THE IMPACT OF TRANSPORTATION TRANSFORMATION ON THE GRDP RATIO OF THE TRANSPORTATION SECTOR IN 5 PROVINCES ON JAVA ISLAND

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ABSTRACT

Transportation transformation plays a crucial role in supporting the transportation sector's contribution by increasing the mobility of goods and services. This study aims to analyze the influence of transportation transformation on the GRDP ratio of the transportation sector in five provinces on Java during 2014–2023. The research uses a quantitative approach based on secondary data from the Central Statistics Agency (BPS). The dependent variable in this study is the GRDP ratio of the transportation sector. In contrast, the independent variables include the transportation sector workforce, the number of motorized vehicles, cruise ship visits, and aircraft traffic. The analytical method used is panel data regression. The results show that the number of motorized vehicles, cruise ship visits, and aircraft traffic have positive and significant effects on the GRDP ratio of the transportation sector. In contrast, the transportation sector workforce has no significant effect. This finding indicates that the GRDP ratio of the transportation sector is more influenced by improvements in transportation connectivity and efficiency than by an increase in the number of workers alone. Therefore, strengthening integrated, efficiency-oriented transportation infrastructure is crucial in boosting the transportation sector's contribution to GRDP in the five provinces on the island of Java.

Keywords: GRDP, Java Island, Panel Data, Ratio, Transportation.

1. Introduction

Economic progress in a region is characterized not only by increased economic activity but also by ongoing transformations in sectoral structures. Changes in effective economic structures are a crucial foundation for regional development, as they reflect shifts in the roles of economic sectors. This movement can be seen through the composition of Gross Regional Domestic Product (GRDP), which illustrates the contribution of each sector to the overall regional economy over time (Cokro et al., 2025). Provinces on the island of Java play a crucial role in the Indonesian economy. In 2023, Java contributed approximately 57.04% of the national Gross Regional Domestic Product (GRDP). The largest contribution came from Jakarta (16.77%), followed by East Java (14.39%), West Java (12.79%), Central Java (8.26%), and Banten (3.97%) (Badan Pusat Statistik, 2024). This figure shows that the economy on the island of Java is very active and is very dependent on the smooth movement of goods and people (Saraung, 2023).

In this context, the transportation sector directly supports inter-regional connectivity and is an important part of the structure of GRDP formation (Elisabeth & Sari, 2023). Transportation functions as the main means of increasing community mobility and providing logistical support for economic activities (Kuswati, 2019). The availability of adequate transportation networks and maintained infrastructure can reduce logistics costs and distribution travel times, thereby increasing product competitiveness and encouraging regional economic productivity (Soumena et al., 2024). In addition, an efficient transportation system also expands people's access to public services and economic activities, which ultimately contributes to improving welfare (Suharli et al., 2024). The role of the transportation sector on Java Island is reflected in its contribution to GRDP, for example, in DKI Jakarta, which reached 3.81% or around IDR 69.26 trillion (Indi & Putri, 2022).
The rapid economic activity and mobility of the provinces of Java Island have also given rise to various structural problems in the transportation sector, reflected in national logistics costs, which are still in the

range of 20-25 percent of Gross Domestic Product, thus potentially causing inefficiencies in the distribution system (Sinaga et al., 2025). This condition is related to the increasing number of motorized vehicles, which is not commensurate with infrastructure capacity, land traffic congestion, high operational burdens at major ports, and air traffic density at strategic airports (Setiawan et al., 2020; Frista & Muhammad, 2025).

Problems also occur in maritime transportation, including high container volumes, limited loading and unloading facilities, and administrative processes that have not been fully digitized, resulting in an average ship waiting time of 2.1 days (Frista & Muhammad, 2025). This condition increases logistics costs, disrupts the smooth distribution of goods, and could drive regional inflation (Palilu, 2018). Meanwhile, air transportation activity at Java's main airports continues to increase, potentially reducing operational efficiency if not balanced with optimal transportation capacity and management, thus hampering regional mobility and the economy (Utama & Rezki, 2021).

Several studies have shown that the transportation sector contributes to the economy. Still, results are mixed and generally focus on physical infrastructure, a single mode of transportation, or a specific region. Unlike previous studies, this study uses several indicators, such as transportation-sector employment, the number of motorized vehicles, cruise ship visits, and aircraft traffic, to examine the effect of transportation transformation on the transportation sector's GRDP ratio in five provinces on the island of Java. ASEAN-level research, such as that conducted by Wafa & Narendra (2022)Using a macro approach involving several countries, assuming that regional structures are the same across all countries, it fails to capture differences in regional characteristics. In contrast, Indonesia has a dense economic system and a complex, well-connected transportation network. Therefore, this study addresses this gap by applying panel data regression across several provinces to capture differences and dynamic changes in each region more accurately.

This article is systematically structured to provide a comprehensive overview of the research stages. This research is important because economic activity is closely linked to transportation, which plays a role in driving the movement of goods, services, and labor. Developments in the transportation sector can accelerate distribution, reduce logistics costs, and increase economic efficiency and productivity, making it a strategic element influencing efficiency, energy savings, and the regional economy. The selection of five provinces on the island of Java—DKI Jakarta, West Java, Central Java, East Java, and Banten—was based on their significant economic contributions and on the comprehensiveness and integration of their transportation infrastructure, including land, sea, and air. These five provinces have the most complex and integrated transportation systems in Indonesia, with varying economic characteristics, making them ideal locations for an in-depth analysis of how changes in the transportation sector affect the regional economy.

2. Literatur Review

Gross Regional Domestic Product is the total value of goods and services produced by a region within a certain period. Analysis of planning, development, and economic growth often uses GRDP as a primary data source (Satria et al., 2023). According to Kamilla & Hutajulu (2020), the added value generated by economic activity is generally reflected in the Gross Regional Domestic Product (GRDP), which indicates a region's development. GRDP based on constant (real) prices is used to show overall economic development and by industry from year to year, as all values are calculated using prices in the base year, namely 2010 (Jamilah et al., 2019). This value represents the region's real income (Triwulandari et al., 2023). In the publication of GRDP by industry, the transportation sector is included in one of the business sectors calculated in GRDP. Any increase in output from the transportation sector will directly boost gross value added in that category and contribute to the region's total GRDP (Badan Pusat Statistik, 2024).

Within an economic framework, labor plays a central role as a factor of production. Labor is defined as people aged 15 to 64 who have the physical and mental capacity to engage in economic activities (Mamuane et al.,

2021). Labor plays a role as one of the most important production factors in the process of making goods and services (Rahayu & Martini, 2022). According to Adam Smith, in the research of Prasetyo & Huda (2019) It emphasizes that effective human resource allocation is key to increasing production capacity. As economic activity expands, the need for physical capital accumulation also increases to support production. Theoretically, labor is considered the most important and variable factor of production because its quantity can be increased or decreased. Therefore, labor's role is crucial in determining the size of production output or GRDP. This can be explained through the Cobb–Douglas production function (Saefurrahman et al., 2020).

Besides labor, the transportation sector plays a vital role in supporting economic development. The word transportation comes from the Latin word "transportare," meaning to carry or convey from one place to another (Kamaludin, dalam penelitian Yawauply, 2018). Meanwhile, Miro, in research Maisara et al., (2023) defines transportation as an effort or process that involves the movement of people, goods, or services from one place to another, using appropriate facilities and infrastructure, to support the smooth functioning of the economy, society, and regional development. Transportation has become an inseparable part of everyday life because the general public often uses it to carry out various activities that cannot be described as part of everyday life (Dwianto et al., 2021). According to Anugerah & Yahya, (2024) Transportation is a key factor in economic development. Progress in the transportation sector is reflected in the quality of services offered by public transportation providers; poor performance impacts production.

Operationally, the transportation system includes various complementary modes. Land transportation is a means of mobilization on land used to transport passengers and goods via motorized vehicles and trains (Awainah et al., 2024). Sea transportation plays a role in moving people and goods between locations using shipping vessels and supporting international trade through export and import activities (Samekto & Pujiastuti, 2019). Meanwhile, air transportation is a transportation service that utilizes airplanes for shipping goods and is an important part of the global trade system because of its flexibility in transporting various types of products (Madani & Sahara, 2023).

Several previous studies have shown that the transportation sector is closely linked to a region's economic capacity. Palilu (2018) found that highways have a significant impact on regional income in Ambon City, whereas ports and airports do not. This indicates that land transportation remains the primary driver in the region. Ahmad (2022) also explained that the Trans Java Toll Road has had a positive impact on economic progress in Central Java, based on panel data analysis. In general, Wafa & Narendra (2022) show that most transportation indicators, including land, sea, and air transportation, have a significant impact on GDP per capita in ASEAN countries. In general, these studies hold that transportation is a crucial factor in facilitating economic activity. However, most studies tend to focus on a specific region, a single mode of transportation, or use a partial qualitative approach.

3. Research Methods

This research is a quantitative study with an explanatory approach that examines the transportation sector's contribution to the economy in 5 provinces on the island of Java. The data used are secondary in the form of panel data covering five provinces, including DKI Jakarta, West Java, Central Java, East Java, and Banten, during the period 2014–2023. The number of samples in this study is 50. Sampling was carried out using a purposive sampling method based on the criteria of completeness and consistency of data originating from the official agency, the Central Bureau of Statistics. The dependent variable in this study is the ratio of the transportation sector's Gross Regional Domestic Product (GRDP) to the total GRDP. In contrast, the independent variables include the transportation sector workforce, the number of motorized vehicles, cruise ship visits, and aircraft traffic. All variables are measured in the official units specified in publications from the relevant data sources.

This study begins with descriptive statistical analysis to provide an overview of the characteristics of the research data (Martias, 2021). The data analysis method used in this study is panel data regression, because the research data has cross-regional and cross-time dimensions, so it can capture the dynamics of growth between provinces while controlling for unobserved heterogeneity (Widiarti, 2025). The entire analysis process is carried out to obtain empirical results that are accurate and can be scientifically accounted for (Hermawan et al., 2022). The operational definitions of the research variables are presented in the following table. The empirical model used in this study is as follows:

$$\gamma_{it1} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \varepsilon$$

Note:

γ_{it1} : Transportation Sector GRDP Ratio
X_{1it} : Transportation Sector Workforce
X_{2it} : Number of Motor Vehicles
X_{3it} : Cruise Ship Visit
X_{4it} : Aircraft Traffic
α : Constanta
$\beta_1 - \beta_4$: Regression coefficient of independent variables
i : Cross-section
t : Time
ε : Error term

Table 1 Operational Definition of Variables

Variable	Definition	Unit
Ratio of Transportation GRDP (R_TGRDP)	The ratio of GRDP of the transportation sector to total GRDP	%
Transportation Labor (TL)	Total workforce in the transportation & warehousing subsector	Soul
Motor Vehicle Ownership (MVO)	Total licensed vehicles (motorbikes, passenger cars, goods vehicles)	Unit
Shipping Vessel Visits (SVV)	Number of domestic & international vessels visiting/loading and unloading	Unit
Air Traffic Volume (ATV)	Total domestic and international aircraft movements (departures and arrivals)	Unit

Source: Central Bureau of Statistics

4. Results and Discussion

4.1 Results

The results in Table 2 show the average, standard deviation, and range. The GRDP ratio of the transportation sector has an average value of 0.041 with a standard deviation of 0.012, which indicates that the contribution of the transportation sector to the GRDP ratio of the transportation sector is relatively stable in the five provinces of Java Island. The transportation sector workforce has an average of 661,518 with a standard deviation of 298,506, indicating a fairly consistent distribution of the workforce despite differences between provinces.

Table 2 Descriptive Statistics

Variabel	N	Minimum	Maximum	Mean	Std. Deviation
R_TGRDP	50	0.024	0.067	0.041	0.012
TL	50	324,685	1,806,727	661,518	298,506
MVO	50	1,897,581	24,023,666	14,762,478	6,911,698
SVV	50	4,905	50,146	21,790	12,996
ATV	50	7,502	463,069	114,018	127,038

Source: Data Processed, 2025

The number of motorized vehicles has an average of 14,762,478 and a standard deviation of 6,911,698, reflecting that land transportation is the main mode of economic mobility on the island of Java. Ship visits show an average of 21,790 with a standard deviation of 12,996, indicating relatively low variation in visits between provinces and a relatively even distribution of sea transportation. Meanwhile, aircraft traffic has an average of 114,018 with a standard deviation of 127,038, which shows high variation between provinces and indicates that air transportation activities are still concentrated in certain regions.

Table 3 Best Model Test

Effect Test	Prob	Result
Chow Test	0.0000	Fix Effect Model
Hausman Test	0.0000	Fix Effect Model

Source: Data Processed, 2025

Based on Table 3, two tests were conducted to determine the most appropriate estimation model: the Chow Test and the Hausman Test. From the test results, the probability value is 0.0000 with an error rate of 0.05, indicating that the probability is <0.05 (0.000 <), so the best model for estimating the data is the Fixed Effect Model.

Table 4 Panel Data Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob
R_TGRDP	0.023580	0.002982	7.908.153	0.0000
TL	2.23E-09	2.19E-09	1.018189	0.3146
MVO	4.73E-10	1.21E-10	3.927917	0.0003
SVV	1.81E-07	7.65E-08	2.373926	0.0224
ATV	4.43E-08	1.05E-08	4.230262	0.0001
Adjusted R-squared	0.945965			
Prob(F-statistic)	0.000000			

Source: Data Processed, 2025

Based on the results of data processing in Table 4, the following regression equation formula can be formed.:

$$\gamma_{it1} = 0.023 + 2.23X_{1it} + 4.73X_{2it} + 1.81X_{3it} + 4.43X_{4it}$$

The constant value of 0.023 indicates that, when all independent variables are held constant, the transportation sector's contribution to the GRDP ratio is 2.3%. The regression coefficients for the transportation sector workforce, the number of motorized vehicles, cruise ship visits, and aircraft traffic are all positive. This indicates that an increase in each of these variables has a positive impact on the transportation sector's contribution to GRDP in the five provinces on Java Island.

The test results indicate that the transportation sector workforce has a positive but insignificant effect on the transportation sector's GRDP ratio, with a p-value of 0.3146 > 0.05. Meanwhile, the number of motorized

vehicles, shipping visits, and aircraft traffic has a positive and significant effect on the GRDP ratio of the transportation sector, with probability values of 0.0003, 0.0224, and 0.0001, respectively, which are smaller than α = 0.05. Furthermore, the probability of the Prob(F-statistic) is 0.0000 < α = 0.05. It can be concluded that all independent variables simultaneously have a significant effect on the dependent variable.

The R-squared value of 0.954787 indicates that the model can explain approximately 95.47% of the change in the transportation sector's contribution to the GRDP ratio of the transportation sector in the five provinces of Java during the study period, while the remaining 4.53% is influenced by factors not included in the model. The Adjusted R-squared value of 0.945965 indicates that the model remains stable and explains the data well, even though it has accounted for many variables and data points.

4.2 Discussion

The Influence of Labor in the Transportation Sector on the GRDP Ratio of the Transportation Sector

Based on the research results, the labor force variable in the transportation sector did not significantly affect the GRDP ratio in the transportation sector across five provinces on Java Island during the research period. This research is inconsistent with the concept of GRDP, which is the total added value of goods and services produced by a region, so that increasing the labor force as a production factor should drive an increase in output and the sector's contribution to GRDP. This finding indicates that increasing the labor force does not have a positive impact on the GRDP ratio of the transportation sector, relative to other sectors.

These results are comparable to several previous studies by Palilu (2018) Road construction has a significant impact on regional income. Furthermore, Ahmad (2022) He explained that the construction of the Trans-Java Toll Road has had a positive impact on economic growth in Central Java, underscoring the importance of investing in infrastructure rather than relying solely on workforce growth. Besides that, Wafa & Narendra (2022) stated that overall, transportation indicators have a significant impact on per capita income across various ASEAN countries. Thus, the findings of this study indicate different impacts depending on the variables used. Therefore, the results of this study confirm that the contribution of the transportation sector is more influenced by road quality, the effectiveness of the transportation system, and technological progress than simply focusing on the number of workers.

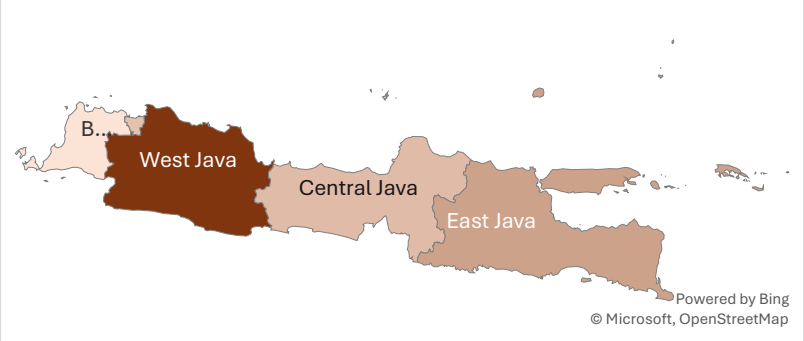

Figure 1 Transportation Sector Workforce in 5 Provinces of Java Island

The map above shows the highest concentration in West Java, followed by East Java and Central Java, then DKI Jakarta, and finally Banten, with the lowest. This pattern suggests that the number of workers entering the transportation sector is influenced by the region's economic structure, industry size, territorial size, and the province's role in the national logistics system, not just its status as an economic hub. Provinces with manufacturing capabilities and roles in shipping typically require greater movement of goods and services, creating a need for more transportation workers. This situation suggests that work capacity, equipment utilization, and the level of expertise and transportation technology have a greater impact.

The Influence of the Number of Motorized Vehicles on the GRDP Ratio of the Transportation Sector

Based on the research results, the variable of the number of motorized vehicles has a positive and significant effect on the GRDP ratio of the transportation sector in five provinces on the island of Java, indicating that an increase in the number of motorized vehicles can facilitate the mobility of goods and services and encourage the contribution of the transportation sector to economic activity (Maisara et al., 2023). This finding is in line with the concept of GRDP, which states that increasing the output of the transportation sector will increase the added value and its impact on total GRDP, thereby strengthening the role of the transportation sector in the regional economic structure (Badan Pusat Statistik, 2024). This research is also in line with Palilu (2018) which shows that land transportation has a significant impact on regional income. The findings from Wafa & Narendra (2022) shows that transportation indicators significantly impact GDP per capita in ASEAN countries. Furthermore Ahmad (2022) also shows that increased connectivity through road construction has a positive impact on regional economic activity. Therefore, increasing the number of motorized vehicles as part of physical capital in transportation has been shown to increase the transportation sector's role in the GRDP structure.

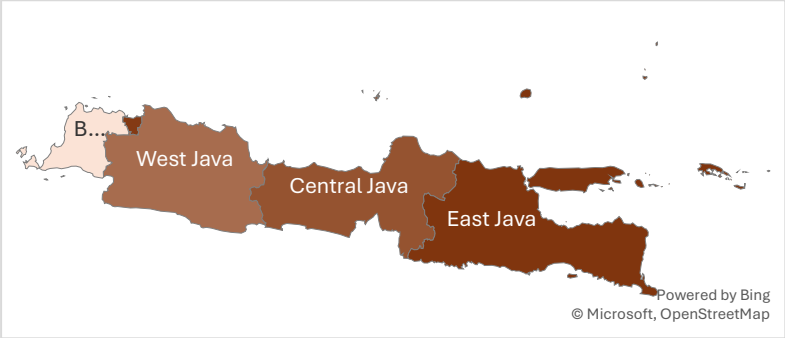

Figure 2 Number of Motorized Vehicles in 5 Provinces of Java Island

Based on the figure above, East Java has the highest number of vehicles, followed by DKI Jakarta, Central Java, and West Java, while Banten has the lowest number. This variation in intensity reflects differences in mobility, population, and economic activity across provinces. The greater the capacity, the greater the potential for generating added value in the transportation sector. This aligns with research findings showing that the greater the number of motorized vehicles, the higher the GRDP ratio of the transportation sector. Therefore, differences in the number of motorized vehicles between provinces also explain the variation in the transportation sector's contribution to the GRDP structure across the five provinces on Java Island.

The Impact of Cruise Ship Visits on Economic Growth

Based on the research results, the variable of cruise ship visits has a positive and significant effect on the GRDP ratio of the transportation sector in five provinces on the island of Java, indicating that increasing shipping activities can encourage the contribution of the transportation sector, this is in line with the GRDP concept, which states that increasing the output of the transportation sector will increase added value and its impact on the total GRDP, thus strengthening the role of the transportation sector in the regional economic structure (Badan Pusat Statistik, 2024). Increased shipping activity leads to more efficient distribution of goods, facilitates trade interactions between regions, and improves export and import processes, which in turn encourages increased output and value within a region (Samekto & Pujiastuti, 2019). The findings of this study also support the findings Wafa & Narendra (2022) which shows that transportation factors, including the maritime sector, play an important role in GDP per capita in various ASEAN countries. Furthermore, Palilu (2018) Find the influence of transportation infrastructure on regional income. Meanwhile, Ahmad (2022) revealed that increased connectivity in the transportation sector has a positive impact on economic activity in the region. Thus, an increase in the number of ships in operation indicates

greater trade and connections between regions, ultimately boosting the transportation sector's contribution in the region.

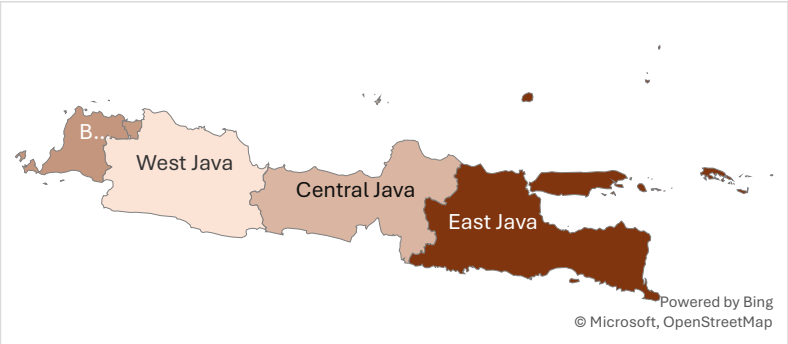

Figure 3 Cruise Ship Visits to 5 Provinces on Java Island

Based on the map showing the distribution of cruise ship visits across five provinces on the island of Java, East Java recorded the highest number of visits, indicated by the darkest color, followed by Banten, DKI Jakarta, and Central Java. At the same time, West Java had the fewest visits, as indicated by the lightest color. This pattern reflects variations in the level of port activity and trade between regions. The increase in ship visits to East Java indicates the presence of a distribution and logistics center for the eastern region of Java Island, with the potential to make a more significant economic contribution. In line with the research results, the increase in cruise ship visits reflects increased trade activity and closer interactions between regions, which in turn boost the transportation sector's contribution in the region.

The Impact of Aircraft Traffic on Economic Growth

Based on the research results, the aircraft traffic variable has a positive and significant effect on the GRDP ratio of the transportation sector in five provinces on the island of Java. Increasing flight frequency indicates intensive movement of people, goods, and information, which in turn increases profits in the transportation sector. In accordance with the GRDP concept, increasing output in the transportation sector will increase added value and its impact on the total GRDP (Badan Pusat Statistik, 2024). Air transportation has the potential to connect and accelerate various activities such as investment, trade, and tourism (Madani & Sahara, 2023). Increased air mobility creates significant time utility by accelerating economic interactions between regions. These results align with research conducted by Wafa & Narendra (2022) which states that transportation indicators, including air transportation, affect GDP per capita in various ASEAN countries. Moreover, Ahmad (2022) also shows that transportation infrastructure is closely related to regional income. Therefore, increased air traffic strengthens the transportation sector's contribution to shaping GRDP.

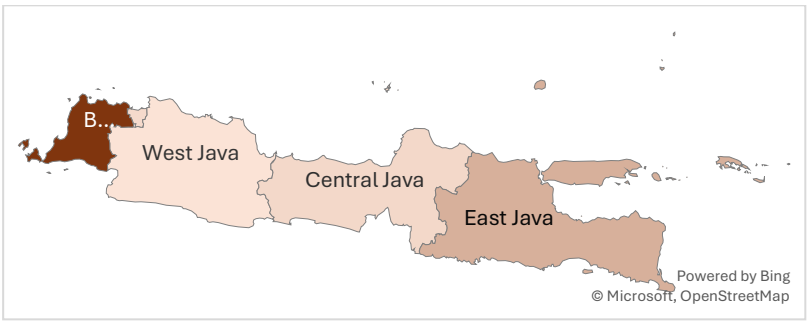

Figure 4 Aircraft Traffic in the 5 Provinces of Java Island

Based on the distribution of air traffic across the five provinces on Java Island, Banten recorded the highest volume (darkest), followed by East Java, Central Java, and Jakarta. In contrast, West Java recorded the lowest volume (lightest). This pattern reflects differences in air quality connections and the density of economic

activity across regions. High flight volumes indicate significant passenger and freight mobility, which contributes to increased added value in the transportation sector.

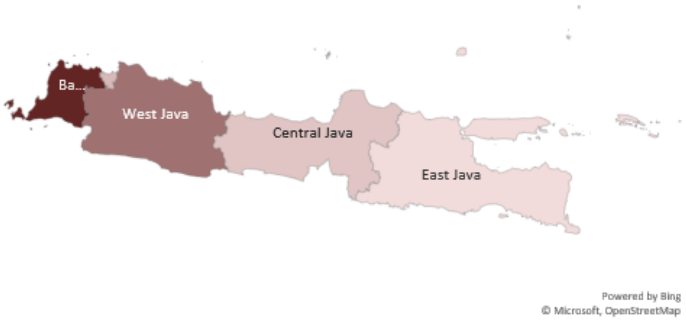

Figure 5 GRDP Ratio of the Transportation Sector in 5 Provinces on Java Island

This map illustrates the contribution of the transportation sector to GRDP in five provinces on Java Island. The color scheme on the map shows varying levels of contribution, with darker colors indicating a higher proportion. Banten Province has the darkest color, indicating that the transportation sector contributes more significantly to its GRDP than other provinces. This is likely related to Banten's strategic position as the center of the Jakarta Special Capital Region (DKI Jakarta) and the presence of ports and industrial areas that facilitate the distribution of goods and economic movement. On the other hand, East Java is shown in a lighter color, indicating that the transportation sector contributes less to its GRDP. This situation reflects differences between provinces, and the role of the transportation sector in generating economic output varies across regions.

5. Conclusion

This study shows that transformation in the transportation sector plays a significant role in the contribution of the transportation sector in five provinces on the island of Java. The results indicate that the number of motorized vehicles, shipping visits, and aircraft traffic has a positive and significant influence on the GRDP ratio of the transportation sector. Transportation activities increase the speed of distribution of goods and human mobility, facilitate interregional and international trade, and increase efficiency in various economic activities, thereby increasing the transportation sector's contribution to GRDP formation. On the other hand, the transportation sector workforce does not significantly influence the GRDP ratio of the transportation sector, indicating that the increase in the number of workers has not been matched by an increase in productivity or the quality of human resources in the transportation sector. This study also revealed that aircraft traffic has the greatest influence on the GRDP ratio of the transportation sector, underscoring the importance of air transportation in strengthening interregional connectivity, accelerating the delivery of high-value goods, and supporting trade, investment, and tourism activities in the transportation sector. Therefore, the government needs to focus on improving air transportation infrastructure and efficiency by maximizing airport capacity, building integrated air cargo facilities, and connecting transportation modes with industrial areas and logistics centers. In addition, the digitalization of airport services and the simplification of logistics procedures need to be accelerated to increase productivity and add value in the transportation sector.

This study has several limitations. First, the variables used are limited to quantitative indicators (workforce, vehicles, ship visits, and aircraft traffic), thus not fully representing the quality of infrastructure, efficiency levels, or digitalization aspects of the transportation system. Second, the coverage area is limited to five provinces on the island of Java, so the research results cannot be generalized to all regions of Indonesia, which have different transportation characteristics and economic structures. Future research should include additional variables such as the quality of transportation infrastructure, investment in the transportation sector, and the level of logistics digitalization to obtain a more comprehensive picture of the factors influencing the transportation sector's GRDP ratio. Expanding the scope to include the entire country and

applying more flexible analytical methods, such as dynamic panel models or Structural Equation Modeling (SEM), can help better understand the relationships between variables and understand how the transportation sector contributes to the dynamic structure of the economy.

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