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The Influence of Road Transportation Infrastructure Development on Economic Growth in ASEAN

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Abstract: This study analyzes the effect of the ratio of paved road length to population density as a proxy for road transportation infrastructure on economic growth in the ASEAN region during the period 2008-2023, with the value added of the industrial sector, including construction, and inflation based on the GDP deflator as control variables. This study uses balanced panel data from nine ASEAN member countries, namely Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, and Thailand, resulting in a total of 144 observations. Vietnam and Timor-Leste were not selected due to data limitations. Based on the results of the Chow test and the Breusch-Pagan Lagrange Multiplier test, the Common Effect Model was chosen as the most appropriate estimation method. The results show that the ratio of paved road length to population density has a positive and statistically significant effect on economic growth. This finding indicates that improving road infrastructure can strengthen interregional connectivity, facilitate the distribution of goods and services, and increase economic efficiency. Meanwhile, the value added of the industrial sector, including construction, has a significant negative effect on economic growth, while inflation has a positive but insignificant effect. This finding suggests that the ratio of paved road length to population density is positively associated with economic growth in the ASEAN region during the study period.

Keywords: road transportation infrastructure; economic growth; asean; panel data

JEL Classification: O18; R42; O47; F15

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Introduction

Economic growth can be interpreted as the process of developing economic activity, which is characterized by an increase in the number of goods and services produced in a country and an improvement in the level of community welfare (Baskara et al., 2022). In the context of development, economic growth is often used as the main indicator for assessing a country's success (Sari & Sari, 2021). The problem of economic growth is a long-term macroeconomic issue. Over time, a country's ability to produce goods and services tends to increase (Pratiwi & Utama, 2022). Economic growth is very important for a country because every country strives to increase its economic growth to increase national income and the welfare of its people (Revinski et al., 2022). This is also experienced by countries in the ASEAN region, most of which are classified as developing nations and continue to strive to strengthen their economic structures.

The Association of Southeast Asian Nations (ASEAN) is a regional organization consisting of eleven countries in the Southeast Asian region (Damanik & Saragih, 2023). Along with the formation of the ASEAN Economic Community (AEC), it encourages ASEAN member countries, the majority of which are developing countries, to continue to increase infrastructure development as physical capital to support smooth trade and economic integration between countries (Kurniawan & Nihayah, 2021). Logistical challenges faced by ASEAN countries, such as high transportation costs, low inter-regional connectivity, and infrastructure gaps between countries, are major obstacles in realizing effective regional economic integration. This is one of the impacts of the demands of the era of globalization, which requires each country to engage in trade and economic cooperation. Regional economic cooperation was formed to increase the economic growth of ASEAN countries, both from the beginning of its formation and in the future (Sari & Kaluge, 2017).

Economic growth essentially indicates a long-term increase in per capita output resulting from a country's economic activity. Economic growth demonstrates the relationship between economic activity and a sustained increase in a country's income (Ramadhani & Faridatussalam, 2024). In terms of numbers, economic growth can be measured by comparing the level of output or national income in one period with the previous period. In classical economic theory, economic growth is determined by the extent to which a country's national production system increases output. This production system is based on three main components: natural resources as a land-based production factor, human resources represented by the population, and the availability of accumulated capital (Kurniawan & Nihayah, 2021). These three factors interact to determine a country's ability to increase output and drive sustainable economic growth. The following shows economic growth data for ASEAN member countries, excluding Vietnam and Timor-Leste, as these countries lack sufficient data for research:

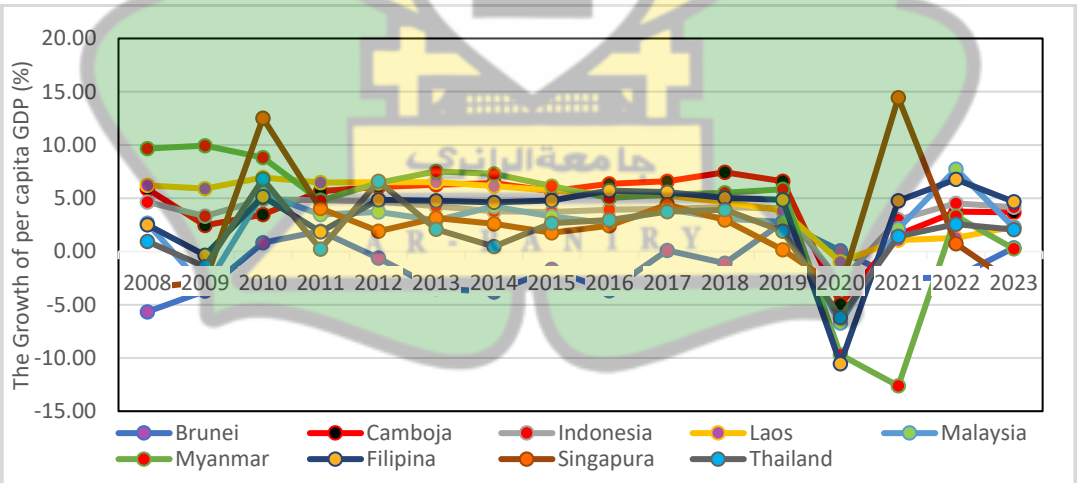


Figure 1 The dynamics of the growth of per capita GDP in ASEAN Countries 2008-2023
Data Source: World Bank Open Data

Based on data on ASEAN economic growth for the 2008-2023 period, ASEAN's economic growth fluctuates annually. During 2008-2019, most ASEAN countries experienced relatively stable economic growth, with average growth rates in the positive range.

Cambodia and Laos recorded relatively high per capita growth compared with other countries, reflecting accelerated economic development in both. In 2020, a sharp decline was observed across almost all ASEAN countries due to the COVID-19 pandemic, which disrupted economic activity, trade, and community mobility. Myanmar experienced the deepest contraction among the countries. In the 2021-2023 period, per capita economic growth began to recover as economic activity and international trade improved. Furthermore, Indonesia demonstrated relatively stable per capita economic growth compared to several other ASEAN countries. The graph shows that ASEAN's per capita economic growth is influenced by several factors, including road transportation infrastructure.

Infrastructure development is the main foundation of economic development (Taufik & Markhamah, 2024). Infrastructure is categorized as social overhead capital. This is because infrastructure is seen as a basic facility that has a significant influence on community activities (Prasetyo, 2019). Social overhead capital plays a role in improving productivity, fostering awareness of human resource potential, and creating supportive conditions for optimal utilization. Supply chains, formed through infrastructure, create a pull effect on the economy and serve as a catalyst linking market production and final consumption. Therefore, infrastructure serves as the backbone of the economy, supporting the smooth flow of logistics throughout economic activity.

The transportation sector contributes significantly to economic growth by serving as the primary driver of various economic activities, shaping national income from production to distribution. Furthermore, the availability of good transportation infrastructure is a key factor that investors consider when investing, as it can support the smooth flow of economic activity (Kartiasih, 2019).

The development of transportation infrastructure is one of the factors supporting economic growth through increasing connectivity, smooth distribution of goods and services, and increased community mobility (Laode et al., 2025). According to Aschauer (1989), public infrastructure is public capital that functions as a productive input, thereby increasing private-sector productivity by reducing production and distribution costs and encouraging higher economic output. Therefore, government investment in infrastructure is seen as a crucial factor in accelerating economic growth. Krugman (1990), in New Economic Geography, explains that reducing transportation costs and increasing connectivity will encourage the concentration of economic activity, expand market access, and increase production efficiency, thereby contributing to economic growth.

Furthermore, Syrquin & Chenery (1989) argue that industrialization is characterized by a shift in value added from the primary sector to the manufacturing and non-tradable sectors, thereby making industrial development part of the economy's structural transformation. Ghosh & Phillips (1998) found a statistically significant negative relationship between inflation and economic growth, such that higher inflation is associated with lower economic growth.

Based on this theoretical perspective, transportation infrastructure development is seen as a form of public investment that can increase the efficiency of economic activities, reduce distribution costs, and expand access to them, thereby driving economic growth. In this study, road transportation infrastructure development is measured by the ratio of paved road length to population density. This proxy was selected because ASEAN countries differ substantially in their geographic characteristics and population densities. By incorporating population density, the ratio of paved road length to population density indicator considers differences in the spatial distribution of population when assessing paved road infrastructure across countries. Based on ASEANstats and World Development Indicators (WDI) data, this ratio reveals distinct developments across ASEAN countries during the period 2008-2023. Some countries experienced improvements despite varying levels of infrastructure provision. This condition indicates a gap in road transportation infrastructure that could affect economic growth. In addition to road transportation infrastructure, economic growth is influenced by other factors, such as the industrial sector's value added, including construction, and inflation. Therefore, this study aims to analyze the effect of the ratio of paved road length to population density on economic growth during the period 2008-2023, while controlling for other variables.

Although various studies have examined the relationship between transportation infrastructure and economic growth in the ASEAN region, theoretical and empirical gaps remain in the existing literature. Research conducted by Kurniawan & Nihayah (2021) analyzed the influence of transportation infrastructure and foreign investment on the economic growth of ASEAN countries. However, these studies generally use transportation infrastructure indicators such as absolute road length, thereby failing to fully capture the relative availability of infrastructure between countries. However, ASEAN countries have varying geographic characteristics and population densities. Therefore, the ratio of paved road length to population density is used to consider differences in population density and spatial characteristics when comparing road transportation infrastructure across countries. Furthermore, structural economic factors need to be considered through the contributions of the industrial and construction sectors and price stability, each reflected in the value added of the industrial sector, including construction, and inflation, as measured by the GDP deflator, since both factors can influence the dynamics of economic growth.

Additionally, Revinski et al. (2022) used air freight as a proxy for transportation infrastructure. This approach is considered less representative of the real conditions in the ASEAN region, given that most member states are developing nations that still rely heavily on land transportation connectivity as the backbone of goods distribution and the mobility of production factors. Meanwhile, Wicaksono et al. (2021) used road length and population as research variables. However, they covered only one country, namely Indonesia, using a time-series approach, so the results cannot be generalized to the entire ASEAN region, which has diverse economic structures and geographic characteristics. The gap in this research lies in the still-limited number of cross-country panel studies in the ASEAN region that simultaneously analyze the relationships among road transportation infrastructure, economic structure, macroeconomic stability, and economic growth. Therefore, this study uses panel data for nine ASEAN countries for the period 2008-2023,

including the value added of the industrial sector (including construction) and inflation, based on the GDP deflator, as control variables. In addition, this study uses the ratio of paved road length to population density as a proxy for infrastructure accessibility, offering an alternative perspective for measuring the availability of road infrastructure relative to population and thereby complementing empirical evidence on the influence of road transportation infrastructure on economic growth in the ASEAN region.

Road Transportation Infrastructure and Economic Growth

Many studies have examined the influence of road transportation infrastructure on economic growth, yielding mixed results. Ng et al. (2019), using fixed-effects panel linear regression on 60 countries from 1980 to 2010, found that growth in the ratio of road length per thousand inhabitants had a positive and significant effect on economic growth. Road infrastructure has been shown to increase public mobility, facilitate the distribution of goods and services, and support increased exports, ultimately driving overall economic growth. Road infrastructure has been shown to increase public mobility, facilitate the distribution of goods and services, and support increased exports, ultimately driving overall economic growth. Wicaksono et al. (2021), in his research on the impact of land transportation, infrastructure, and population on Indonesia's GDP, he also found that infrastructure has a positive and significant impact on economic growth, indicating that adequate land transportation infrastructure significantly contributes to increasing national economic output. Kurniawan & Nihayah (2021), in their research on 9 ASEAN countries for the period 2008-2017, they found that road infrastructure and FDI simultaneously influenced economic growth in ASEAN. However, the road infrastructure variable had a negative effect, indicating that ASEAN economic growth was influenced more by other factors, such as human resources and investment, than by physical capital alone. Differences in the results of previous studies suggest that the relationship between road infrastructure and economic growth may vary with the measure of infrastructure and country characteristics. In this study, the ratio of paved road length to population density is used to account for differences in population density and spatial characteristics across ASEAN countries when measuring road infrastructure.

Added Value of the Industrial Sector to Economic Growth

The relationship between industrial sector value added and economic growth has been studied extensively, with findings that are not always consistent. Adiwinata & Annisa (2024), in their research using the spatial regression econometric approach on panel data, found that the contribution of the industrial sector to added value hurts economic growth in Indonesia, which indicates that an increase in the share of the industrial sector in GDP is not always directly proportional to an increase in the rate of economic growth. Djubu et al. (2025) used panel data regression on districts and cities in Gorontalo Province for the 2014-2023 period. They found that the added value of the industrial sector hurts regional economic growth due to weak industrial structure, dependence on imported raw materials, low technology adoption, and minimal linkages between the industrial sector and other economic sectors. Different findings were put forward by Mamonto et al. (2024). They found that increasing the industrial sector's value added positively affected

Indonesia's gross national income because the sector attracted domestic investment and created new jobs. The differences in these research findings indicate that the industrial sector's influence on economic growth is highly dependent on the level of efficiency, productivity, and maturity of the industrial structure in each country.

Inflation on Economic Growth

The effect of inflation on economic growth is a topic widely debated in the economic literature, with mixed results. Damanik & Saragih (2023), using a Common Effect Model panel data regression on 10 ASEAN countries for the 2017-2021 period, found that inflation had a positive but insignificant effect on economic growth, indicating that the relatively moderate inflation rate in the ASEAN region was not strong enough to directly and significantly influence economic growth. Febryani (2017), in his research on four ASEAN countries, he also found similar results: inflation had no significant effect on economic growth, as low and stable inflation rates in most ASEAN countries did not exert significant pressure on economic growth rates. These studies concluded that the effect of inflation on economic growth is conditional, with moderate inflation in the ASEAN region generally insignificant.

Research Method

This study uses a balanced panel data approach covering nine ASEAN member countries: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, and Thailand, over the period 2008-2023, resulting in 144 country-year observations. Vietnam and Timor-Leste were not included due to data limitations in some periods. This observation period was chosen because it encompasses key phases in the economic development of the ASEAN region, including the impact of the 2008 global financial crisis, the period of regional economic expansion, the global economic slowdown, the COVID-19 pandemic, and the post-pandemic economic recovery. The availability of good transportation infrastructure plays a strategic role in driving economic growth and development (Mahendra & Firmansyah, 2025).

The use of panel data was chosen because it can simultaneously account for cross-country and over-time variation in the data. (Hutagalung & Darnius, 2022) Panel data allow for more observations, resulting in more efficient estimates and greater degrees of freedom. (Basuki & Prawoto, 2021). Furthermore, this approach can reduce multicollinearity among independent variables and control for heterogeneity that is not directly observable in each country. In the context of this research, each ASEAN country has different economic characteristics, institutions, levels of infrastructure development, and production structures. Therefore, the use of panel data is considered the most appropriate approach for capturing cross-country variation and within-country changes over the observation period.

All data used in this study are secondary data obtained from international institutions known for their credibility and consistency in providing statistical data. Data on GDP per

capita annual % growth, Industry, including construction, value added % of GDP, Inflation, GDP deflator annual % growth, and population density people/km2 were obtained from the World Development Indicators (WDI) published by the World Bank. Meanwhile, data on the length of paved roads were obtained from the ASEAN Statistics Database (ASEANstats). Furthermore, data on paved road length were processed alongside population density data to compute the ratio of paved road length to population density, which is used as an indicator of road transportation infrastructure development. The use of uniform data sources aims to maintain consistency in definitions and measurement methods across countries, enabling more accurate comparisons of estimated results.

To improve comparability across countries, road transportation infrastructure is measured using the ratio of paved road length to population density. This measurement is intended to capture the relationship between the availability of paved road infrastructure and the spatial concentration of the population within each country. Population density is measured as the number of inhabitants per square kilometer, while paved road length represents the total length of paved roads. Therefore, the ratio of paved road length to the population density indicator reflects road infrastructure conditions relative to population density and spatial characteristics, rather than measuring road length per capita. Higher paved road length-to-population density values indicate greater paved road length relative to the observed area's population density.

Therefore, this ratio is expected to provide a complementary measure of road transportation infrastructure in cross-country analyses. It allows differences in paved road infrastructure to be considered together with differences in population density across ASEAN countries, rather than relying solely on absolute road length. The variable Industry, including construction, value added (% of GDP), is used as a control variable to capture the contribution of the industrial and construction sectors to economic growth. In contrast, the variable Inflation, GDP deflator (annual % growth) is used to control for the influence of price stability on economic growth. The use of indicators in ratio and percentage forms aims to improve data comparability across countries with different regional characteristics and population sizes, thereby providing a more consistent interpretation of the relationship between Road transportation infrastructure development and economic growth. This approach is commonly used in development economics research involving cross-country panel data. In the estimation process, the variables of the ratio of paved road length to population density and the value added of the industrial sector, including construction, are transformed into natural logarithms (ln). This transformation was performed because all observed values of the ratio of paved road length to population density and the added value of the industrial sector including construction were positive so that a natural logarithmic transformation was performed to adjust for the characteristics of the data that have a relatively high spread and range of values so that it can reduce the influence of extreme values, stabilize variance, and produce more stable and easily interpreted model estimates. In contrast, the GDP per capita growth and inflation variables measured using the GDP deflator were not transformed because they contained negative values in several observation periods, so the logarithmic transformation could not be applied.

Regression equation model:

$$PEC_{it} = \beta_0 + \beta_1 \ln _PJD_{it} + \beta_2 \ln _IND_{it} + \beta_3 INF_{it} + \epsilon_{it}$$

The dependent variable in this study is GDP per capita growth, which is the primary indicator of a country's economic development. GDP per capita growth reflects increased economic activity and the average income of the population over a given period. The main independent variable is the ratio of paved road length to population density, which is used as a proxy for road transportation infrastructure development. This ratio is intended to illustrate the relationship between paved road infrastructure and population density. Thus, this indicator incorporates differences in population density across ASEAN countries when measuring road transportation infrastructure. Road transportation infrastructure plays a strategic role in improving regional connectivity, facilitating the distribution of goods and services, reducing logistics costs, and increasing the efficiency of economic activities. Increasing the ratio of paved road length to population density is expected to contribute positively to economic growth by improving accessibility and economic activity.

In addition to the main variables, this study includes two control variables theoretically related to economic growth. The value added of the industrial sector, including construction, is used because these sectors are key drivers of production activity, creating value and generating national output, thereby contributing to economic growth. Furthermore, inflation, as measured by the GDP deflator, is used to gauge price stability in the economy. High inflation can reduce purchasing power, heighten economic uncertainty, and hinder investment and production, potentially slowing economic growth. By including these two control variables, it is hoped that estimates of the impact of road transportation infrastructure development on economic growth can be obtained more accurately and that bias due to the omission of relevant variables can be avoided.

The empirical analysis in this study was conducted using panel data regression with three approaches: the Common Effect Model (CEM), the Fixed Effect Model (FEM), and the Random Effect Model (REM). A series of model selection tests was used to determine the most appropriate model. The Chow Test was used to determine whether the Fixed Effect Model was more appropriate than the Common Effect Model. Furthermore, the Hausman Test was used to select between the Fixed Effect Model and the Random Effect Model. Furthermore, the Breusch-Pagan Lagrange Multiplier (LM) Test was used to determine whether the Random Effect Model was more appropriate than the Common Effect Model. Furthermore, a stationarity test (Levin-Lin-Chu) was conducted to ensure that the relationship found in the regression was not spurious. The model selected based on the test results was then used to interpret the research results. All data processing and estimation were carried out using Stata. To ensure valid statistical inference in the presence of heteroscedasticity and potential serial correlation across panel units, the primary Common Effect Model specification employs cluster-robust standard errors aggregated at the country level.

Results and Discussion

The result of descriptive statistics

Before estimating the panel data regression model, descriptive statistical analysis was performed to provide an overview of the characteristics, distribution, and variation of the data for each research variable. A summary of descriptive statistics for the variables GDP per capita growth (PEC), the ratio of paved road length to population density (PJD), the value added of the industrial sector, including construction, to GDP (IND), and inflation based on the GDP deflator (INF), with a total of 144 observations, is presented in Table 1.

Table 1 Descriptive statistics and correlation matrix

Descriptive statistics				
	GDP growth per capita (annual %)	**Ratio of Length of Paved Roads to Population Density**	**Value added of the industrial sector, including construction (% of GDP)**	**GDP deflator inflation (annual growth %)**
Mean	2.843	761.118	37.170	3.684
Maximum	14.430	2925.302	76.432	24.421
Minimum	-12.627	0.432	22.146	-21.739
Std. Deviation	4.057	912.817	11.759	6.222
Observations	144	144	144	144
Correlation matrix				
Annual GDP per capita growth (%)	1.000			
Ln_Ratio of the length of paved roads to population density	0.081	1.000		
Ln_Value added of the industrial sector, including construction (% of GDP)	-0.350	0.314	1.000	
GDP deflator inflation (annual growth %)	0.154	0.170	0.009	1.000

Source: Authors (processed data) by Stata 17, 2026.

The results of descriptive statistical analysis indicate that the economic growth conditions and macroeconomic indicators in nine ASEAN countries during the 2008-2023 period exhibit significant variation. These differences are reflected in the mean, standard deviation, minimum, and maximum values of the research variables. The economic growth variable, proxied by GDP per capita (annual growth), has an average of 2.843 percent, a standard deviation of 4.057 percent, a maximum of 14.430 percent, and a minimum of -12.627 percent. This indicates that during the research period, some countries experienced economic contraction, while others recorded high economic growth.

The ratio of paved road length to population density during the observation period had an average value of 761.119 with a standard deviation of 912.817. The maximum value of the ratio reached 2925.302, while the minimum value was 0.432. The substantial standard deviation highlights significant variation and spatial heterogeneity in the availability of paved road infrastructure relative to population density across ASEAN countries during the study period. Furthermore, the value-added variable for the industrial sector, including construction, as a percentage of GDP had an average of 37.170, a standard deviation of 11.759, a maximum of 76.432, and a minimum of 22.146. These results indicate that the industrial sector's contribution to the economy varies across the sample. Meanwhile, the inflation variable, measured using the GDP deflator (annual growth), had an average of 3.684, a standard deviation of 6.222, and ranged from a maximum of 24.421 to a minimum of -21.739. This shows that the inflation rate in ASEAN countries during the research period fluctuated; in some periods, deflation occurred, as indicated by negative inflation values.

Overall, the descriptive statistics show a diversity of economic characteristics among ASEAN countries during the period 2008-2023. This variation illustrates that each country has different economic growth conditions, road transportation infrastructure development, industrial sector contributions, and inflation rates. Therefore, the use of panel data in this study allows for a more comprehensive depiction of cross-country heterogeneity. In addition to descriptive statistics, a Pearson correlation matrix was computed to assess the direction and strength of the initial linear relationships among the independent variables (cross-correlation) and to serve as an early indicator of multicollinearity in the regression model. The results of the correlation matrix test are presented in Table 1.

The relationship between the ratio of paved road length to population density and inflation, as measured by the GDP deflator, shows a correlation coefficient of 0.170, indicating a weak positive relationship. The relationship between the value added of the industrial sector, including construction, and GDP and inflation, based on the GDP deflator, shows a very small correlation of 0.009, indicating no significant linear relationship between the two variables. The relationship between GDP per capita growth and the ratio of paved road length to population density shows a correlation coefficient of 0.081, indicating a very weak positive relationship. Meanwhile, the relationship between GDP per capita growth and the value added of the industrial sector, including construction, to GDP shows a negative correlation of -0.350, indicating an inverse relationship between economic growth and the industrial sector's contribution in this study sample. Furthermore, the relationship between GDP per capita growth and inflation based on the GDP deflator shows a positive correlation of 0.154, which is considered weak. Overall, there is no strong indication of multicollinearity problems between independent variables, so the regression model is suitable for further estimation using the panel data method.

Table 2 The results of panel regression

Constant & predictor variables	Dependent Variable: PEC					
	Common Effect		**Fixed Effect**		**Random Effect**	
	Estimate coefficient	**p-value**	**Estimate Coefficient**	**p-value**	**Estimate Coefficient**	**p-value**
Constant	22.423 [6.28]	0.000	31.695 [2.72]	0.007	22.724 [4.92]	0.000
Ln_PJD	0.300 [2.45]	0.040	-1.600 [-1.29]	0.201	0.296 [1.97]	0.049
Ln_IND	-5.992 [-6.34]	0.000	-5.854 [-1.65]	0.102	-6.068 [-4.53]	0.000
INF	0.082 [1.54]	0.161	0.066 [1.24]	0.218	0.080 [1.58]	0.114
Goodness of fit test						
R2/ overall	0.179		0.004		0.179	
AdjustedR2	0.161		-		-	
F-stat/Wald X2	27.31		2.85		24.08	
Prob(F-stat)	0.000		0.040		0.000	
Chow test and Breusch-Pagan (LM) test						
	Chow test				*Breusch and Pagan (LM)*	
	Effects Test	Stat	p-value	Test Summary	X2 Stat	p-value
	Cross-section F	1.25	0.276	Random cross-section	0.17	0.341
	Hausman	3.00	0.392			
Stationary Test Results (LLC)						
	Unadjusted t	Adjusted t*	P-value	Information		
PEC	-7.987	-5.138	0.000	Stationer		
Ln_PJD	-5.106	-3.551	0.000	Stationer		
Ln_IND	-5.046	-3.407	0.000	Stationer		
INF	-8.787	-2.219	0.013	Stationer		
Classical Assumption Test Results						
Test	Stat	p-value	Conclusion			
Heteroscedasticity	1.41	0.234	There is no heteroscedasticity.			
Autocorrelation	5.218	0.051	Marginal/ no severe autocorrrelation			

Note: Reported standard errors and p-values for the Common Effect Model (CEM) are adjusted for country-level clustering using cluster-robust standard errors.
Source: Authors (processed data) by Stata 17, 2026.

Table 3 Estimation Results of the bivariate model (PEC and Ln_PJD)

Constant & predictor variables	Dependent Variable: PEC					
	Common Effect		Fixed Effect		Random Effect	
	Estimate coefficient	p-value	Estimate Coefficient	p-value	Estimate Coefficient	p-value
Constant	2.184 [2.88]	0.005	15.690 [2.69]	0.008	2.677 [1.85]	0.064
Ln_PJD	0.129 [0.97]	0.334	-2.515 [-2.20]	0.029	0.032 [0.13]	0.898
Goodness of fit test						
R2/ overall	0.006		0.006		0.006	
AdjustedR2	-0.000		-		-	
F-stat/Wald X2	0.94		4.86		0.02	
Prob(F-stat)	0.333		0.029		0.897	
Chow test and Breusch-Pagan (LM) test						
	Chow test				Breusch and Pagan (LM)	
	Effects Test	Stat	p-value	Test Summary	X2 Stat	p-value
	Cross-section F	4.47	0.000	Random cross-section	16.69	0.000
	Hausman	5.24	0.022			
Classical Assumption Test Results						
Test	Stat	p-value		Conclusion		
Heteroscedasticity	4.06	0.043		Heteroscedasticity is present		
Autocorrelation	5.199	0.052		Marginal/no severe autocorrelation		

Note: Reported R^2 values for all models (FEM and REM) represent the overall R^2
Source: Authors (processed data) by Stata 17, 2026.

The bivariate estimation results presented in Table 3 provide important diagnostic insights into the baseline relationship between the ratio of paved road length to population density and economic growth in the absence of control variables. In the simple Pooled OLS specification (CEM), the coefficient of the ratio of paved road length to population density is positive but statistically insignificant ($\beta = 0.129$, $p = 0.33$), accompanied by very low explanatory power ($R^2 = 0.006$). Under the Fixed Effect Model (FEM), the Hausman test indicates a statistically significant difference between the FEM and REM estimates ($stat = 5.24, p = 0.022$. The FEM estimation produces a negative and statistically significant coefficient ($\beta = -2.515, p = 0.029$), with a relatively low overall-R^2 of 0.006. The divergence in coefficient signs across estimation approaches suggests that the relationship between road infrastructure density and economic growth is sensitive to how country-specific heterogeneity is treated. More specifically, the positive and significant relationship observed in the baseline model, with control

variables, may reflect the influence of other structural economic factors that are correlated with both road infrastructure and economic growth. Therefore, the bivariate results should be interpreted as diagnostic evidence rather than as evidence of a direct causal relationship between the ratio of paved road length to population density and economic growth.

Discussion

Before interpreting the regression results, the most appropriate panel data model was first selected. Model selection was performed using the Chow test, the Hausman test, and the Breusch-Pagan Lagrange Multiplier (LM) test. The Chow test results showed a test statistic of 1.25 with a p-value of 0.276, indicating that the Common Effect Model is more appropriate than the Fixed Effect Model. Additionally, the Hausman test yielded a test statistic of 3.00 with a p-value of 0.392, failing to reject the null hypothesis and confirming that individual fixed effects are not required. Furthermore, the Breusch-Pagan LM test yielded a statistic of 0.17 and a p-value of 0.341. A p-value greater than 0.05 indicates that the Common Effect Model is more appropriate than the Random Effect Model. Based on the results of these three tests, the panel data in this study showed no significant individual effects. Therefore, the Common Effect Model was chosen as the primary estimation model. A stationarity test (Levin-Lin-Chu) was conducted to avoid spurious regressions. The results for the variables of economic growth, length of paved roads to population density, Value Added of the Industrial Sector, and Inflation Deflator showed that all data were stationary. Furthermore, the analysis and discussion are based on the results of the CEM estimation.

The Influence of Road Transportation Infrastructure on Economic Growth

Based on the Common Effect Model (CEM) estimation results, the ratio of paved road length to population density variable has a coefficient of 0.300 with a p-value of 0.040 (significant at the $\alpha = 5\%$ level). These results indicate that the ratio of paved road length to population density is positively and significantly associated with GDP per capita growth. Every 1% increase in the ratio of paved road length to population density, ceteris paribus, is estimated to increase economic growth by 0.003 percentage points. Although the ratio of paved road length to population density remains statistically significant at the 5% level ($p = 0.040$), the estimate is relatively marginal given the nine country-level clusters utilized in the robust inference procedure. The positive association suggests that differences in the ratio of paved road length to population density indicator are related to differences in GDP per capita growth during the observation period. The result may reflect the role of road infrastructure in supporting economic activities, although the estimated relationship should not be interpreted as a causal effect. More adequate road infrastructure also facilitates the mobility of labor and goods, thereby supporting increased economic output in ASEAN countries. This result is broadly consistent with Ng et al. (2019), which reported a positive and significant relationship between road infrastructure development and economic growth using the growth of road length per thousand population as an infrastructure measure. However, the infrastructure measure used in that study differs from the ratio of paved road length to population density indicator employed in this study.

Therefore, the findings are comparable in terms of the positive direction of the relationship, but the difference in measurement should be taken into consideration. Furthermore, our positive finding contrasts with the findings of Kurniawan & Nihayah. (2021), who reported a negative effect of road infrastructure across 9 ASEAN countries for the 2008-2017 period. This empirical divergence likely stems from two key factors. First, Kurniawan & Nihayah. (2021), relied on absolute road length, our study employs a spatial density proxy (PJD) that accounts for population distribution and geographic scale. Second, by extending the observation window to 2023, our dataset captures the lagged economic returns to long-term infrastructure investments and the post-pandemic recovery of regional trade across ASEAN economies.

The Influence of Industrial Sector Added Value on Economic Growth

The industrial sector value-added variable, including construction, was included as a control variable to account for each ASEAN country's economic structure and to ensure unbiased estimation of the main variables. The industrial sector value-added variable shows a coefficient of -5.992 with a p-value of 0.000 (significant at the $\alpha = 1\%$ level). This indicates that, ceteris paribus, a 1% proportional increase in the industrial sector's share of GDP is associated with a 0.05992 percentage-point decline in per capita GDP growth. These results indicate that the industrial and construction sectors have a significant negative effect on economic growth during the observation period. This finding is in line with Djubu et al. (2025), which states that the industrial sector can negatively impact economic growth if its development is not accompanied by increased productivity, efficiency, technology adoption, and strong linkages with other economic sectors. This finding differs from Nasir & Suripto. (2025), which indicates that the manufacturing sector's value added has a positive effect on economic growth. This difference is thought to be caused by differences in the scope of the research area, observation period, and the characteristics of the variables used. This study uses panel data from nine ASEAN countries with Industry indicators, including construction value added (% of GDP), so an increase in the industrial sector's share of GDP does not necessarily reflect an increase in industrial sector productivity. Therefore, the inclusion of this control variable does not alter the study's main interpretation of the effect of the ratio of road length to population density on economic growth in ASEAN countries.

The Effect of Inflation on Economic Growth

The inflation variable based on the GDP deflator has a positive coefficient of 0.082 with a p-value of 0.161, indicating it is not statistically significant at the 5% level. This finding is in line with Damanik & Saragih (2023), which found that inflation had a positive and insignificant effect on economic growth in ASEAN, indicating that the relatively moderate inflation rate in the ASEAN region was not strong enough to influence economic growth directly.

The R^2 value of 0.179 indicates that the paved road length-to-population density variable, the industrial sector value-added variable (including construction), and the inflation variable based on the GDP deflator variables explain only 17.9% of the variation in GDP

per capita growth. In comparison, the remaining 82.1% is influenced by other variables outside the research model. This result is understandable because economic growth is a phenomenon influenced by many factors. Farzana et al. (2024) state that various factors influence a country's economic growth. Furthermore, differences in economic growth between countries are also caused by differences in the explanatory variables used in empirical models. Therefore, other factors not included in this study also influence economic growth.

Conclusion

This study aims to analyze the influence of road transportation infrastructure development, proxied by the ratio of paved road length to population density, the added value of the industrial sector (including construction), and inflation, as measured by the GDP deflator, on GDP per capita growth in the ASEAN region. Based on a series of model specification tests (Chow Test and LM Breusch-Pagan), the Common Effect Model method was selected as the best estimator for analyzing panel data with 144 observations.

The results of the study indicate that the ratio of paved road length to population density has a positive and significant effect on economic growth. This finding indicates that increasing the availability of road transportation infrastructure can drive economic growth by improving regional connectivity, enhancing the efficiency of the distribution of goods and services, and reducing logistics costs. Furthermore, the industrial sector's added value, including construction, has a significant negative effect on economic growth. These results indicate that an increase in the industrial and construction sectors' contribution to GDP is not always accompanied by an increase in short-term economic growth, possibly due to structural inefficiencies, sector-specific dependence, or low marginal productivity in these sectors. Inflation, as measured by the GDP deflator, has a positive but not statistically significant effect on economic growth.

This indicates that changes in inflation rates during the study period were not strong enough to influence economic growth in the ASEAN region. Overall, the results suggest that the ratio of paved road length to population density indicator is positively associated with GDP per capita growth during the observation period. However, this association should not be interpreted as a causal effect of road transportation infrastructure development on economic growth. However, its effectiveness is highly dependent on the quality of integration with other productive sectors and the structural conditions of each country's economy. Based on the observed positive association, ASEAN countries may consider improving paved road infrastructure while accounting for differences in population density and spatial characteristics. However, infrastructure planning should also consider broader country-specific economic and geographic conditions. This population-density-based approach aligns with the ASEAN Highway Network (AHN) policy framework, which emphasizes inclusive connectivity across regions.

Highly populated countries such as Indonesia and the Philippines need to prioritize road infrastructure budget allocation to maximize their impact on economic growth. This study

has several limitations that require attention. First, excluding Vietnam and Timor-Leste from the sample due to data limitations reduces the generalizability of the study results to the entire ASEAN region. Second, the primary infrastructure proxy relies on a population density adjustment, and future studies could incorporate a direct per-capita road measure as a robustness check. Third, given the regional interdependencies among ASEAN economies, future empirical work with extended panel timeframes could benefit from explicitly modeling cross-sectional dependence and global macroeconomic shocks. Fourth, incorporating initial GDP per capita could further account for conditional convergence dynamics across heterogeneous member states. Fifth, the use of the Common Effect Model assumes homogeneity across countries, even though ASEAN countries have diverse economic, social, and institutional characteristics, so this assumption may not fully reflect the actual conditions. Furthermore, this study includes only the paved road length variable in relation to population density, industrialization, and inflation, thereby excluding other factors that could influence economic growth. Therefore, further research is recommended to include variables such as Foreign Direct Investment (FDI), seaport infrastructure, labor force, human resource quality, and institutional quality to provide a more comprehensive picture of the determinants of economic growth in the ASEAN region.

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Author Contributions

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Conflicts of Interest

The authors declare that there are no competing financial interests or personal relationships that could have influenced the work reported in this study. The funders had no role in the study design; data collection, analysis, or interpretation; preparation of the manuscript; or the decision to submit the manuscript for publication.

Generative AI and AI-assisted

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) as a support tool for language editing to improve the manuscript's clarity, readability, and overall presentation. ChatGPT was also used to assist with figure editing, including background removal and image quality enhancement, as well as to support data analysis. All outputs generated with the assistance of ChatGPT were carefully reviewed, validated, and revised by the authors. The authors remain fully responsible for the accuracy, integrity, originality, and scientific content of the manuscript. ChatGPT was not involved in generating scientific conclusions, replacing authors' intellectual contributions, or the decision-making process regarding the research and publication.

References

Adiwinata, J., & Annisa, S. (2024). Analisis Pengaruh Industri Mikro dan Kecil terhadap Pertumbuhan Ekonomi di Indonesia dengan Pendekatan Ekonometrika Regresi Spasial Data Panel. *Ragam: Journal of Statistics and Its Application*, *3*(1), 83–96. https://doi.org/10.20527/ragam.v3i1.12799

Aschauer, D. A. (1989). Is public expenditure productive? *Journal of Monetary Economics*, *23*(2), 177–200. https://doi.org/10.1016/0304-3932(89)90047-0

Baskara, I., Ilyas, N., & Indrati, M. (2022). Tenaga Kerja, Tingkat Inflasi, Pendidikan Dan Pengangguran Pengaruhnya Terhadap Pertumbuhan Ekonomi. *Jurnal Ekonomi: Journal of Economic*, *13*(1), 118–126. https://ejurnal.esaunggul.ac.id/index.php/Eko/article/view/5236

Basuki, A. T., & Prawoto, N. (2021). *Analisis Data Panel Dalam Penelitian Ekonomi Dan Bisnis (Dilengkapi dengan Penggunaan Eviews)* (1st ed.). PT Rajagrafindo Persada.

Damanik, D., & Saragih, M. (2023). Korupsi, Inflasi dan Pertumbuhan Ekonomi di ASEAN. *EKUILNOMI : Jurnal Ekonomi Pembangunan*, *5*(1), 71–81. https://doi.org/10.36985/ekuilnomi.v5i1.494

Djubu, M. R., Abdul, I., & Dai, S. I. S. (2025). Analisis Pengaruh Industrialisasi Terhadap Pertumbuhan Ekonomi di provinsi Gorontalo. *Jurnal Studi Ekonomi Dan Pembangunan (Jsep)*, *3*(3), 641–652.

Farzana, A., Samsudin, S., & Hasan, J. (2024). Drivers of economic growth : a dynamic short panel data analysis using system GMM. *Discover Sustainability*, *5*(1), 393. https://doi.org/10.1007/s43621-024-00612-9

Febryani, T. (2017). Determinan Pertumbuhan Ekonomi di 4 Negara ASEAN. *Jurnal Ilmu Ekonomi Terapan*, *2*(1), 10–19. https://doi.org/10.20473/jiet.v2i1.5501

Ghosh, A., & Phillips, S. (1998). *Inflation, Disinflation, and Growth* (WP/98/68; IMF Working Paper No. WP/98/68).

Hutagalung, I. P., & Darnius, O. (2022). Analisis Regresi Data Panel dengan Pendekatan Common Effect Model (CEM), Fixed Effect Model (FEM), dan Random Effect Model (REM). *Jurnal Matematika Dan Pendidikan Matematika*, *5*(2), 217–226. https://doi.org/10.47662/farabi.v5i2.422

Kartiasih, F. (2019). Dampak Infrastruktur Transportasi Terhadap Pertumbuhan Ekonomi Di Indonesia Menggunakan Regresi Data Panel. *Jurnal Ilmiah Ekonomi Dan Bisnis*, *16*(1), 67–77. https://doi.org/10.31849/jieb.v16i1.2306

Krugman, P. (1990). Increasing Returns and Economic Geography. In *NBER Working Paper* (Vol. 3275).

Kurniawan, G. F., & Nihayah, D. M. (2021). Impact of Road Infrastructure and Foreign Direct Investment to Asean Economy. *Economics Development Analysis Journal*, *10*(2), 233–242. http://journal.unnes.ac.id/sju/index.php/edaj

Laode, R., Satyadharma, M., Wuga, L., & Hado. (2025). Pengembangan Transportasi dan Dampaknya terhadap Sektor Ekonomi (Kajian Literatur). *Jurnal Ekonomi, Manajemen, Bisnis Dan Akuntansi Review*, *5*(2), 1–12. https://penerbitadm.pubmedia.id/index.php/JER/article/view/2994

Mahendra, R., & Firmansyah. (2025). Peran Infrastruktur Transportasi Dalam Pertumbuhan Ekonomi: Bukti Empiris di Lima Negara Asean. *Journal of Economics and Business*, *7*(2), 68–75. https://doi.org/10.47729/indicators.v7i2.189

Mamonto, S., Arham, M. A., & Akib, F. H. Y. (2024). Pengaruh Nilai Tambah Sektor Industri , Sektor Manufaktur , Sektor Pertanian , dan Sektor Jasa Terhadap Pendapatan Nasional Bruto di Indonesia Periode 1992-2022. *Jurnal Manajemen, Bisnis Dan Akuntansi*, *3*(3), 193–215. https://doi.org/10.58192/profit.v3i3.2367

Nasir, M. S., & Suripto. (2025). Analysis of the Impact of Value Added in the Manufacturing Industry on Economic Growth in Indonesia. *BALANCE: Economic, Business, Management and Accounting Journal*, *22*(1), 1–14. https://doi.org/10.30651/blc.v22i1.24179

Ng, C. P., Law, T. H., Jakarni, F. M., & Kulanthayan, S. (2019). Road infrastructure development and economic growth. *IOP Conference Series: Materials Science and Engineering*, *512*(1). https://doi.org/10.1088/1757-899X/512/1/012045

Prasetyo, G. A. (2019). Pengaruh Pembangunan Infrastruktur Telekomunikasi Terhadap Pertumbuhan Ekonomi Di Asean. *JIET (Jurnal Ilmu Ekonomi Terapan)*, *4*(1), 47–58. https://doi.org/10.20473/jiet.v4i1.13941

Pratiwi, I. A. C., & Utama, M. S. (2022). Pengaruh Tingkat Pendidikan, Tenaga Kerja, Investasi, Dan Ekspor Terhadap Pertumbuhan Ekonomi Di Indonesia. *E-Jurnal Ekonomi Pembangunan Universitas Udayana (E-Jurnal EP Unud)*, *11*(7), 2869–2899. https://doi.org/10.24843/eep.2022.v11.i08.p08

Ramadhani, N. N., & Faridatussalam, S. R. (2024). Analisis Infrastruktur Terhadap Pertumbuhan Ekonomi di 5 Negara ASEAN. *Al Qalam: Jurnal Ilmiah Keagamaan Dan Kemasyarakatan*, *18*(2), 1125–1136. http://dx.doi.org/10.35931/aq.v18i2.3392

Revinski, R., Adry, M. R., & Akbar, U. U. (2022). Pengaruh Infrastruktur Transportasi dan Urbanisasi Terhadap Pertumbuhan Ekonomi di Negara ASEAN. *Jurnal Kajian Ekonomi Dan Pembangunan*, *4*(2), 63–68. https://doi.org/10.24036/jkep.v4i2.13363

Sari, A. C. P., & Kaluge, D. (2017). Analisis Faktor-Faktor Yang Mempengaruhi Pertumbuhan Ekonomi Asean Member Countries Pada Tahun 2011-2016. *Jurnal Ilmiah Bisnis Dan Ekonomi Asia*, *11*(1), 24–29. https://doi.org/10.32812/jibeka.v11i1.26

Sari, S. I., & Sari, C. P. M. (2021). Pengaruh Infrastruktur terhadap Pertumbuhan Ekonomi di Sumatera Selatan. *Jurnal Ekonomi Regional Unimal*, *04*(1), 49–56. https://doi.org/10.29103/jeru.v4i1.4819

Syrquin, M., & Chenery, H. B. (1989). Patterns of development, 1950 to 1983. In *World Bank discussion papers* (Issue March).

Taufik, I., & Markhamah, S. (2024). the Effect of Infrastructure Development on Economic Growth in Asean Countries: Dynamic Panel Data Analysis. *NECENT: Nusantara Economics and Entrepreneurships Journal*, *2*(1), 85–92. https://doi.org/10.59971/necent.v2i1.38

Wicaksono, B., Triwahyuningtyas, N., & Aminda, R. S. (2021). Analisis Pengaruh Jumlah Transportasi Darat, Infrastruktur dan Jumlah Penduduk Terhadap Produk Domestik Bruto (PDB) Indonesia. *JIMEA Jurnal Ilmiah MEA (Manajemen, Ekonomi, Dan Akuntansi)*, *5*(3), 1472–1487.