

Economic and Technological Determinants of Transportation Sector Performance in Indonesia: A Panel Data Approach (2020–2024)

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Abstract

This research analyzes the impact of economic and technological factors on the performance of the transportation sector in Indonesia using a panel data approach across 34 provinces during the period 2020–2024. The independent variables include the inflation rate, realization of transportation investment, and the regional digitalization index (EVDCI), while the dependent variable is the growth rate of the transportation sector. The estimation method uses panel data with a Fixed Effect Model (FEM) approach. The estimation results show that inflation and the realization of transportation investment have a positive and significant impact on the performance of the transportation sector, indicating that in the context of post-pandemic economic recovery, the increase in economic activity reflected by inflation and the realization of transportation investment also drives the demand for transportation services, while digitalization does not show a significant impact. These findings critique the short-term effectiveness of the digitalization program, which has not yet been fully functionally integrated into the national transportation system. This research emphasizes the importance of more targeted and region-based policy planning in strengthening the synergy between macroeconomic policies and the digital transformation of the transportation sector.

Keywords: digitalization, Indonesia, inflation, investment, panel data, transportation

INTRODUCTION

The transportation sector in Indonesia plays a critical role in the national economy, serving as a vital link for goods distribution and population mobility. According to Statistics Indonesia (BPS), the sector contributed approximately 10.3% to the national GDP in 2021, amounting to around IDR 1,472 trillion. This underscores the importance of transport in supporting economic activity, especially in rapidly growing urban areas.

Several macroeconomic factors influence transportation performance, notably per capita income, inflation, and infrastructure investment. The per capita income in 2021 reached IDR 56.4 million, indicating increased purchasing power and demand for public and private transport services. Inflation, recorded at 5.51% in 2022, can affect both consumer demand and operational costs in the transport industry. Meanwhile, the Indonesian government allocated over IDR 150 trillion for transport infrastructure in 2022, aiming to boost sectoral growth and connectivity.

Macroeconomic stability, particularly inflation and investment, plays a significant role in improving transport efficiency. Calderón and Servén (2010) emphasized that infrastructure investment is key to long-term economic growth, especially in developing countries. In contrast, inflation can elevate logistics costs and reduce demand (Mishkin, 2007).

In the era of digital transformation, technology enhances efficiency, safety, and sustainability in transportation. Studies by Zhang et al. (2022) and the World Bank (2020) show that digital technologies—such as big data and cloud systems—can improve logistics and productivity by up to 20% in developing economies.

However, in Indonesia, there is a lack of integrated research analyzing the combined effects of inflation, investment, and digitalization on the transportation sector at the provincial level using panel data. Therefore, this study investigates the impact of inflation, transport investment, and the Digital Competitiveness Index (EV-DCI) on the performance of Indonesia's transportation sector from 2020 to 2024 using a panel data approach. The findings are expected to contribute to evidence-based policy formulation in transport development strategies. The

transportation sector is fundamental to both regional and national economic performance. As economic activity grows, so does the mobility of goods and people, increasing the demand for transport services. Key economic theories explain this relationship: Demand and Supply Theory (Marshall, 1890) links transportation costs and fuel prices to service demand; Economic Growth Theory (Solow, 1956; Barro, 1990) highlights the impact of rising income on transport consumption; and Infrastructure Growth Theory (Aschauer, 1989) emphasizes the role of transport investment in enhancing efficiency and output.

Empirical studies support these frameworks. Firdaus (2019) and Sumarno (2020) found that income levels and infrastructure spending significantly influence transport sector growth. Inflation has mixed effects—while it raises operating costs, it can also shift demand depending on necessity (Sutrisno et al., 2021; Haryanto & Nugroho, 2022). Zulkarnain (2021) and Gertler et al. (2019) confirmed that quality infrastructure improves economic activity and connectivity.

Recent studies also highlight the role of digital transformation. Technologies like GPS, e-ticketing, and digital logistics platforms improve efficiency and service quality (Islamov et al., 2022; East Ventures & Katadata, 2023). However, the level of digital adoption in Indonesia remains uneven across regions.

This study builds on previous literature by simultaneously analyzing the effects of inflation, infrastructure investment, and digital competitiveness (EV-DCI) on transport sector performance using provincial panel data from 2020 to 2024.

METHOD

This study employs a quantitative approach using a panel data design, covering 34 provinces in Indonesia over the period 2020–2024. Panel data enables the integration of both cross-sectional and time-series variations, allowing for more robust and representative analysis. The study uses secondary data, including:

Transport Sector Growth Rate: obtained from Statistics Indonesia (BPS)

Inflation Rate: sourced from Bank Indonesia (BI)

Transport Infrastructure Investment: collected from the Ministry of Transportation and BPS

Digitalization Index (EV-DCI): from East Ventures and Katadata Insight Center

The general regression model used is as follows (Widarjono, 2017):

$$\text{Transport} = \alpha + \beta_1 \text{Inflation}_{it} + \beta_2 \text{Loginvestment}_{it} + \beta_3 \text{EVDCl}_{it} + \text{uit}$$

Transport	= Transport sector growth
Inflation	= Inflation rate
LogInvesment	= Log of transport investment
EVDCl	= Digital competitiveness index (EV-DCI)
α	= Intercept (province-specific effect)
$\beta_1, \beta_2, \beta_3$	= Coefficient
ε	= Error term
i	= Number of cross sections
t	= Period

RESULTS AND DISCUSSION

This section presents the estimation results of the fixed effect panel data regression model used to analyze the impact of macroeconomic and technological factors on the performance of Indonesia's transportation sector during the 2020–2024 period. The model includes three main independent variables: inflation, transport infrastructure investment, and the Digital Competitiveness Index (EV-DCI). The results are summarized in Table 1 below, showing the

estimated coefficients, standard errors, t-statistics, and probability values for each variable. These findings serve as the basis for evaluating the significance and direction of each factor's influence on transport sector growth.

Table 1. Fixed Effect Model Estimation Results

Variable	Coefficient	Std. Error	T-Statistic	Probability
C	-7.189592	2.364815	-3.036429	0.00289
Inflation	1.753073	0.496329	3.532078	0.00060
Investment	21.377420	5.001389	4.274296	0.00000
EV-DCI	0.015375	0.020188	0.761550	0.44770

Source: Secondary Data (2025)

The estimation results show that inflation has a positive and significant effect on the growth of Indonesia's transportation sector. The coefficient of inflation is 1.753 ($p = 0.0006$), meaning a 1% increase in inflation is associated with a 1.75% rise in transport sector growth. This aligns with the Relative Cost and Demand Theory, where moderate inflation may stimulate transport activity due to increased economic transactions (Blanchard & Johnson, 2013). Yusuf and Adisasmita (2020) also found that inflation positively affects air transport demand in Indonesia, particularly for essential services, reflecting a pass-through effect where cost increases are transferred to consumers.

Transport investment (LOG_INV) shows a strong and significant impact, with a coefficient of 21.377 ($p = 0.0000$), indicating that both public and private investments significantly enhance the sector's capacity and efficiency. These findings support Calderón and Servén (2010) and Esfahani & Ramírez (2003), who emphasized the multiplier effect of infrastructure investments in developing economies.

Meanwhile, the digitalization index (EV-DCI) displays a positive but statistically insignificant coefficient of 0.015 ($p = 0.4477$), suggesting that digital transformation has not yet contributed meaningfully to transport sector performance. This may be due to low adoption levels, institutional readiness, and regional disparities in digital infrastructure (Janssen et al., 2012; Prasetyo & Wahyuni, 2023). As Rogers' (2003) Diffusion of Innovation Theory posits, the impact of new technologies requires time to mature and widespread adoption.

The model's R-squared is 0.205, indicating that about 20.5% of the variation in transport sector growth can be explained by the three independent variables. However, the Adjusted R-squared is -0.011, suggesting that the model's explanatory power is weak after accounting for the number of variables and cross-sectional dummies. This reflects limitations due to a relatively short time span (5 years) and large cross-sectional effects.

To determine the most appropriate panel data model, both the Chow and Hausman tests were conducted. The Chow test produced a probability value of 0.9978, which is greater than the 0.05 significance level. This indicates that the Common Effect Model (CEM) is preferred over the Fixed Effect Model (FEM). However, the subsequent Hausman test yielded a probability value of 0.02, which is less than 0.05, suggesting that the Fixed Effect Model (FEM) is more appropriate than the Random Effect Model (REM). Based on these results, the Fixed Effect Model was selected as the best-fitting model for this study, as it accounts for unobserved heterogeneity across provinces during the 2020–2024 period.

CONCLUSION

This study analyzes the impact of economic and technological factors on the performance of Indonesia's transportation sector using panel data from 2020 to 2024. The findings reveal that inflation has a positive and significant effect on transport growth, indicating that inflationary pressures during this period did not hinder, but rather supported, transport activity due to increased logistics and distribution needs. Investment in transport infrastructure also shows a strong and significant positive impact, emphasizing its critical role in enhancing the sector's

capacity and connectivity across regions. In contrast, the digitalization index (EV-DCI) exhibits a positive but statistically insignificant effect, suggesting that digital transformation efforts in the transport sector remain limited due to uneven adoption, infrastructure gaps, and low electric vehicle penetration. Although two of the three variables have significant effects, the relatively low R-squared value (20.5%) and negative adjusted R-squared indicate that other unobserved factors—such as public policy, urbanization, regulatory quality, and geography—may also play substantial roles. Overall, this study underscores the importance of sustained investment policies and the need to accelerate digital transformation to enhance the efficiency and competitiveness of Indonesia's transportation sector.

The findings of this study suggest several key policy directions to support the growth of Indonesia's transportation sector. First, although inflation is typically seen as a risk to economic stability, its positive short-term effect on transport growth highlights the need for balanced macroeconomic management. Policymakers should maintain inflation within the target range while supporting logistics-related activities through coordinated fiscal and monetary policies, such as energy subsidies or logistics incentives.

Second, the significant impact of transport investment calls for better evaluation and prioritization. Infrastructure spending should be focused on high-impact areas—such as ports, urban transit, and inter-regional connectivity—particularly in regions with stagnant transport performance. Collaboration between central and local governments is essential to ensure that investment aligns with regional needs and yields optimal returns.

Third, although digitalization currently lacks a statistically significant effect, it remains strategically vital. The government should accelerate digital transformation in transportation by promoting e-ticketing, integrated route systems, and smart mobility solutions. This must be accompanied by improvements in digital infrastructure and literacy to ensure equitable digital benefits across regions.

Lastly, the strong cross-regional variation in transport performance indicates the need for spatially responsive policies. Decentralized, region-specific transport planning will allow provinces to develop systems tailored to their demographic and economic contexts. A comprehensive approach that balances short-term inflation control, targeted investment, digital innovation, and regional strategies is critical to sustaining long-term growth in the transport sector.

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