021; Rizka & Hasrianti, 2024; Supiandi, 2024). The availability of clean water in the long run also helps in enhancing the quality of human resource that also factors in economic growth.

H3: Water infrastructure plays an important role in determining economic growth of the regencies/cities in West Nusa Tenggara Province.

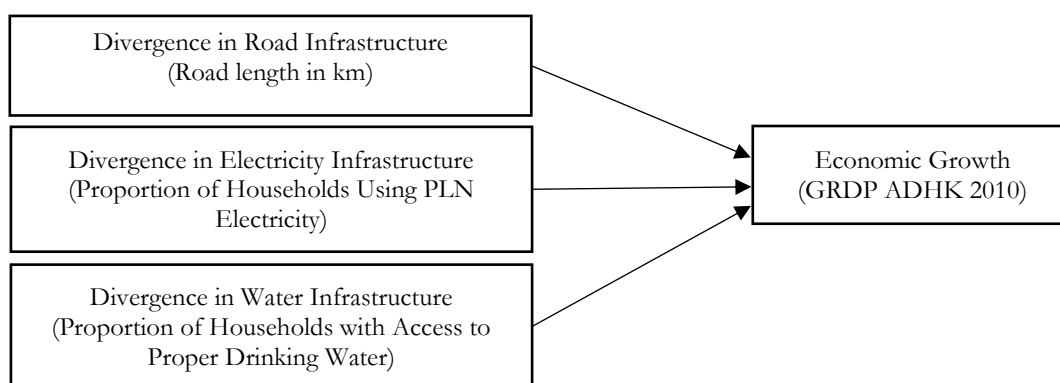


Figure 5. Conceptual Framework

METHODS

The research methodology is a quantitative with an explanatory design used to analyze the causality between regional infrastructure and economic growth. This research methodology focuses on the impact of infrastructure (roads, electricity and water) on economic growth in the regencies and cities of the West Nusa Tenggara (NTB) Province in the period 2015 to 2024. The 2015-2024 research period was selected because the data for this period is consistent and relevant to the infrastructure development time frame in the region. The data used are secondary data collected annually for each regency/city during the observation period. All data comes from official sources, namely publications by the of BPS-Statistics of NTB Province, particularly from the *NTB in Figures* reports and other supporting statistical tables for the 2015–2024 period.

The economic growth, measured in Gross Regional Domestic Product (GRDP) of each regency and city at constant 2010 prices is the dependent variable in this research. The

independent variables mainly include three types of infrastructure. Road infrastructure is represented by the total length of the road network (measured in kilometers) under the jurisdiction of the relevant regency or city authority. The electricity infrastructure is indicated by the proportion of households using PLN electricity. Water infrastructure is reflected in household access to proper drinking water at the regency and city levels within the NTB.

The type of analysis is panel data regression, an estimation method that combines cross-regional and time series data dimensions to reflect changes in characteristics between regions and changes in conditions over time (Yalçın et al., 2021). The estimation was performed using Stata 14 software. The best estimation model was chosen after a succession of testing processes; in the first step, Chows test came into place to compare the common effects model and the fixed effects model, the Hausmans test was conducted in the second step to decide whether to adopt the fixed effect model or the random effect model, and in the third stage, the Lagrange Multiplier test to determine the feasibility of adopting the random effects model. After the optimal model was identified, the estimation of the panel data regression equation that formed the empirical basis of this study was continued:

$$(Y_{it})=\alpha+\beta_1 X1+\beta_2 X2+\beta_3 X3+\epsilon_{it} \dots \dots \dots (1)$$

The model was then converted into a natural logarithmic form to standardize the units of measurement of the variables and to reduce the potential for heteroskedasticity. The final equation used is:

$$\ln(Y_{it})=\alpha+\beta_1 \ln(X1_{it})+\beta_2 \ln(X2_{it})+\beta_3 \ln(X3_{it})+\mu_i+\epsilon_{it} \dots \dots \dots (2)$$

Panel data equation models are mathematical representations of variables applied in panel data analysis. These models satisfy two dimensions of data, namely regional unit differences and inter-period differences. Model estimation is performed after model selection procedures and classical hypothesis tests such as multicollinearity and heteroscedasticity, which aim to ensure that the final estimator is BLUE (Best Linear Unbiased Estimators). If heteroscedasticity occurs, estimation is performed using a robust standard error approach to ensure that the parameter coefficients are consistent and unbiased. R2 indicates how much the variables in the regression model have. The F test and T test are also analyzed through probability and coefficient analysis to determine whether the influence between independent variables is significant or not.

DISCUSSION

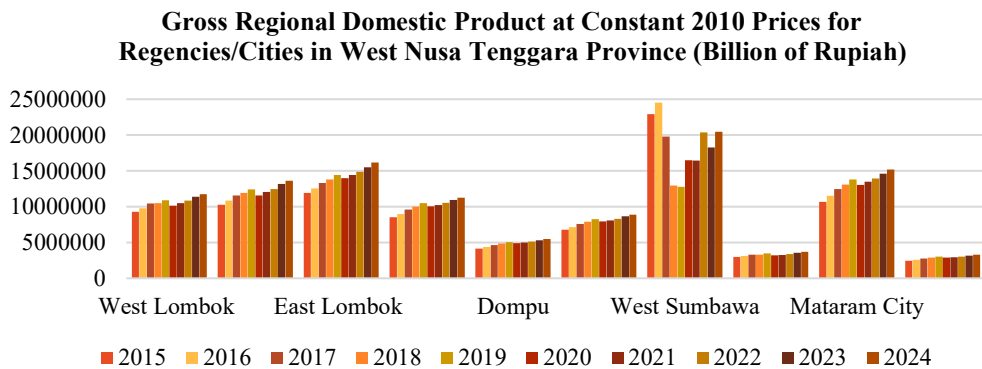


Figure 6. GRDP of Regencies/Cities in NTB Province 2015–2024

Figure 6 shows the dynamics of economic growth in West Nusa Tenggara (NTB) Province in terms of GRDP at constant 2010 prices, which demonstrates the differences in the growth rates between the regions during the period 2015-2024. East Lombok Regency and Mataram City show stability compared to other regions. On the other hand, fluctuations in West Sumbawa Regency are quite sharp, as the region relies on the mining sector as the main pillar of its economy. Conversely, North Lombok Regency and Bima City recorded lower growth, reflecting limitations in the economic structure and suboptimal infrastructure support in stimulating economic activity in the region. The fact that regencies and cities have diverse development trends shows differences in regional capacity to adapt to economic dynamics. This situation highlights the uneven economic growth in NTB, specifically the disparity in economic growth rates between regions.

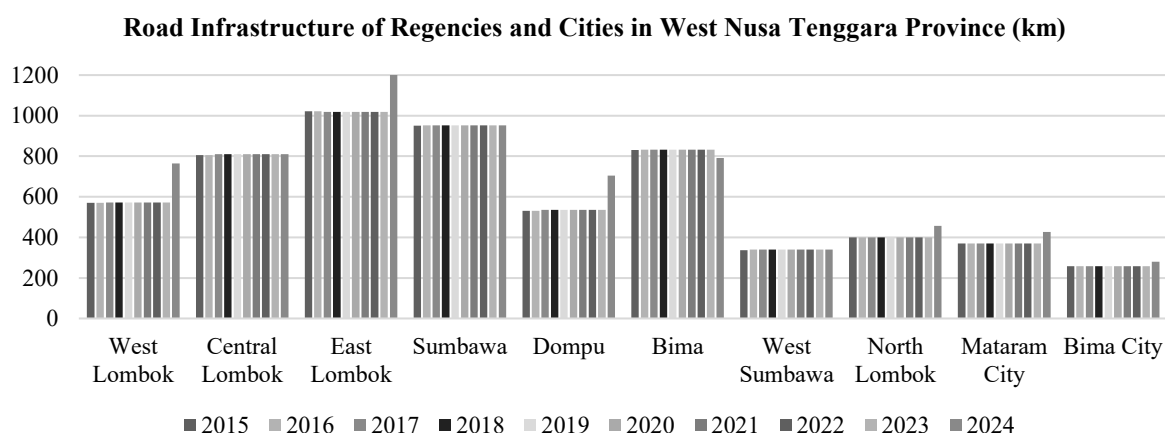


Figure 7. Length of Regency/City Roads in NTB Province by Authority 2015-2024

Figure 7 shows that in the period of observation, the road network lengths of each regency and city in West Nusa Tenggara (NTB) Province remained relatively stable, fluctuating with very minimal variations. Differences in road length between regions primarily stem from variations in jurisdictional area size and settlement patterns. East Lombok Regency boasts of the most extensive road network since it is a large region that needs to be linked to other areas. Conversely, Bima City has the shortest road length due to its limited jurisdictional scope. The relatively small rate of road length increase in NTB indicates that road infrastructure policy prioritizes maintenance and management over network expansion. However, by the end of the observation period, road length had increased in some areas, causing variations in data between regencies/cities.

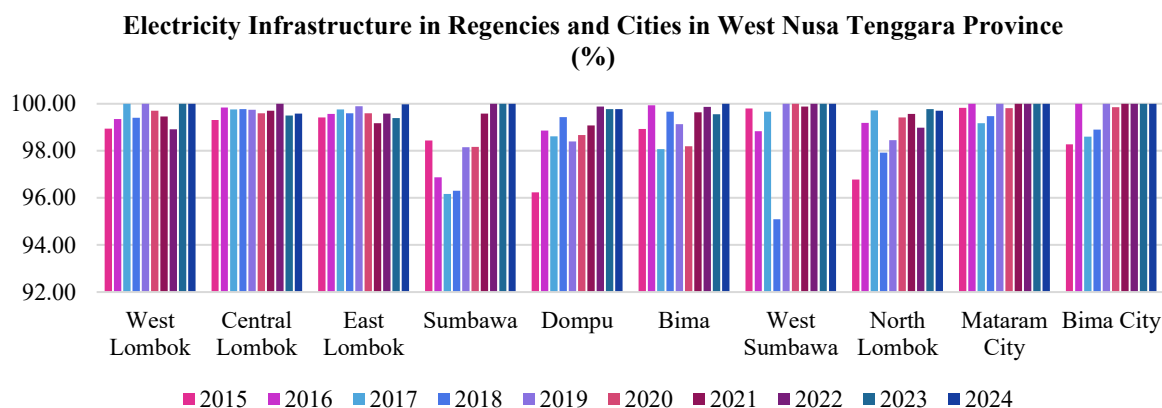


Figure 8. PLN Electricity Users in Households in Regencies/Cities in NTB 2015–2024

Figure 8 shows that there has been very positive development in electricity infrastructure. Electricity service coverage, measured by the proportion of households using the public electricity company (PLN) as their source of lighting, has grown steadily and now covers almost the entire population. Although there are slight variations in certain regions, the overall trend shows that there has been positive equalization of access to electricity as a basic infrastructure that facilitates economic operations, increases productivity, and enhances the quality of life for citizens.

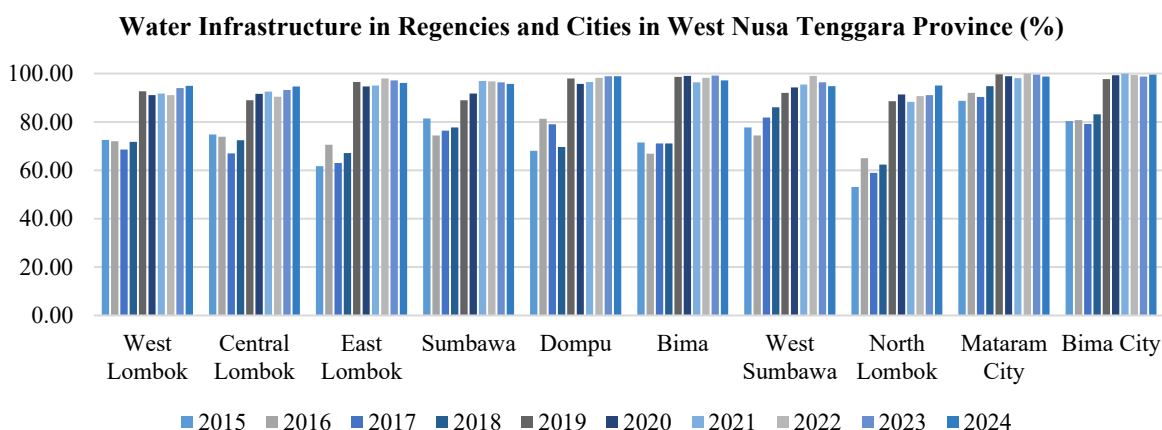


Figure 9. Accessibility of Proper Drinking Water Sources for Households in NTB Regencies/Cities 2015-2024

Figure 9 shows that progress in water infrastructure, as reflected in household access to proper drinking water, has shown a relatively strong positive trend during 2015–2024. Although growth slowed during the period 2016–2018, access has continued to increase in almost all regencies/cities since 2019, with a relatively faster rate in urban areas. This improvement in services contributes to public health, time efficiency in households, and work productivity in the region. Differences in the rate of growth in access to proper drinking water indicate that the efficiency of various regions in utilizing water infrastructure to advance economic activities is developing at different speeds.

Table 1.
Statistic Results of Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
ln_grdp	100	2.438.487,00	24.534.899,00	9.740.536,00	4.999.703,00
ln_road	100	258,00	1.211,00	614,91	264,75
ln_electricity	100	95,10	100,00	99,31	0,96
ln_water	100	53,09	100,00	87,06	12,20

According to descriptive statistics, the average Gross Regional Domestic Product (GRDP) of all regions the West Nusa Tenggara (NTB) Province between 2015 and 2024 reached IDR 9,740,536 billion, representing a relatively high data dispersion (standard deviation of IDR 4,999,703 billion). The significant gap between the minimum and maximum values reflects regional economic disparities, with some areas performing significantly better than others. Regarding infrastructure, the average length of the road network reached 614,91 km, with considerable variability, indicating that the level of connectivity between regencies/cities varies greatly. Electricity infrastructure, however, shows a very high average value of 99.31 with low deviation. Access to proper drinking water has an average value of 87.06 percent, with a relatively wide range. These differences in infrastructure characteristics, particularly in the road system and supply of proper drinking water, reflect variations in regional capacity to support economic activities, which can reinforce disparities in regional economic performance.

Table 2.
Model Determination Test Results

Test	Prob	Selected Model
Chow Test	0.0000	FEM
Hausman Test	0.9695	REM
Lagrange Multiplier (LM) Test	0.0000	REM

The selection of the model estimate was tested in three stages. The Chow test yielded a significance level of less than 5 percent, confirming the fact that the fixed effects model (FEM) was superior over the common effects model (CEM). The Hausman test gave a value of better than 0.05 implying that random effects model (REM) was superior to fixed effects model (FEM). The Lagrange multiplier (LM) test was then used to prove this conclusion and it showed that the REM was better than the CEM. Based on the findings of all the tests, this study eventually settled on the REM as the central estimation model.

Table 3.
Multicollinearity Test Results

Variabel	ln_road	ln_electricity	ln_water
ln_road	1.0000	-0.0922	-0.1294
ln_electricity	-0.0922	1.0000	0.3651
ln_water	-0.1294	0.3651	1.0000

The multicollinearity test indicates that the linear relationships between the independent variables within the model are tolerable. This is evident by the values of the variance Inflation

Factor (VIF) where all the variables of infrastructure fall within the limit of 0.70. This means that each variable can explain the variation in economic growth relatively independently, so that regression coefficient estimates can be interpreted more accurately.

Table 4.
Heteroscedasticity Test Results

Variable	Hypothesis	Chi ²	Prob
Fitted value of ln _y	Constant Variance	27.63	0.0000

Heteroscedasticity test was done based on the Breusch-Pagan/Cook-Weisberg method, the Chi² value was 27.63 with a significance of less than 5 percent. This result implies that not all observations have the same amount of residual variance. To address this issue, mode estimation uses robust standard errors grouped into ten regencies/cities in the GLS model estimation with a REM. Thus, the coefficient estimates remain consistent and the statistical conclusions are valid for interpretation.

Table 5.
Estimated Results Using the Random Effects Model (REM) Approach

Variable	Coefficien t	Robust Error	Std. z	p > z	Wald chi ²	Prob chi ²	>	R ²
ln _{road}	0.4142961	0.121296	3.42	0.001				
ln _{electricity}	3.433955	1.380154	2.49	0.013	87.73	0.0000		0.2093
ln _{water}	0.2165514	0.1107553	1.96	0.051				
C	-3.442216	5.637577	-0.61	0.541				

$$\ln(\text{Grdp}_{it}) = -3.442 + 0.414 \ln(\text{Road}_{it}) + 3.433 \ln(\text{Electricity}_{it}) + 0.216 \ln(\text{Water}_{it}) + \mu_i + \varepsilon_{it}$$

According to the regression values of the panel data estimated using the REM, the constant term was determined to be -3.442, which indicates the baseline level of economic growth in all regions of NTB when other infrastructure variables remain constant. A positive significant correlation was found between the road infrastructure variable and its coefficient of 0.414 between significance level of 0.001. This result indicated shows that road infrastructure contributes to economy growth, confirming the first hypothesis. Similar to road infrastructure, electricity infrastructure also demonstrates positive and significant relationship with economy growth. With a correlation of 3.433 and a significance level of 0.013, improvements in household electricity supply are strongly connected with all regions, supporting the second hypothesis.

However, water infrastructure has a positive but not statistically significantly. Having the coefficient of 0.216 but a probability above the 0.05 threshold (0.051), This means that the supply of proper drinking water cannot play a significant role in economy growth, so the third hypothesis is rejected. At the same time, the Wald chi² test value is 87.73 with a very high significance level (0.0000). It is an indication that the three variables of infrastructure have a concurrent impact on the economic growth of a region. The coefficient of determination (R²) of 0.2093 implies that these three infrastructures can explain 20.93 percent of the variation in GRDP growth. The remaining variation can be explained by other structural variables that are not found in this model.

The outcomes of the estimations reveal that the impact of road infrastructure on the economic growth of all regions in NTB is positive and statistically significant. It has a regression coefficient of 0.414 with the level of significance of less than 5 percent (0.001). Holding other things constant, an increment of 1 percent in road infrastructure is associated with a 0.41 percent

increment in GRDP. This positive consequences of this expansion in road networks are the availability of better interregional networking that will facilitate the spread of goods and services, lower transportation expenses, and increase market accessibility, increasing regional economic activity by a significant factor. This is significant in the economic make-up of NTB which is majorly controlled by the agriculture, tourism and service industries. This observation is consistent with neoclassical growth theory, infrastructure is included in physical capital that drives better economic performance. This finding supports several empirical studies that show that road construction is a powerful factor affecting the development of the region economy (Damanik et al., 2024; Jemumu & Shanty Ratna Damayanti, 2024; Yovani & Irfan, 2024).

Also, the electricity infrastructure has a positive significant impact on economic with a coefficient of 3.433 with a probability of 0.013. This indicates that, assuming *ceteris paribus*, GRDP growth will increase by 3.43 percent for every 1 percent increase in household electricity supply. The benefits of electricity infrastructure improvement directly affect the economy by enhancing productivity with time-saving in the workforce, extending the working hours, and creation of economic activities that are based on technology and services. The stability of electricity supply is very significant in economic development at the regional level in NTB dominated by tourism, small industry and service sectors. The fact that the electricity supply has risen to 99.89 percent in 2024, as compared to 97.74 percent in 2015 is an indication that the policy of increasing electricity accessibility in NTB has been achieved. This finding is consistent with the views of endogenous growth theory that electricity does not only act as a physical input but also a technology driver that supports the realization of productivity growth in the long term. These findings are consistent with other empirical research on the importance of electricity availability for regional economic performance (Aziz & Hidayah, 2025; Damanik et al., 2024; Hanum et al., 2025; Mutumba et al., 2024; Sapthu, 2023).

Contrary to electricity infrastructure, water infrastructure positively, but non-statistically significantly, influences economic growth. The outcomes of the estimation show that the coefficient of the water variable is 0.216 and the significance level is 0.051, which is slightly above the 5 percent. These results indicate that although the correlation between the two is positive, the role of water infrastructure in economic performance in the NTB region is not yet considered statistically significant. The direct impact of water infrastructure tends not to be seen in direct increases in economic output, but rather in improving the quality of public health and household activities, so that the impact of water infrastructure on economic growth is indirect and long-term. This situation is supported by the fact that the water sector in NTB makes a relatively minor share of the GRDP and that drinking water supply by the private sector in bottled water and the utilization of well water remain predominant, not to mention the insufficient supply of the local water company (PDAM). Water infrastructure is used as a social investment to maintain the quality of human resources and long-term productivity, in accordance with endogenous growth theory. However, the economic impact is largely dependent on the quality of public services. The same conclusion was made in a number of prior empirical studies, which also suggested that availability of water infrastructure is not always a determining factor in the economic development of the region (Afriyana et al., 2023; Aziz & Hidayah, 2025; Mardiah & Irwan, 2024; Syahputra et al., 2021).

The significant Wald χ^2 test value shows that the three types of basic infrastructure simultaneously influence economic growth in NTB. This indicates that economic development in NTB is more strongly determined by integrated basic infrastructure development than by the development of each type of infrastructure separately. This finding confirms the endogenous

growth theory, which considers infrastructure as public capital that increases private sector productivity and generates a multiplier effect when development is coordinated. However, differences in the availability and quality of infrastructure between regions indicate that the impact of infrastructure development on economic growth is uneven. These results support several empirical studies that the of road, electricity, and water infrastructure has a stronger impact on economic growth than fragmented development (Angelina & Wahyuni, 2021; Harsono et al., 2024). Therefore, regional development planning in NTB must focus on an integrated approach, as this approach contributes to more productive and sustainable economic growth.

CONCLUSION

These findings indicate that the effect of the basic infrastructure on economic growth of all regions within NTB varies depending on the type of infrastructure. During the observation period, a positive correlation was found between water supply infrastructure and economic, but this correlation was not statistically significant. Conversely, road and electricity infrastructure had a positive and significant impact on the region economic growth. Electricity infrastructure has the strongest impact with a coefficient of 3.433, road infrastructure with a coefficient of 0.414. Although these three types of infrastructure together influenced economic growth they contributed 20.93 percent to the change in economic growth with the rest being attributed to other factors that were not included in the model. The differences in the impact of various types of infrastructure indicate differences in development between regions. Regions with advanced infrastructure often have greater economic advantages, while regions with limited infrastructure face more obstacles. This shows that infrastructure development in NTB isn't fully even and integrated yet, so its contribution to regional economic growth is still limited and not uniform across all regions.

SUGGESTION

Based on these findings, infrastructure development policies in NTB Province must prioritize integrated development strategies and service quality improvement. To increase productivity in all economic sectors, the stability of electricity supply must be improved evenly across the province by developing road networks that enhance connectivity and quality between regions. At the same time, water infrastructure development should focus on improving the efficiency of public services to make a considerable contribution to the economic growth. It is suggested that additional studies should be performed to expand the scope of variables by adding infrastructure quality indicators and other economic aspects and the duration period within which the dependence between infrastructure and economic growth is researched, and the range of study becomes the macroeconomic level.

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