The Influence of Toll Road Operations on the Economy in Central Java Province

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ABSTRACT

The Trans Java Toll Road infrastructure is an integral part of the development initiatives within Central Java Province. By the end of 2018, the province witnessed a significant rise in economic activities due to the operation of several cross-Java toll roads. Therefore, this research explores the impact of road length, investment, human development index, and labor on the economy in the city area due to the operational influence of toll roads. The sample of this study was 15 cities and regencies in Central Java Province. The period studied is from 2018 to 2022. The analysis utilizes multiple regression methods, including panel and logistics regression using Eviews and Stata software. The investment analysis results have a negative coefficient with no significant effect. High foreign investment can undermine economic growth due to weak infrastructure support, low-quality human resources, and rising inflation. Therefore, for every 1% increase in investment, the gross regional domestic product will decrease by 4%. However, road length, labor, and human development index variables significantly affect the Economy in Central Java Province. Road infrastructure's impact on the economy indicates that an increase in road length per thousand population substantially affects the gross regional domestic product.

1. INTRODUCTION

The construction of the Trans Java Toll Road infrastructure is an important part of the development initiatives in Central Java Province. Sustainable infrastructure development can accelerate equitable development comprehensively [1-5]. Since the inception of several cross-Java toll roads at the end of 2018, the province has experienced rapid growth in economic activity, characterized by a relatively high population and increased travel activities. Improved road network connectivity can improve the regional economy [6-8].

The increasing population, particularly the productive age group, will be accompanied by a rise in economic activities, resulting in a high volume of movement. Therefore, stable and well-connected road infrastructure is imperative to facilitate the direction of the population [9]. However, providing road infrastructure requires a substantial amount of natural resources and human capital and can significantly impact the economy. In addition, the investment plan assessment has not been adequate for preventing traffic problems [10-12]. The construction of the Trans Java toll road serves as an indirect link between regions and can potentially improve the economy. The Inclusive Economic Development Index measures and monitors the extent of Indonesia's inclusive development at the national level. Meanwhile, economic infrastructure constitutes a metric that quantifies the extent to which economic growth is accessible to the broader community. Economic growth is not solely based on high-income figures but also on infrastructure as a supporting capacity to facilitate the achievement of targets.

This research aims to determine the economic impact on the city/regency area due to the influence of toll road operations in Central Java Province. The toll roads have contributed to rapid economic growth as the province is a trade center for the surrounding areas. This research is essential to determine the financial impact on the city/regency area due to the influence of toll road operations using regression methods, including panel and logistics regression, using Eviews and Stata software.

2. BASIC THEORY

Central Java Province has witnessed rapid economic and trade development, accompanied by increased community travel activities since the inauguration of several cross-Java toll roads at the end of 2018 [13, 14]. However, this increase has led to a decline in road capacity. The available capacity of each zone can serve as a foundation for policymakers and urban planners to establish the spatial distribution of new activities based on the transportation system's capacity. Policymakers, to avoid issues relating to traffic congestion and air pollution, it is crucial to impose restrictions on future infrastructure expansion [15].

2.1 Economic development

Harrod Domar's theory states that economic growth, in the long run, is influenced by new investment, which is a net addition to capital stock [16, 17]. At the same time, the growth theory of Robert M. Solow is a pillar that criticizes the existence of Harrod Domar's theory by adding several

indicators that will affect economic growth. Solow considers that economic growth is influenced by labor and technology [18, 19].

Economic development is increasing national and per capita income by considering the existence of a structural population and fundamental changes in a country [20].

2.2 Economy and transportation

The low quality of road infrastructure can hinder economic growth, increase logistics costs, and cause regional development disparities [21, 22]. The various problems faced by the Indonesian economy in 2020 [23] are as follows:

1) It was encouraging relatively low global economic growth in 2020 and a slowdown in export destination countries.
2) It is increasing the ability of the economy to create jobs and reduce the number of poor people.
3) Maintaining economic stability, specifically the price of goods and services and the rupiah exchange rate.

2.3 Analysis of toll road development on economic growth

Road construction is one of the triggers for an increase in a region's economy. The development of toll roads is considered one of the foremost priorities of the Nawacita program initiated by President Joko Widodo. Based on some literature, the factors that influence the development are as follows:

1) Gross regional domestic product
   According to the Central Bureau of Statistics, Domestic Products are all goods and services produced from all economic activities operating in a region. In this research, regional product means income from factors of production received from within and outside the region. The Gross Domestic Product growth rate is obtained by subtracting the value of GDP year n-1, divided by the weight of GDP year n-1, then multiplying by 100 percent. The economic growth in Central Java Province was 5,31 percent in 2022, showing a better performance than the previous year [24].
2) Labor
   Individuals who perform labor in return for a wage can be designated as workers. Under the Central Bureau of Statistics categorization, individuals between the ages of 15 to 64 years are considered part of the workforce. Therefore, this research analyzes the workforce working on toll road construction projects [25]. The total number of people working in Central Java Province in August 2022 was 18,39 million people. The sector of services was still the most worker absorber sector which took 8,16 million workers [24].
3) Long road
   The primary role of road construction is to support the development of the production and service sectors and regional growth. Infrastructure encourages economic growth, foreign investment, and domestic trading activities. Several empirical models, according to the study [26], state that the existence of infrastructure can reduce transportation costs, save travel time, and increase speed. The total length of road in Central Jawa Province is 30,447.85 km, consisting of 1,518.01 km of state roads, 2,404.75 km of provincial roads, and 26,525.10 km of regency roads [24].
4) Investment
   Investment refers to allocating resources for a specific period to generate returns. The toll road construction can trigger investment that improves economic performance [27]. Investment in economic and social infrastructure is essential to facilitate the smooth operation of all activities [20]. The realization of investment in 2022 is 16,287 domestic, regional investment projects with a total investment value of 24.99 trillion rupiahs for a foreign investment value of 33.89 trillion rupiahs [24].
5) *Human Development Index* (HDI)
   The human development index measures achievements based on the quality of life. According to the Central Bureau of Statistics, these indicators are influenced by longevity and healthy living, knowledge, and a decent standard of living. Human Development Index (HDI) in Indonesia in 2022 was about 72.91 [24].

In the hypothesis, there are two possibilities that occur rejected or accepted. If the hypothesis is rejected, then an unprecedented fact or phenomenon is needed so that it becomes a justification for the results of the study. However, if the hypothesis is accepted, it needs to be supported by previous literature.

This study analyzes the influence on the regional economy in Central Java Province. The hypothesis of this study is:

1. Labor variables have a significant effect on the gross regional domestic product in districts/cities of Central Java Province.
2. The variable length of toll roads does not have a significant effect on gross regional domestic production in districts/cities of Central Java Province.
3. Investment variables have a significant effect on the gross regional domestic product in districts/cities of Central Java Province.
4. The variable human development index has a significant effect on the gross regional domestic product in districts/cities of Central Java Province.

3. RESEARCH METHODS

3.1 Research locations

The sample of this study was 15 cities and regencies in Central Java Province. The period studied is from 2018 to 2022. The location reviewed is the city /regency passed by toll roads in Central Java Province.

3.2 Data analysis methods

This study used the Central Bureau of Statistics of Central Java Province data (Figure 1). The data taken are gross regional domestic product, investment, road length, labor, and human development index data of cities/regencies in Central Java Province. The data collection period is the period from 2018 to 2022. Data were analyzed descriptively. This research determines the Effect of the independent variable on the dependent by using multiple regression analysis, namely panel and logistic regression. The panel regression combines time series and individual data regression techniques (cross-

section), and the Chow, Hausman, and Lagrange multiplier tests carried out the determination.

Figure 1. Regencies around the toll road area in Central Java Province
Source: Data is processed in Geographic Information System (GIS) 2023

3.3 Classic assumption test

3.3.1 Normality test

The normality test was designed to determine the normal distribution of the regression model. The test used *Eviews software* by comparing the *jaque falla* (JB) value with the *Chi-Square* value. The hypothesis of the normality test is as follows:

Ho=normally distributed data
H1=data is not normally distributed

If the result of the JB > Chisquare normality test, then the hypothesis states that the residual t-test is usually distributed and vice versa.

3.3.2 Multicollinearity test

The multicollinearity test is a perfect linear relationship of several variables. The model's coefficient becomes very difficult or biased following the Effect of multicollinearity, which can be detected using the variance inflation factor (VIF). If VIF < 10, then it is free from multicollinearity. Conversely, if the value of VIF > 10, then there is multicollinearity.

3.3.3 Heteroscedasticity test

The heteroscedasticity test appears when the errors or residuals of the experienced model do not have a constant variance from one observation to another. This explains that observations have different reliability due to changes in conditions that will be behind in the model specifications. If the model occurs, heteroskedasticity problems by looking at the probability value of chi-square > significance value. If the value is > 0.05, then the heteroskedasticity test is accepted.

3.3.4 Autocorrelation test

Autocorrelation occurs when successive observations over time exhibit a degree of interdependence. This issue frequently arises due to residuals that show a lack of independence among statements. The *Durbin-Watson statistical test (DW-statistic)* is employed from the regression outcomes to check for autocorrelation issues in the model. Meanwhile, the model is considered valid when it does not contain the classical assumption test problem. The equation is as follows:

$$GDP = \int(tk, pj, inv) \tag{1}$$

Information:
GDP=gross domestic product (Rp)
tk=labor (people)
PJ=road length (km)
inv=investment (Rp)

The linear regression equation in this study is stated as follows:

$$Y_{it} = \propto_1 TK_{it} + \propto_2 PJ_{it} + \propto_3 Inv_{it} + \varepsilon_{it} \tag{2}$$

3.4 Research management

This study aims to determine what factors affect the improvement of the community's economy. The research steps are as follows:
1) Step 1 is to conduct an analysis related to relevant journals on the impact of toll roads on the economy.
2) Analyze variables that are thought to affect the impact of the toll road economy on the area, including labor, human development index, investment, and road length to gross regional domestic product.
3) Economic impact analysis using panel regression with generated least square model. The software used to process this data is E-views.
4) The result of the study is then interpreted and compared with relevant previous research.

4. RESULTS AND DISCUSSION

4.1 Descriptive region

As the provincial capital, Semarang City has the highest gross regional domestic product value compared to other cities/regencies in 2022, increased to IDR 152,999,374,-. The description of districts in Central Java is presented in Figure 2.
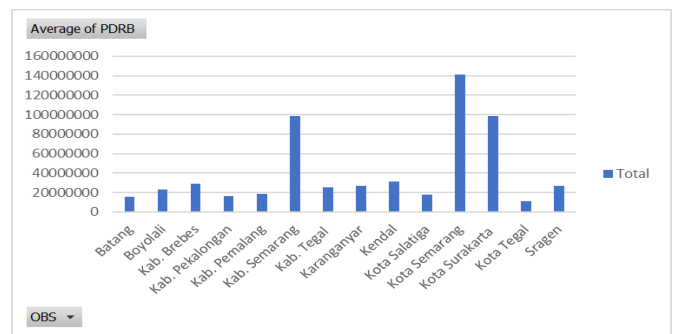

Figure 2. The descriptive region in Central Java Province
Source: research data [24] (processed 2023)

4.2 Panel model selection

The panel regression analysis combines cross-section data with time series, and *common, fixed,* and *random effects* testing should be conducted to identify the model.

Subsequently, it is necessary to conduct a model specifications analysis using *Chow, Hausman,* and *Lagrange multiplier* (LM) tests explained in the hypothesis as follows:
Chow test hypothesis:
Ho=*common effect model*
Ha=*fixed effect model*

Table 1. Chow test

Redundant Fixed Effect Test			
Equation: EQ01			
Test cross-section fixed effects			
Effects Test	**Statistic**	**df**	**Prob.**
Cross-section F	36.234418	(13,45)	0,0000

Source: research data (processed 2023)

The *Chow test* results show that the chi-square probability is 0.0000 < 0,05 (Table 1). Therefore, Ho (*common effect)* and Ha (*fixed effect*) is rejected and accepted, respectively. The subsequent analysis is the *Hausman test* which is used to determine the random or fixed effect method used in the hypothesis as follows:

Ho=*random effect model*
Ha=*fixed effect*

Table 2. Hausman test

Correlated Random Effects – Hausman Test			
Equation: EQ01			
Test cross-section random effects			
Test Summary	**Chi sq. Statistic**	**Chi-Sq. df**	**Prob**
Cross-section random	0,00000	4	1,0000

Source: research data (processed 2023)

The results of the *Hausman test* can be seen that the probability value is 1.0000 > 0.05 (Table 2). The *test* rejects Ha (*fixed effect)* and accepts Ho (*random effect*). Furthermore, it is necessary to conduct a *Lagrange Multiplier* (LM) test with the following hypothesis:

Ho=*common effect model*
Ha=*random effect model*

Table 3. Lagrange Multiplier (LM) test

Lagrange Multiplier Test for Random Effects			
Null hypotheses: No effects			
Alternative hypotheses: Two-sided (Breush-Pagan) and one_sided (all others) alternatives			
	Cross-section	**Time**	**Both**
Breush-Pagan	7,309533	0,769344	8,078877
	(0,0069)	(0,3804)	(0,0045)

Source: research data (processed 2023)

The Lagrange Multiplier (LM) test results show the probability values in the cross-section, time, and both variables with probability values including 0.0069, 0.3804, and 0.0045 (Table 3). These results show that the probability of both is 0.0045. Hence hypotheses Ho=*common effect model* and Ha=*random effect model* (REM) are rejected and accepted, respectively. It can be concluded that the best model is based on *Chow, Hausman,* and LM tests.

4.3 Classical assumption test

The normality test was designed to determine the normal distribution of the regression model.

4.3.1 Normality test
The normality test is used to determine the normal distribution of the data. The result is seen in the *Jaque-Bera value*. The data is normally distributed when the value exceeds alpha (0.05), as shown in the table.

Table 4. Normality test

Jaque-Bera	0,541888
Probability	0,762659

*Significance level > 0.05
Source: research data (processed 2023)

The table results show the value of probability (P-value), namely 0.762659 > 0.05 (Table 4). Based on these values, it can be inferred that the data follows a normal distribution of the normality test.

4.3.2 Heteroscedasticity test
The heteroscedasticity test occurs when the error value is not constant or changes with the independent variable. This existence causes the regression coefficient to be biased and become invalid. The following are the results of the heteroscedasticity using the Park test as follows:

Table 5. Heteroscedasticity test

Variable	Coefficient	Std Error	t-statistic	Prob.
C	-2,50479	5,689861	-0,440221	0,6614
Log(inv)	-0,212793	0,143515	-1,482717	0,1436
Log(pj)	-0,015866	0,097085	-1,090439	0,2800
ipm	0,00094	0,000571	1,584113	0,1186
Log(tk)	-0,794559	0,419803	-1,892696	0,0634

Source: research data (processed 2023)

The results show that the independent variables, including log(inv), log(pj), IPM, and log(tk), have a probability above 0.05 (Table 5). It means that the model is free from heteroscedasticity.

4.3.3 Multicollinearity test
The multicollinearity test is used to test the correlation between the independent variables in the research. The problem arising in a model signifies a definitive relationship between one or more variables, which ultimately leads to the regression failing to demonstrate the actual Effect. The following are the results of the multicollinearity test using *Eviews 9* software (Table 6):

Table 6. Multicollinearity test

	PJ	INV	IPM	TK
PJ	1,000000	-0,13342	-0,032727	-0,291125
INV	-0,183342	1,000000	0,231161	0,431088
IPM	-0,032727	0,231161	1,000000	-0,327938
TK	-0,291125	0,431088	-0,327938	1,000000

Source: research data, processed (2023)

The results show that the data for each dependent variable are free from multicollinearity because PJ (road length), INV (investment), IPM (human development index), and TK (labor) have a nominal value of less than 0.8.

4.4 Statistic test

The partial regression coefficient test (t-test) determines the relationship between each independent variable to the dependent. The dependent variable is the gross regional domestic product (PDRB), while the independent are road length, investment, human development index, and labor. The model uses GLS (*generalized least squares*) with the results (Table 7):

Table 7. Regression test of the random effect model

Variable	Coefficient	Std. Error	t-statistic	Prob.
C	2,892914	0,433338	6,675881	0,00000**
Log(pj)	0,067735	0,018917	3,580557	0,00007**
Log(inv)	-0,004199	0,009122	-0,460281	0,6470
Ipm	0,001018	3,92E-05	25,96651	0,0000**
Log(tk)	0,999782	0,0038034	26,28671	0,0000**

Source: research data (processed 2023)

Information
α=0.05
**) significant

Based on the data processing with *Eviews 9 software*, the panel data regression equation is as follows:

$$Log(gdp) = \propto + \beta_1 Log(pj)_{it} + \beta_2 \log(inv)_{it} + \beta_3 ipm_{it} + \beta_4 \log(tk)_{it} + \varepsilon_{it} \quad (3)$$

The equation after processing the data is:

$$Log(gdp) = 2,892914 + 0,067735\ pj - 0,004199\ inv + 0,001018 ipm + 0,999782\ tk \quad (4)$$

where:
PJ=road length (km)
INV=investment (million rupiah)
IPM=human development index (%)
TK=labor force (thousands of people)
GDP=gross regional domestic product (million rupiahs)

The interpretation of the above model is as follows:

1) Road length has a positive coefficient on the gross regional domestic product. The regional gross domestic product is expected to grow by 67% when the road's length increases by 1%.
2) Investment has a negative coefficient and no significant effect. It means that when investment increases by 1%, the gross regional domestic product will decrease by 4%. This variable has no significant impact on the Economy in Central Java Province.
3) The human development index has a positive coefficient. The gross domestic product will increase by 10% when the human development index grows by 1%.
4) Labor significantly influences the gross regional domestic product in Central Java province, as well as a positive coefficient. It means that when the workforce increases by 1%, the gross domestic product grows by 99%.

4.5 Simultaneous regression coefficient test (F Test)

The F test is used to determine the regression model on the independent variables simultaneously with the dependent variable. Based on the results of data processing, the F test was obtained as follows (Table 8):

Table 8. F-statistic test

F-statistic	360,6085
Prob (F-Statistic)	0,00000

Source: research data, processed (2023)

Based on the statistical F-test, the probability value in the research model is 0.0000 < 0.05. Therefore, the model is an independent variable simultaneously affecting the dependent variable.

4.6 Coefficient of determination

The coefficient of determination (R^2) can be used to determine the ability of the independent variables to affect the dependent variable. The function is to measure the dependent variable, and based on the results of data processing, the coefficients are as follows (Table 9):

Table 9. Coefficient of determination

R-squared	0,961345
Adjusted R-square	0,958679

Source: research data, processed (2023)

The table shows that the R^2 value is 0.961345 while the Adjusted R-Square value is 0.958679. Therefore, the model can explain 96.13% of the independent variables in the study, and others explain the remaining 3.87%.

4.7 Economic interpretation in regencies in Central Java Province

4.7.1 The effect of road length on the economy in the districts of Central Java Province
The provision of physical infrastructure affects the movement of people and increases the trade sector. Research examining road infrastructure's impact on the economy indicates that an increase in road length per thousand population significantly affects the gross regional domestic product. It is supported by research [21, 28], where there is a significant relationship between road infrastructure and the economy. Previous literature and research have demonstrated a significant correlation between road infrastructure and the economy in terms of their results and hypotheses.

4.7.2 The effect of investment on the economy in the districts of Central Java Province
The investment consists of both foreign direct and domestic investment. The results show that investment has no significant effect on the economy in the districts/cities of Central Java Province. The assertion appears inconsistent with the existing body of research and associated hypotheses, as demonstrated by the findings of the study [29], where foreign investment positively impacts the economy. It is because high foreign investment can undermine economic growth due to weak infrastructure support, low-quality human resources, and rising inflation. Furthermore, the research [30] shows that increased investment hurt economic growth during Joko Widodo's presidency. The research [31] shows that investment significantly affects the economy by increasing the productivity of goods and services in each sector.

4.7.3 The Effect of the human development index on the economy in the Districts of Central Java Province
The research results show that the human development index has a significant relationship with economic growth. It is also consistent with the research [32], where there is a significant relationship between the economy and the human development index. Moreover, the research [33] explained that the human development index significantly affects economic growth. Research [22] stated a reciprocal relationship exists between economic growth, infrastructure, and development.

4.7.4 The influence of labor on the economy in the districts/cities of Central Java Province

The results of the research found that the workforce has a significant influence on the Economy in Central Java Province. It is in line with research [34], where there is a significant relationship between labor and the economy in an industrial area. Increasing the workforce is important for the inclusion of economic development in regions with a transformation structure from a labor-intensive agricultural to a more capital-intensive manufacturing-based economy. These structural changes affect the workforce, which can absorb a lot of labor until it decreases [35]. It is in line with research [36], where the labor variable has no significant long-term or short-term Effect on the gross domestic product. This can be attributed to poor workforce skills, resulting in reduced productivity with growing workers.

5. CONCLUSION

Based on the analysis and discussion that has been described previously, it can be concluded that:
1. The construction of toll roads in Central Java Province has an impact on the people's economy.
2. The investment analysis results have a negative coefficient with no significant effect. It is because high foreign investment can undermine economic growth due to weak infrastructure support, low-quality human resources, and rising inflation. Investment in several regencies/cities is still classified as small and does not spread over several sectors.
3. Road length, labor, and human development index variables significantly affect the Economy in Central Java Province. Road infrastructure's impact on the economy indicates that an increase in road length per thousand population significantly affects the gross regional domestic product. Increasing the workforce is important for the inclusion of economic development in regions with a transformation structure.
4. Investment in several regencies/cities is still classified as small and does not spread over several sectors.

6. SUGGESTIONS

Suggestions are provided based on the analysis and discussion that has been described previously:
1. There is a need for a study on the impact of the construction of new roads specifically regarding the social and economic impacts of the community.
2. Infrastructure development should be carried out evenly in the center and outskirts of the city to increase investment value through the absorption of human resources.
3. Increasing the human development index and labor skills is necessary to further the economy.
4. As a policy maker, the government should continue to ensure transportation services by providing non-jammed traffic options.

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