The impacts of infrastructure development on economic growth (case study: DKI Jakarta, Banten Province and West Java Province)

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Abstract. This research investigates the impacts of infrastructure development on economic growth. The scope of this study includes all regencies and cities in three provinces, namely West Java, DKI Jakarta, and Banten. These provinces are chosen because of their strong connection between economic activities and infrastructure. The method combines the analysis of regional economic growth with regional infrastructure development. Regional economic growth in every city/regency of the three provinces is measured by the Share of GDP, Human Development Index (HDI), and Head Count Index (HCI) of poverty. Infrastructure is defined by transportation (road), sanitation, electricity, clean water, educational facilities, medical facilities, and waste infrastructure. This research uses multiple regression to analyze the impact of infrastructure indicators on regional economic growth. This research is expected to contribute to science, especially in the area of Regional and City Planning. The results of this research are infrastructure indicators with significant impacts on economic growth indicators, both positive and negative.

1. Introduction
The development of infrastructure has a positive impact on human activities. The construction of the Trans Java Toll Road can change agricultural into non-agricultural activities (urban activities) that will further increase the economic activity [1]. At one research argues that the construction of a bridge connecting the two islands in Indonesia is sufficient to involve economic inspectors between the two islands and reduce inter-island finance [2]. However, the other study argues that infrastructure improvement has a small role in driving the economy, household income, and encouraging labor if being compared to industrial sector improvement [3].

Infrastructure Development is the epicenter of the development center of other activities such as socio-economic, welfare, and prosperity of the community, as infrastructure facilitates the community's activities. There is a research that explains the complex relationship between the infrastructure and the economy. On one side, infrastructure can reduce production costs from industrial processes. On the other side, in some developing countries, for example, there has been a decline in exports due to increased transportation costs and the inability to provide ports. [4]

The increasing demand for infrastructure as a result of changes in economic activity and socio-cultural society has an impact on the government's efforts in developing infrastructure. The
government faces three main challenges in maintaining infrastructure and improving its level of service. First, the construction of facilities and infrastructure requires a very large capital, a long payback period, extensive land use, high technology utilization, and the planning, and implementation process needs a long time to reach a certain economic scale. However, the ability of the national economy is currently very limited, both government and the private sector funds. Second, the construction of facilities and infrastructure is a precondition for new development opportunities in various fields. Population growth encourages additional facilities and infrastructure services provision. Third, facing global competition as well as meeting the demands of the community for facilities and infrastructure services require restructuring in the operation of facilities and infrastructure services. To accelerate Indonesia's economic recovery, the construction of facilities and infrastructure along with the supporting services is carried out by taking into account the following criteria: (1) create a large number of jobs, either directly or indirectly; (2) support regional economic development; (3) create maximum economic benefits to the communities adjacent to the infrastructure projects; and (4) economically and financially feasible to attract domestic and foreign investors. Previous research uses attributes in determining regional development, namely the Regional/Regional GDP per capita and the Human Development Index (HDI) [5]. Another challenge for a large country such as Indonesia is infrastructure provision to support economic activities. One of the crucial things is the infrastructure that boosts connectivity between regions to accelerate and expand Indonesia's economic growth. Improved connectivity will reduce transportation costs and logistics costs, increase product competitiveness, and accelerate economic mobility. Therefore, this study aims to identify the impact of infrastructure on economic growth. The scope of this study includes all regencies and cities in three provinces, namely West Java, DKI Jakarta, and Banten. The three provinces are chosen because of the strong connection between economic activities and infrastructure among them. Also, community activities in the three provinces are interrelated, resulting in opportunities for economic investment growth to increase. It is expected that in the future cities in the three Provinces can become samples for developing urban infrastructure to support sustainable development in other provinces.

2. Method and Indicator
This study aims to analyze the impact of infrastructure on economic growth. This study uses secondary data and desk study for data collecting. The analytical method used in this study is the multiple regression that combines transportation indicators as independent variables against economic indicators as the dependent variable. In a previous study, it has been analyzed the effect of infrastructure on regional economic growth in Indonesia using the regression method, this study results in electricity, road length, and clean water variables have a positive effect on Indonesia's economic growth [6]. Meanwhile, the other study uses a regression method in identifying the effect of infrastructure conditions on economic growth in West Java. In his research, he finds that the variable road, education, and electricity have a positive influence on economic growth in West Java [7]. The following table is a number of regional infrastructure indicators used in previous studies in identifying their effects on economic growth.

**Table 1. Indicators and References. (Source: Desk Study, 2020)**

| Indicators                        | References                           |
|----------------------------------|--------------------------------------|
| Gross Domestic Product (GDP)     | Prasetyo, Firdaus, 2009               |
|                                  | Maqin, 2011                           |
|                                  | Maryaningsih, Hermansyah, Savitri, 2014 |
|                                  | Warsilan, Noor, 2015                  |
|                                  | Lestari, Suhadak, 2019                |
| Human Development Index (HDI)    | Cutanda, A., & Paricio, J., 1994     |
|                                  | Lestari, Suhadak, 2019                |
| Poverty Gap Index                | Warsilan, Noor, 2015                  |
|                                  | Lestari, Suhadak, 2019                |
There is a study that uses panel data estimation techniques and identifies that the average school tenure, electricity, roads, port loading and unloading, and the level of trade openness significantly affects economic growth [8]. Moreover, there is a research used regression analysis in assessing the impact of infrastructure on economic growth. The analysis result states that road, railroad, transportation infrastructure, and electricity have positive effects on economic growth and the level of global competition [9]. Other research uses the augmented gravity model method in identifying the impact of infrastructure on economic growth and stated that variable road networks, air transportation, railroads, ports, logistics, and information infrastructure can have a positive influence on the level of trade in Asia [10]. Furthermore, a regression method has been used in identifying regional infrastructure and economies in Spain. They suggest that transportation and communication indicators have significant impacts on the regional economy [11]. In one study, they use the regression method and the Analytical Hierarchy Process (AHP). They suggest that the indicators of clinics, clean water, and roads have a positive influence on economic improvement and reducing poverty [12]. The addition of road lengths and road facilities is a priority for increasing economic growth. The use of the PLS inner model method in identifying the effect of infrastructure development on Indonesia's economic growth, they conclude that variables that positively affect economic growth include road infrastructure, electricity, and clean water [13]. These indicators are presented in Table 2.

**Table 2.** Economic growth dan infrastructure indicator. (Source: Desk Study, 2020)

| Criteria              | Indicator                                |
|-----------------------|------------------------------------------|
| Economic Growth       | Gross Domestic Product (GDP)             |
|                       | Human Development Index                  |
|                       | Head Count Index (HCI) of Poverty        |
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| Criteria       | Indicator                      |
|----------------|--------------------------------|
| Infrastructure | Transportation (Road)          |
|                | Sanitation                     |
|                | Electricity                    |
|                | Clean Water                    |
|                | Educational Facilities        |
|                | Medical Facilities             |
|                | Waste infrastructure           |

Indicators for economic growth are defined by Gross Domestic Product (GDP), the Human Development Index, and Head Count Index (HCI) of poverty. Transport infrastructure is represented by the length of roads. Sanitation is represented by the percentage of improved sanitation. Electricity is represented by the percentage of electricity use. Clean water infrastructure is represented by the percentage of piped water. Educational facilities are represented by several indicators, namely the number of elementary schools, the number of junior high schools, the number of senior high schools, and the number of universities. Furthermore, medical facilities are represented by the number of hospitals, and the waste management system is used as an indicator of waste infrastructure.

3. Case Study overview: DKI Jakarta, Banten Province, and West Java Province

The research area includes the provinces of DKI Jakarta, Banten, and West Java. These three provinces are the parts of the Greater Jakarta metropolitan areas (Jakarta, Bogor, Depok, Tangerang, Bekasi). The Regencies and Cities in all three provinces and the area of each regency/city can be seen in Table 3.

Tabel 3. Regency and City Area in DKI Jakarta, Jawa Barat Province, and Banten Province. (Source: BPS, 2019)

| No  | Regency/City      | Area (ha) |
|-----|------------------|-----------|
| 1   | Bogor Regency    | 2710.02   |
| 2   | Sukabumi Regency | 4145.7    |
| 3   | Cianjur Regency  | 3840.16   |
| 4   | Bandung Regency  | 1767.96   |
| 5   | Garut Regency    | 3074.07   |
| 6   | Tasikmalaya Regency | 2551.19 |
| 7   | Ciamis Regency   | 1414.71   |
| 8   | Kuningan Regency | 1110.56   |
| 9   | Cirebon Regency  | 984.52    |
| 10  | Majalengka Regency | 1204.24 |
| 11  | Sumedang Regency | 1518.33   |
| 12  | Indramayu Regency | 2040.11 |
| 13  | Subang Regency   | 1893.95   |
| 14  | Purwakarta Regency | 825.74  |
| 15  | Karawang Regency | 1652.2    |
| 16  | Bekasi Regency   | 1224.88   |
| 17  | Bandung Barat Regency | 1305.77 |
| 18  | Pangandaran Regency | 1010    |
|     |                  |           |
| 19  |                  |           |
| 20  |                  |           |
| 21  |                  |           |
| 22  | Cirebon City     | 37.36     |
| 23  | Bekasi City      | 206.61    |
| 24  | Depok City       | 200.29    |
| 25  | Cimahi City      | 39.27     |
| 26  | Tasikmalaya City | 171.61    |
| 27  | Banjar City      | 113.49    |
|     |                  |           |
|     |                  |           |
|     |                  |           |
|     |                  |           |

DKI Jakarta

| No  | Regency/City       | Area (ha) |
|-----|--------------------|-----------|
| 1   | Kepulauan Seribu   | 8.7       |
| 2   | Jakarta Selatan City | 141.27  |
| 3   | Jakarta Timur City  | 188.03    |
| 4   | Jakarta Pusat City  | 48.13     |
| 5   | Jakarta Barat City  | 129.54    |
| 6   | Jakarta Utara City  | 146.66    |

Banten Province

| No  | Regency/City       | Area (ha) |
|-----|--------------------|-----------|
| 1   | Pandeglang Regency | 2746.89   |
| 2   | Lebak Regency      | 3426.56   |
| 3   | Tangerang Regency  | 1011.86   |
| 4   | Serang Regency     | 1734.28   |
| 5   | Tangerang City     | 153.93    |
According to [14], DKI Jakarta is the capital city of Indonesia, having a land area of 662.33 km$^2$ and an ocean of 6,977.5 km$^2$. DKI Jakarta has 110 islands spread across the Kepulauan Seribu Regency. As the nation’s capital, DKI Jakarta consists of one administrative Regency and five administrative cities. According to 2018 data, DKI Jakarta has a number of Education facilities consisting of 2,476 Elementary Schools; 1,071 Junior High Schools; 489 Senior High Schools; and 320 universities. The number of hospitals in DKI Jakarta is 205 units. The number of poor people in DKI Jakarta in 2018 was 373,120,000 people. Human Development Index (HDI) in DKI Jakarta at 80.47. DKI Jakarta HDI in 2018 was increased compared to 2017.

West Java Province has an administrative area consisting of 18 Regencies and 9 Cities. West Java Province has a land area of 35,377.76 km$^2$. The Human Development Index (HDI) in West Java increased from 2013 to 2018. In 2018, the HDI of West Java Province amounted to 71.3. The poverty gap index in the Province of West Java in 2017 was 1.32 in urban and rural areas.

Banten Province has an administrative area consisting of 4 Regencies and 4 Cities. The area of Banten Province is 9,622.92 km$^2$. In 2018, there were 4,562 units of Elementary Schools, 1,421 Junior High Schools, and 529 Senior High Schools. The percentage of poverty in Banten Province in 2018 was 5.45%. The Human Development Index (HDI) in Banten Province in 2018 was 71.95, an increase from the previous year which reached 71.42. Banten Province per capita expenditure of 11.99 million rupiahs per year. In 2018, the length of roads in Banten Province was 549.41 km in good condition, 147.13 km in moderate condition, and 22.3 km in heavily damaged condition.

\begin{table}
\centering
\begin{tabular}{|c|c|c|c|c|}
\hline
No & Regency/City & Area (ha) & No & Regency/City & Area (ha) \\
\hline
19 & Bogor City & 118.5 & 6 & Cilegon City & 175.5 \\
20 & Sukabumi City & 48.25 & 7 & Serang City & 266.71 \\
21 & Bandung City & 167.67 & 8 & Tangerang Selatan City & 147.19 \\
\hline
\end{tabular}
\end{table}

\textbf{Figure 1.} Area of DKI Jakarta, Banten Province, and West Java Province (Source: tanahair.indonesia.go.id, 2020)
Figure 1 shows the area of DKI Jakarta, Banten Province and West Java Province. Administrative boundaries of the three provinces include: to the north are the Java Sea; in the east bordering Central Java Province; the south borders the Indonesian Ocean; and to the west is bordered by the Sunda Strait.

4. Result and Discussion
The data is sourced from 2018 in DKI Jakarta, Banten Province, and West Java Province. Indicators of economic growth used in this study are the Share of Regional GDP, Human Development Index (HDI), and Head Count Index (HCI) of Poverty. Regional infrastructure indicators uses in this study including the length of roads, Percent of Improved Sanitation, electricity user percentage, piped water percentage, the number of Elementary Schools, the number of Junior High Schools, the number of Senior High Schools, the number of Universities, the number of Hospital, and level of service in Waste Management. The following are the distribution of panel data that is used in this research.

| Table 4. Data Distribution. (Source: Analysis, 2020) |
|------------------------------------------------------|
| **Indicators** | **Mean** | **Max** | **Min** | **Deviation Std** |
| Economic Growth | | | | |
| GDP | 88,052.32 | 424,324.60 | 3,066.88 | 111,894.51 |
| HDI | 72.29 | 84.44 | 63.37 | 5.91 |
| HCI | 7.01 | 12.71 | 1.68 | 3.05 |
| Infrastructure | | | | |
| Length of Road (km) | 170,491.13 | 2,437,779.95 | 0.2 | 504,014.72 |
| Percent of improved sanitation (%) | 62.59 | 98.72 | 0.20 | 27.02 |
| Percent of electricity user(%) | 98.96 | 100.00 | 87.85 | 2.46 |
| Percent of piped water (%) | 7.27 | 46.46 | 0 | 9.37 |
| Number of Elementary School | 648.07 | 1801.00 | 14.00 | 418.83 |
| Number of Junior High School | 185.20 | 662.00 | 7 | 124.21 |
| Number of Senior High School | 62.73 | 178.00 | 1 | 43.85 |
| Number of Universities | 20.05 | 105.00 | 0 | 26.39 |
| Number of Hospital | 13.34 | 62.00 | 0 | 12.15 |
| Level of Service in waste management | 69.57 | 115.91 | 34.31 | 19.35 |

The following are the results of calculations using the multiple regression method. This calculation predicts the impact of infrastructure on economic growth (Share of GDP).

| Table 5. Table of the results of calculations using the multiple regression method to predicts the impact of infrastructure on economic growth (Share of GDP). |
|---------------------------------------------------------------|
| **Stepwise Selection of Terms** | **α to enter = 0.05, α to remove = 0.05** |
| **Model Summary** | **S** | **R-sq** | **R-sq (adj)** | **R-sq (pred)** |
| | 4.78513 | 64.70% | 60.78% | 46.18% |
| Durbin-Watson Statistic | 1.09781 |

A multiple regression model of the impact of infrastructure on the Share GDP indicator in the area of DKI Jakarta, Banten Province, and West Java Province is generated. The model shows that the Durbin Watson value for this analysis is 1.09. The Durbin Watson value indicates that no autocorrelation was found between the variables used in the regression model. The R-square value indicates that 64.70% of this regression model can be explained by the indicators used in this study, and the rest (35.3%) is explained by other indicators. The Confidence level of this analysis is 0.05.
Indicators that significantly affect the Share of GDP include the length of roads, the percentage of piped water, number of hospitals, and the level of service in waste management. Indicators that do not significantly affect the Share GDP model are Percent of Improved Sanitation, Consumer Electricity Percentage, Number of Elementary Schools, Number of Junior High Schools, Number of Senior High Schools, and Number of Universities. Regression models for GDP in DKI Jakarta, Banten Province, and West Java Province can be seen as follows.

**Table 6.** Table of the regression models for GDP in DKI Jakarta, Banten Province, and West Java Province.

| Term                        | Coef      | SE Coef | T-Value | P-Value | VIF |
|-----------------------------|-----------|---------|---------|---------|-----|
| Constant                    | -3.05     | 2.94    | -1.04   | 0.306   |     |
| Road                        | 0.000006  | 0.000002| 3.62    | 0.001   | 1.36|
| Percentage leading piped water | -0.2666  | 0.0883  | -3.02   | 0.005   | 1.20|
| Number of Hospital          | 0.2641    | 0.0724  | 3.65    | 0.001   | 1.35|
| Waste Management LoS        | 0.1108    | 0.0454  | 2.44    | 0.020   | 1.35|

*Regression Equation*

\[
\text{Share GDP} = -3.05 + 0.000006 \text{Road} - 0.2666 \text{Percentage leading piped water} + 0.2641 \text{Number of Hospital} + 0.1108 \text{Waste Management LoS}
\]

The regression model of the influence of infrastructure on Share GDP produces four indicators that have a significant effect. Each increase in the indicator length of roads, number of hospitals, and the level of service in waste management will increase GDP Share from Regency and City of DKI Jakarta, Banten Province and West Java Province. Each increase in the piped water Percentage indicator will reduce Share GDP from the DKI Jakarta Regency/City, Banten Province and West Java Province. The following are the results of calculations using the multiple regression method. This calculation predicts the impact of infrastructure on economic growth (Human Development Index).

**Table 7.** Table of the results of calculations using the multiple regression method to predicts the impact of infrastructure on economic growth (Human Development Index).

| Stepwise Selection of Terms | α to enter = 0.05, α to remove = 0.05 |
|-----------------------------|---------------------------------------|
| Model Summary               | R-Sq       | R-Sq (adj) | R-Sq (pred) |
| S                           | 2.19141    | 87.29%     | 86.26%      | 84.06%     |
| Durbin-Watson Statistic     | 1.95027    |            |             |             |
Table 8. Table of the regression models for HDI in DKI Jakarta, Banten Province, and West Java Province.

| Term                   | Coef   | SE Coef  | T-Value | P-Value | VIF |
|------------------------|--------|----------|---------|---------|-----|
| Constant               | 62.86  | 1.11     | 56.56   | 0.000   | 1.94|
| Road                   | 0.000003 | 0.000001 | 3.07    | 0.004   | 1.38|
| Percentage of Improved Sanitation | 0.0697 | 0.0150 | 4.63    | 0.000   | 1.38|
| Junior High School     | 0.07862 | 0.00684 | 11.49   | 0.000   | 1.54|

Regression Equation
Human Development Index = 62.86 + 0.000003 Road + 0.0697 Percentage of Improved Sanitation + 0.07862 Junior High School

The regression model of the impact of infrastructure on HDI produces three indicators that have a significant effect. Each increase in the length of the road, the percentage of improved sanitation, and the number of junior high schools will increase HDI in the regencies/cities of Banten Province and West Java Province. The most powerful indicator in influencing HDI is the number of junior high schools of 0.078. The following are the results of calculations using the multiple regression method.

Table 9. Table of the results of calculations using the multiple regression method to predicts the impact of infrastructure on economic growth (HCI of Poverty).

| Stepwise Selection of Terms | α to enter = 0.05, α to remove = 0.05 |
|------------------------------|----------------------------------|
| Model Summary                | S      | R-sq     | R-sq (adj) | R-sq (pred) |
|------------------------------|--------|----------|------------|-------------|
| Durbin-Watson Statistic      | 2.20846 | 50.12%   | 47.50%    | 39.32%      |

The calculation of the regression model of the impact of infrastructure on the Head Count Index (HCI) of Poverty indicator in the area of DKI Jakarta, Banten Province, and West Java Province shows that the Durbin Watson value for this analysis is 1.81. The Durbin Watson value indicates that no autocorrelation is found between the variables used in the infrastructure regression model against the Head Count Index (HCI) of Poverty. The R-square value indicates that 50.12% of this model can be explained by the indicators used in this study, and the rest (49.88%) is explained by other indicators outside of this model. Furthermore, the R-square value (50.12%) also indicates that the model cannot represent the impact of infrastructure on HCI of poverty.

Based on the results of the three multiple regression analysis in identifying the impact of infrastructure on economic growth, there are several significant infrastructure indicators on economic growth indicators, which can be seen in the following table.

Table 10. Significant and not significant infrastructure indicator on economic growth. (Source: Analysis, 2020)

| Economic Growth Indicator | Infrastructure indicator |
|---------------------------|--------------------------|
| Share of GDP              | Length of road           |
|                           | Percent of Improved Sanitation |
|                           | Percentage of leding piped water |
|                           | Number of hospital       |
|                           | Level of Service in Waste management |
| Human Development Index (HDI) | Length of road       |
|                           | Percentage of improved sanitation |
|                           | Number of junior high school |
|                           | Percentage of electricity consumer |
|                           | Number of hospital       |
|                           | Level of Service on waste management |
Infrastructure indicators with significant effects on economic growth indicators have positive and negative impacts. These indicators can be seen in the following table.

**Table 11.** Positive and negative impact infrastructure indicator on economic growth. (Source: Analysis, 2020)

| Economic Growth Indicator | Infrastructure indicator |
|---------------------------|--------------------------|
| Share of GDP              | Length of road           |
|                           | Number of hospital       |
|                           | Level of Service on waste management |
| Human Development Index (HDI) | Length of road       |
|                           | Percentage of improved sanitation |
|                           | Number of junior high school |
|                           | Percentage of piped water |

The transportation indicator has always been a significant indicator and has a positive effect on economic indicators. It proves that the transportation indicator is very influential on the economic growth. When positive interventions are carried out in the transportation sector, especially road length, it will increase economic growth in regencies and cities in DKI Jakarta, West Java, and Banten. However, the length of the road is continuous between regions. Therefore, the coordination between the Regency and the City Governments in its provision is needed.

5. Conclusion
This study identifies the impacts of infrastructure on economic growth in DKI Jakarta, West Java Province, and Banten Province. Indicators used in economic growth criteria are Share of Gross Domestic Product (GDP), Human Development Index (HDI), and Head Count Index (HCI) of Poverty. Indicators used in infrastructure criteria include transport infrastructure, sanitation, electricity, clean water, educational facilities, medical facilities, and waste management. Transport infrastructure is represented by the length of roads, sanitation is represented by the Percentage of improved sanitation, electricity is represented by the percentage of electricity users, and clean water infrastructure is represented by the percentage of piped water. Educational facilities are represented by the number of elementary schools, the number of junior high schools, and the number of senior high schools. Moreover, medical facilities are represented by the indicator number of hospitals. Waste Management uses a level of service indicator on the waste management system. All indicators are used in the attributes of regencies and cities in DKI Jakarta, Banten Province, and West Java Province.

This study uses a multiple regression method. The dependent variable is economic growth, and the independent variable is the infrastructure indicator. The multiple regression model shows that several infrastructure indicators significantly influence the economic growth in DKI Jakarta, Banten Province, and West Java Province. The length of roads, the percentage of piped water, the number of hospitals, and the level of service in waste management have significant effects on the Share of GDP indicators. The length of roads, the percentage of improved sanitation, and the number of junior high schools have significant effects on the Human Development Index (HDI). Furthermore, it is also found that infrastructure indicators have positive and negative impacts on economic growth indicators. Infrastructure indicators with positive impacts on Share of GDP are the length of roads, the number of hospitals, and the level of service on waste management. The infrastructure indicator that negatively affects the share of GDP is the percentage of piped water. Infrastructure indicators that have a positive
impact on HDI include the length of roads, the percentage of improved sanitation, and the number of junior high schools.

The weakness of this study is that the HCI of the Poverty regression model cannot predict the impact of the infrastructure indicators. Therefore, further research is suggested to enrich studies on the effect of infrastructure on poverty levels in several regions. Furthermore, the analysis results of this study can be recommendations to district, city, and provincial governments as a strategy to increase regional economic growth by intervening in several regional infrastructure indicators.

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