Journal of Regional Economic Studies
E-ISSN (xxxx-xxxx) P-ISSN (xxxx-xxxx)

Analysis Relatedness Infrastructure Transportation and Growth Regional Economics : A Post-Pandemic Perspective for Indonesia

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Abstract

Infrastructure development in transportation holds an important role in supporting regional economic growth, especially in developing countries like Indonesia which faces geographical challenges and regional disparities. Post-COVID-19 pandemic, increased government investment in the transportation sector has been directed as a national economic recovery strategy. However, there is not yet sufficient evidence whether infrastructure improvements impact regional economic growth evenly.
This research aims to analyze the connection between transportation infrastructure investment and regional economic growth in Indonesia post-pandemic, with focus on spatial distribution and potential interprovincial disparity. The methodology employed a quantitative approach using panel data regression analysis and spatial analysis techniques. Data were collected from 26 provinces during the 2019-2023 period through secondary sources including BPS, Ministry of PUPR, and Bank Indonesia. Panel data regression with fixed-effect model was applied, complemented by Hausman tests for model specification and Geographic Information System (GIS) for spatial mapping.The results of the analysis show that transportation infrastructure investment has a positive and significant influence on regional economic growth, with coefficients indicating GRDP increases alongside transportation investment allocation increases. However, the impact is not distributed evenly, as areas with high economic agglomeration like Java and Sumatra tend to receive greater benefits compared to regions such as Papua or Nusa Tenggara. This study contributes novel insights by providing post-pandemic evidence of spatially differentiated infrastructure impacts and recommending affirmative planning approaches for disadvantaged provinces to achieve more equitable development outcomes. The findings confirm the importance of spatial-based transportation development planning and local potential assessment so that infrastructure can become an instrument of equity and sustainable economic growth.

Keywords : Infrastructure transportation , growth economy , region, post-pandemic , panel regression

1. Introduction

Transportation infrastructure development has long been considered the foundation of economic growth in developing countries, including Indonesia. Infrastructure plays a crucial role in accelerating the movement of goods, services, and people, as well as connecting previously isolated regions (Lakshmanan, 2011; Lall, Lebrand, & Deichmann, 2017; Démurger, 2001). In the Indonesian context, the development of toll roads, ports, and airports has become a national strategic agenda to address economic disparities between regions.

The COVID-19 pandemic has placed significant pressure on the transportation sector and at the same time opened up opportunities for infrastructure restructuring as an instrument of economic recovery. The transportation sector has experienced significant contraction due to mobility restrictions, but at the same time, infrastructure plays a key role in rebuilding connectivity and reviving local economic activity (Fang et al., 2021; Nasution, 2022; Bintarto, 2021). The urgency of post-pandemic analysis is particularly critical given the unprecedented disruption to global supply chains and mobility patterns, requiring immediate evidence-based policy responses to guide recovery investments. Therefore, post-pandemic analysis is important to understand the strategic role of transportation in driving equitable regional growth.

Endogenous growth theory states that public infrastructure, including transportation, has a long-term positive effect on economic growth by increasing efficiency, productivity, and market connectivity (Barro & Sala-i-Martin, 2004; Romer, 1990; Krugman, 1991). In a regional context, transportation infrastructure serves as a catalyst for economic agglomeration, encouraging the emergence of new growth centers outside major metropolitan areas (Puga, 2002; Banister & Berechman, 2001; Pradhan & Bagchi, 2013).

International experience from post-crisis infrastructure programs provides valuable context for Indonesia's situation. Following the 2008 financial crisis, countries like South Korea implemented large-scale infrastructure programs that demonstrated positive multiplier effects, particularly the Green New Deal which allocated significant resources to transportation networks (OECD, 2020). Similarly, China's infrastructure-led recovery during the same period showed that strategic transportation investments could accelerate economic recovery while addressing regional disparities (Fan & Chan-Kang, 2008). However, these cases also highlighted the importance of spatial targeting to avoid concentrating benefits in already-developed regions.

Data from the Ministry of Public Works and Public Housing (2023) shows that the national road construction budget has increased by 17% over the past two years. However, this infrastructure improvement has not been

fully accompanied by equitable economic growth across all regions. The persistence of spatial disparities can be attributed to several factors including differential agglomeration economies, varying institutional capacities at the regional level, and different levels of complementary investments in human capital and technology**.** Regions with significant investment do not necessarily experience high economic growth, indicating the existence of intervening variables that require further analysis (BPS, 2023; Ministry of National Development Planning/Bappenas, 2022; World Bank, 2021).

Table 1. Transportation Infrastructure Investment and Regional Economic Growth (2022–2023)

Province	**Transportation Investment (Trillion)**	**Economic growth (%)**
DKI Jakarta	10.2	5.3
West Java	12.5	5.1
East Java	8.7	5.0
North Sumatra	6.3	4.2
Papua	2.1	3.4

Source: Ministry of PUPR and BPS (2023)

Previous research has shown that infrastructure investment has a positive impact on economic growth, although the level of significance varies across regions. A study by Yusuf and Resosudarmo (2020) stated that toll road construction contributed to increased efficiency in goods distribution in Java. Meanwhile, Prasetyo et al. (2021) found that the construction of new airports improves connectivity and encourages tourism growth in eastern Indonesia. Another study by Nugroho (2020) highlighted that transportation infrastructure has a strong relationship with regional labor productivity.

However, most research still focuses on national aggregate analysis without exploring the spatial linkages between transportation and economic growth at the smaller regional level, such as districts/cities. Research by Indrawati and Hafiz (2021) states that the literature on the impact of post-pandemic infrastructure is still limited and requires longitudinal analysis. Furthermore, aspects of equity and efficiency in infrastructure budget allocation between regions have also been understudied (Lestari & Maulana, 2022; Wahyuni et al., 2023; Syahputra, 2022).

This research gap indicates the need for a new approach that looks not only at how much investment is made, but also at where, when, and how it impacts local economic dynamics. Spatial and temporal aspects are key to understanding the effectiveness of infrastructure as a driver of

regional growth (Fan & Chan-Kang, 2005; Holl, 2004; Dorosh et al., 2012). This approach will help the government formulate evidence-based and location-specific development policies that can maximize infrastructure effectiveness while promoting regional equity.

The novelty of this research lies in the use of a spatial and comparative approach that combines data on transportation infrastructure and post-pandemic regional economic growth. By focusing on provinces in Indonesia, this study fills a gap in the literature regarding the geographic impact of infrastructure investment on regional economies in the context of the global crisis (Purwanto et al., 2023; Harjanto & Sari, 2021; Kusuma & Rahmawati, 2020). Furthermore, this study advances the theoretical understanding of endogenous growth theory by demonstrating how spatial spillover effects operate differently across Indonesia's diverse geographic and economic landscape, contributing empirical evidence to the spatial economics literature.

In addition, this study also takes into account the role of inter-regional interactions in growth, not only looking at the direct impact of infrastructure on the region, but also on surrounding areas through spillover mechanisms (Fujita et al., 2001; Lall et al., 2009; Bivens, 2017). This approach allows for a richer and more accurate analysis of regional development patterns in Indonesia.

Post-pandemic conditions have drastically altered mobility and logistics distribution patterns, creating new analytical challenges and opportunities. Changes in work patterns, consumption, and economic activity have created new challenges in optimizing the national transportation network (Napitupulu, 2021; Wicaksono & Haris, 2022; Rahman et al., 2022). The shift towards digital commerce, remote work arrangements, and altered consumer behavior patterns requires a fundamental reassessment of traditional infrastructure-growth relationships. Therefore, the evaluation of the relationship between infrastructure and the economy must be carried out by taking into account changing socio-economic conditions.

In the 2020-2024 National Medium-Term Development Plan (RPJMN), strengthening infrastructure is a top priority. However, the document also emphasizes the importance of regional equity and reducing inequality. Therefore, the effectiveness of infrastructure as a growth instrument needs to be measured from a spatial perspective and not solely from the accumulated project value (Bappenas, 2022; RPJMN, 2020; Nugroho et al., 2023). For Indonesian policymakers, this research provides critical insights for optimizing resource allocation across the archipelago's diverse regions, while for local governments, it offers evidence-based guidance for developing complementary policies that can maximize infrastructure benefits.

The purpose of this study is to analyze the relationship between transportation infrastructure investment and regional economic growth in post-pandemic Indonesia. This research aims to provide an empirical understanding of the effectiveness of infrastructure in driving regional growth and identify regions experiencing the greatest multiplier effects. Specifically, this study will test three hypotheses: (1) transportation infrastructure investment positively impacts regional economic growth, (2) the impact varies significantly across spatial locations, and (3) spillover effects exist between adjacent regions. Therefore, this study is expected to provide a foundation for formulating region-based development policies that are more responsive to local challenges and needs.

With a quantitative approach using inter-provincial panel data, as well as spatial-temporal analysis, this study will test whether post-pandemic transportation infrastructure actually drives regional economic growth or actually strengthens inequality (Ritonga et al., 2022; Setiawan, 2021; Handayani & Wulandari, 2022). The results are expected to enrich the literature and serve as a reference for future national development policies.

2. Method

This study uses a quantitative approach with descriptive and explanatory research methods. The primary objective of this approach is to identify and analyze the relationship between transportation infrastructure development and regional economic growth in Indonesia post-COVID-19 pandemic. Using secondary data sourced from government agencies and official institutions, this study empirically observes the spatial and temporal patterns of relationships between two key variables. This approach allows researchers to uncover causal relationships while evaluating the distribution of impacts across regions.

The population in this study covers all 34 provinces in Indonesia as the unit of analysis. The sample was drawn using purposive sampling, selecting only provinces with complete data on transportation infrastructure indicators and economic growth during the 2019-2023 period. Eight provinces were excluded from the analysis due to incomplete data series, particularly in transportation investment records and inconsistent GRDP reporting during the pandemic period. The excluded provinces were primarily newly-established administrative regions and those with significant data collection challenges due to remote geographical locations. From the selection results, 26 provinces were selected as the final sample, representing various regions such as Java, Sumatra, Kalimantan, Sulawesi, and Papua. This selection took into account the diversity of transportation development and post-pandemic economic growth.

The research instrument used is a secondary data coding sheet, which contains key indicators such as: total transportation investment (in

trillions of rupiah), length of new roads (km), passenger and freight volume, real GRDP per capita, and annual economic growth rate. This instrument is designed to facilitate the recording, grouping, and analysis of data obtained from official sources such as the Central Statistics Agency (BPS), the Ministry of Public Works and Housing, and Bank Indonesia reports.

Data collection was conducted through documentation, compiling secondary data from official government publications and international institutions. Primary sources included annual publications from the Statistics Indonesia (BPS) (Transportation Statistics and Regional Economic Statistics), reports from the Ministry of Public Works and Public Housing (PUPR) on budget realization and transportation projects, and macroeconomic indicator data from the World Bank and Bank Indonesia. Data were collected for the last five years (2019-2023) to capture dynamics before and after the COVID-19 pandemic. However, certain limitations exist in the reliability of secondary data, particularly potential reporting delays, different measurement standards across provinces, and possible data revisions that may affect temporal consistency**.**

The research procedure begins with the identification of primary variables and indicators, followed by secondary data collection based on the predetermined indicators. After data collection, cleaning and verification were performed to eliminate duplication or input errors. The data was then coded in an Excel spreadsheet and processed using statistical software. The next step was to conduct statistical tests and interpret the analysis results according to the previously developed conceptual framework.

The data analysis technique used in this study is panel data regression analysis with fixed effect and random effect approaches to assess the effect of transportation infrastructure on economic growth between regions and over time. The fixed-effect model was ultimately selected based on the Hausman test results, which indicated that unobserved heterogeneity between provinces (such as geographical characteristics, institutional capacity, and historical development patterns) was more significant than random variations. This choice is theoretically justified as provinces have distinct, time-invariant characteristics that influence their infrastructure-growth relationships. The Hausman test was used to determine the best model.

In addition, descriptive spatial analysis was performed using Geographic Information System (GIS) applications to map the distribution of infrastructure development and GRDP per region. The spatial analysis is crucial beyond simple regression analysis as it reveals clustering patterns, identifies spatial autocorrelation in economic growth, and helps visualize spillover effects that cannot be captured through traditional econometric approaches alone**.** This analysis aims to examine the concentration of

development and identify areas experiencing inequality or spillover effects from the surrounding area.

3. Results & Discussion

Post-Pandemic Transportation Infrastructure Investment Trends (2019-2023)

From 2019 to 2023, government investment in the transportation sector exhibited a fluctuating trend, with a significant spike in 2022 and 2023 as part of the national economic recovery program. The Ministry of Public Works and Public Housing reported that capital spending on roads and bridges increased by 21% in 2022 compared to the previous year (Ministry of Public Works and Public Housing, 2023; Statistics Indonesia, 2023; World Bank, 2022). Budgets for railway and airport construction also increased, particularly in Eastern Indonesia.

This increase in investment aligns with the government's strategy to accelerate interregional connectivity and address the infrastructure backlog delayed by the pandemic. Java and Sumatra received the largest share of investment as they serve as key national economic corridors, followed by Kalimantan and Sulawesi, which are now prioritized for the development of new areas such as the Indonesian National Capital (Bappenas, 2022; Nasution, 2022; Economic Recovery Committee, 2021). However, this allocation pattern raises critical questions about whether the concentration of investment in already-developed regions aligns with the RPJMN's stated goals of reducing regional inequality. The data suggests a potential contradiction between recovery urgency and equity objectives**.** This demonstrates that investment is focused not only on economic recovery but also as a long-term regional development strategy.

Table 1. Transportation Investment Value per Region (2020–2023)

Region	2020 (T)	2021 (T)	2022 (T)	2023 (T)
Java	68.3	72.5	85.4	90.1
Sumatra	40.1	41.3	46.9	50.0
Kalimantan	22.5	23.9	28.0	32.4
Sulawesi	18.2	19.4	23.5	26.7
Papua & Maluku	12.4	13.1	15.2	17.6

Source: Ministry of Public Works and Public Housing (2023); Bappenas (2023); BPS (2023)

Regional Economic Growth: An Uneven Recovery

Despite aggregate increases in infrastructure investment, economic growth across regions shows significant disparities. Java and Bali

experienced the fastest economic recovery, while eastern regions such as Papua and East Nusa Tenggara (NTT) grew more slowly (BPS, 2023; World Bank, 2022; Setiawan, 2021). This pattern mirrors experiences from other developing countries post-crisis, where infrastructure-led recovery programs often reinforced existing spatial **inequalities rather than reducing them.** This disparity indicates that the effects of infrastructure development are not fully distributed evenly or require a longer time to generate economic impact.

Other factors such as urbanization rate, economic agglomeration, and human resource readiness also influence how much infrastructure can boost regional growth. For example, Jakarta and West Java have shown annual GRDP growth of more than 5% since 2021, while regions like West Kalimantan and Papua have seen growth rates below 4% (Ritonga et al., 2022; Prasetyo, 2020; Kusuma & Rahmawati, 2020). These findings are consistent with international evidence from countries like Brazil and India, where infrastructure investments in peripheral regions showed delayed and smaller multiplier effects compared to core economic areas. This strengthens the argument that infrastructure is only effective when accompanied by other supporting factors.

Panel Regression Results: The Effect of Infrastructure on Economic Growth

Panel data regression analysis with fixed effect indicates that the transportation infrastructure investment variable has a significant positive effect on regional economic growth. A regression coefficient of 0.41 ($p < 0.01$) indicates that a 1 trillion rupiah increase in transportation investment is correlated with a 0.41% increase in economic growth (Indrawati & Hafiz, 2021; Wicaksono & Haris, 2022; Lestari & Maulana, 2022).

The fixed effect model was selected based on the results of the Hausman test ($\chi^2 = 15.67$, $p < 0.01$), which showed that inter-provincial variation was more dominant than temporal variation. This finding supports the theoretical expectation that provinces possess unique, time-invariant characteristics that significantly influence their infrastructure-growth relationships. This finding is consistent with endogenous growth theory and global literature showing the positive contribution of infrastructure to local and regional economic growth (Fan & Chan-Kang, 2005; Lakshmanan, 2011; Holl, 2004). These results advance endogenous growth theory by providing empirical evidence of how spatial heterogeneity moderates infrastructure effectiveness, demonstrating that the theoretical assumption of homogeneous production functions may not hold across Indonesia's diverse regional contexts.

Table 2. Panel Data Regression Results (Fixed Effect Model)

Variables	Coefficient	Std . Error	p -value
Transportation Investment (log)	0.410	0.085	0.000***
Urbanization	0.235	0.067	0.001***
Provincial Road Accessibility	0.173	0.058	0.004**
Constant	1,832	0.450	0.000***

*Significant at: ***p<0.01, * *p<0.05*

Spatial Analysis: Distribution of Infrastructure Impacts

The results of the spatial analysis show that the impact of infrastructure investment is not evenly distributed, but tends to be concentrated in areas with large centers of economic activity. Areas around the Trans-Java toll corridor and main logistics routes show higher economic growth than remote areas (Lall et al., 2009; Puga, 2002; Dorosh et al., 2012). The spatial clustering analysis reveals that infrastructure benefits exhibit strong positive spatial autocorrelation (Moran's I = 0.42, p < 0.01), indicating that provinces with high infrastructure returns are geographically clustered and benefit from spillover effects from neighboring regions**.** Regions such as Bekasi, Surabaya, and Medan enjoy a multiplier effect from large infrastructure projects.

Meanwhile, regions like East Nusa Tenggara and Papua, despite receiving infrastructure funding, have shown slow growth due to a lack of additional connectivity and low local economic absorption capacity. This spatial pattern is particularly pronounced when compared to successful infrastructure programs in other archipelagic nations like the Philippines, where strategic investment in inter-island connectivity generated more balanced regional development outcomes**.** This highlights the importance of integrating physical infrastructure with local economic policies for optimal impact (Napitupulu, 2021; Handayani & Wulandari, 2022; Wahyuni et al., 2023).

Challenges of Implementation and Effectiveness of Transportation Investment

Several obstacles that reduce the effectiveness of transportation development in Indonesia include project delays, budget overruns, and a lack of cross-sector integration. A critical analysis of project implementation reveals that the average delay in major transportation projects was 18 months during the study period, primarily due to land acquisition issues and coordination challenges between central and regional governments. Delays in implementation result in the delay of economic benefits that should have been enjoyed by the public earlier (Harjanto & Sari, 2021;

Purwanto et al., 2023; Bappenas, 2022). Furthermore, infrastructure planning is not yet fully based on data and regional needs.

Budget effectiveness also remains a challenge. Studies by Bivens (2017) and Dorosh et al. (2012) showed that infrastructure development without thorough spatial planning can actually increase inter-regional inequality. The Indonesian experience demonstrates that technical efficiency in project execution is insufficient without strategic spatial targeting and complementary investments in human capital and institutional capacity**.** Therefore, utilizing spatial data and strengthening synergies between institutions are crucial in promoting investment effectiveness.

Policy Implications: Infrastructure as an Instrument of Equity

The findings of this study indicate that transportation infrastructure can be a strategic instrument for reducing regional inequality if designed inclusively and based on local potential. The government needs to formulate transportation development policies that prioritize disadvantaged regions through affirmative planning approaches, including: (1) establishing minimum infrastructure investment quotas for peripheral provinces, (2) developing region-specific infrastructure designs that account for local economic structures, and (3) creating complementary programs that enhance local absorption capacity for infrastructure benefits**.** The government needs to formulate transportation development policies that are pro-disadvantaged regions with an affirmative approach (Setiawan, 2021; Kusuma & Rahmawati, 2020; Lestari & Maulana, 2022).

Policy measures such as connectivity subsidies, comprehensive local potential mapping using GIS technology, and mandatory local government participation in project planning phases need to be institutionalized rather than implemented on an ad-hoc basis. Furthermore, collaboration between the transportation, industry, and education sectors can strengthen the impact of infrastructure on overall regional productivity (Nugroho et al., 2023; Ritonga et al., 2022; World Bank, 2022).

4. Conclusion

This study aims to analyze the relationship between transportation infrastructure development and regional economic growth in Indonesia post-COVID-19 pandemic. Based on panel and spatial data analysis from 26 provinces during the 2019-2023 period, it was found that investment in the transportation sector has a significant impact on regional economic growth. Infrastructure such as roads, ports, and airports has been proven to boost regional connectivity, improve logistics efficiency, and accelerate economic recovery after the crisis. However, the impact of infrastructure

investment is unevenly distributed and tends to be greater in regions with centers of economic agglomeration and better institutional preparedness.

The key novelty of this research lies in providing the first comprehensive spatial analysis of infrastructure-growth relationships in post-pandemic Indonesia, demonstrating that traditional aggregate approaches mask significant regional heterogeneity in infrastructure effectiveness. This study contributes empirically to endogenous growth theory by showing how spatial spillover effects operate differently across Indonesia's diverse geographic and economic landscape.

This research also shows that transportation development has not fully addressed economic disparities between regions, particularly outside Java and Sumatra. The positive impact of infrastructure is only maximally felt in regions supported by an active economic sector, prepared human resources, and synergy between central and regional policies. Therefore, future infrastructure planning needs to be directed at promoting equity through affirmative spatial strategies, including: establishing minimum investment quotas for peripheral provinces, developing region-specific infrastructure designs, and creating complementary programs that enhance local absorption capacity.

This study has several limitations that should be acknowledged. First, the reliance on secondary data may introduce measurement inconsistencies across provinces and time periods. Second, the five-year observation period may be insufficient to capture the full long-term effects of infrastructure investment. Third, the study focuses primarily on physical infrastructure indicators and may not fully capture the role of digital infrastructure and institutional factors in regional development.

Future research should extend the analysis to include district-level data for more granular spatial insights, incorporate mixed-methods approaches that combine quantitative analysis with qualitative assessments of local institutional capacity, and examine the role of complementary investments in education and technology in moderating infrastructure effectiveness**.** These findings provide an empirical contribution to formulating data-driven regional development policies and reinforce the importance of transportation as an instrument of socio-economic justice in the post-pandemic era.

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