Research Article

An Examination of the Logistics Infrastructure's Impact on the Economic Growth of ASEAN

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Abstract.

Despite the substantial economic potential, ASEAN faces challenges in meeting its infrastructure investment needs, resulting in suboptimal logistics performance for several countries. This study proposes an analysis of the contribution of logistics infrastructure and infrastructure investment in ASEAN countries to the overall economic growth of ASEAN. This study also aims to provide valuable insights for formulating effective policies that promote regional connectivity and accelerate economic integration in the ASEAN region. This study employs a fixed effect model with panel data from eight ASEAN nations (Cambodia, Indonesia, Malaysia, Myanmar, the Philippines, Thailand, Singapore, and Vietnam) gathered between 2021 and 2022. The results show that ASEAN countries' logistics infrastructure is yet to affect ASEAN economic growth optimally. However, ASEAN countries' domestic infrastructure investment significantly and negatively affects ASEAN economic growth. ASEAN governments must prioritize and actively develop logistics infrastructure, both nationally and regionally, to help develop regional linkages and promote sustainable economic growth rates. They should also intensify coordination efforts, optimize regional financial integration, identify alternative funding sources, and assess regulations restricting private sector participation to maximize private sector investments in infrastructure development, including public-private partnership (PPP).

Keywords: ASEAN, economic growth, fixed effect, infrastructure investment, logistic infrastructure

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1. Introduction

The goal of development is to enhance the well-being of the community. The government plays a crucial role as a development facilitator, strategically supporting and enhancing people's welfare and the nation's economic growth. Economic growth is an indicator to assess the outcomes of implemented development initiatives and is valuable for determining the future development trajectory. Positive economic growth signifies an expansion in the economy, while negative economic growth indicates a downturn.

Simon Kuznets suggests that the economic advancement of a nation is influenced by various elements, including the accumulation of capital (investments in land, machinery, infrastructure, and human capital), availability of natural resources, the quantity and

quality of the workforce, progress in technology, information accessibility, the inclination towards innovation and self-improvement, and the prevailing work culture [1].

To facilitate growth in Indonesia, the government has implemented various measures to reduce the burden on the business world. The primary objective is for local governments to provide infrastructure and facilitate conditions for businesses to thrive. The secondary goal involves expediting the implementation of infrastructure projects in Indonesia to counteract the potential surge in unemployment. These projects encompass the construction of roads, bridges, ports, docks, energy facilities, transit systems, and housing. Aside from creating job opportunities, such infrastructure advancements stimulate economic activity.

Based on these government aims; it is appropriate to research the impact of infrastructure development on Indonesia's economic growth. The findings are likely to help determine priorities for infrastructure development.

Logistics is a component of the supply chain that manages the movement of goods, information, and finances. It involves key functions such as procurement, storage, transportation, distribution, and delivery services, catering to consumers' preferences in terms of type, quality, quantity, timing, and location. This process is executed by all business entities and relevant industries, ensuring safe, effective, and efficient transport from the point of origin to the designated destination. In practice, implementing these main activities involves various stakeholders: consumers, producers, distributors, logistics service providers, institutions supporting logistics activities, and the government. It requires the support of quality logistics infrastructure in the form of transportation, distribution, information, and financial networks (Presidential Regulation No. 26/2012 on the Blueprint of the National Logistics System).

The logistics sector's growing importance has raised concerns among Southeast Asian countries that are members of the Association of Southeast Asian Nations (ASEAN). In recent decades, the ASEAN logistics sector market has grown significantly as various Free Trade Agreements (FTAs) have been implemented among ASEAN member countries and between ASEAN member countries and several partner countries, including China, Korea, Japan, India, Australia, and New Zealand. ASEAN Economic Ministers chose logistics as one of the 12 priority areas in 2006 to expedite economic integration. Then, in 2007, ASEAN agreed on the Roadmap for the Integration of Logistics Services, which intends to develop an ASEAN single market and an integrated ASEAN logistics environment by liberalizing and facilitating the logistics industry to boost ASEAN manufacturing competitiveness [2].

ASEAN's goal of accelerating economic integration is driven by the fact that ASEAN members collectively have great economic potential. Based on the ASEAN Economic Progress document for the period 1967-2017, it is reported that the combined GDP of ASEAN countries in 2016 reached US$ 2.55 trillion. In addition, in 2016, ASEAN's GDP share of the world almost quadrupled from 3.3% in 1967 to 6.2%. It makes ASEAN the 6th largest economy in the world [3, 4, 5].

Based on the various explanations throughout this background section, it is known that ASEAN faces challenges in conducting economic integration through physical regional connectivity because ASEAN countries have different levels of logistics infrastructure development. Considering that there needs to be more references to previous research related to the contribution of the logistics infrastructure of ASEAN countries to ASEAN economic growth as a whole, the author considers it necessary to carry out this research. This research is relevant to the current condition where infrastructure development to support connectivity is the focus of ASEAN governments' policies. Through this research, the governments of ASEAN countries can have a reference in formulating appropriate policies and regulations related to logistics infrastructure development that encourage the creation of regional connectivity to facilitate the acceleration of economic integration in the ASEAN region.

2. Literature Review

2.1. Theoretical review

2.1.1. Economic growth

Economists believe that economic growth is the most significant determinant of development. The government in any country can fall or rise depending on the level of economic growth achieved, and the quality of government policies and apparatus in the overall economic sector is typically measured based on the rate of growth of national output produced [1].

Meanwhile, according to neoclassical theory, economic output growth is governed by capital stock expansion, labor growth, and technical advancement. An economist who won the Nobel Prize in economics in 1971 for his pioneering efforts in measuring and analyzing national income growth in developed countries, namely Professor Simon Kuznets, has defined a country's economic development. According to Kuznets, economic expansion is a surge in a country's long-term ability to deliver various economic

products to its citizens. The capacity growth is dictated or made feasible by technical, institutional, and ideological advancement or changes to the diverse demands of current conditions [1].

Economic growth is often conventionally measured as a percentage rise in gross domestic product (GDP). GDP represents an economy's total expenditure on different freshly created products and services over a certain period or year, as well as the total revenue gained from these goods and services. GDP is the market value of all commodities and services produced in a country over a specific period [6]. Growth is commonly computed in real values to remove inflation in prices and services generated, so real GDP only reflects changes in the quantity of output.

The emergence of dissatisfaction with neoclassical theory gave rise to a new theory, namely the New Growth Theory. The main motivation for the growth of this theory is to explain the economic development inequality between countries [1]. Robert Lucas from the University of Chicago pointed out world phenomena not by neoclassical growth theory, such as wage differences between countries and population migration between countries [7]. Robert Barro and Xavier Sala-I-Martin from Harvard stated that with diminishing returns to capital in the neoclassical model, capital ought to relocate from developed countries (with high capital-labor ratios) to emerging countries (with low capital-labor ratios). However, the things that happen are the opposite; most developing countries do not experience net capital inflow but experience capital flight. These capital movements should also increase convergence, as found in the Solow model. However, this convergence is not found in the real world [8].

Paul Romer, an economist at the University of California-Barkeley, believes that if technology is endogenous or explained in models, then economists will be able to explain things that neoclassical growth models fail to explain (in neoclassical models, technology is assumed to be exogenous). When technological levels are allowed to vary, we can explain how developed countries have higher levels than developing countries. With these different technologies, the speed of spreading knowledge will determine convergence between developed and developing countries. New theorists such as Romer consider that innovation and technological change that increase capital and labor productivity are the key factors for the growth process [9].

This theory has also received criticism from several experts because it cannot be applied to developing countries because several important factors that often-become obstacles to economic growth in developing countries are not paid attention to by this theory, such as inefficiencies originating from weak infrastructure, inadequate

institutional structures, as well as goods markets and capital markets which are far from perfect [1].

2.2. Previous study

Several scholars have studied the role of logistics infrastructure in economic growth with varying scopes. Some studies include transportation and ICT infrastructure variables as measurement indicators of overall infrastructure variables. Most other research examines the causal link between infrastructure and economic growth and other economic growth variables such as foreign direct investment. It is based on the theory that infrastructure affects economic growth indirectly. Studies often use only one indicator of logistics infrastructure measurement: transportation or ICT infrastructure. In a few studies, there has also been a combination of both. The measurement indicators used are either physical or monetary aspects of infrastructure.

Prasetyo and Firdaus [10] used the Fixed Effect Model to examine the influence of infrastructure on regional economic growth in Indonesia, utilizing panel data from 26 Indonesian provinces. They included the variable of road length (with good and medium conditions) as one of the indicators of infrastructure measurement, which also consisted of the variable of electrical energy sold and the variable of the amount of clean water supplied. The findings revealed that road infrastructure had an advantageous effect on the regional economy in Indonesia. These results are supported by Radiansyah's [11] research on the same topic. The difference lies in the infrastructure measurement indicators used: road, electricity, and telephone infrastructure. Based on the Fixed Effect Model regression results, road and telephone infrastructure are proven to have a favorable and considerable impact on Indonesia's regional economy per capita, where road infrastructure has the largest contribution.

Meanwhile, Pradhan conducted causal relationship analysis in two separate studies using physical measurement indicators of logistics infrastructure in the transportation and ICT sectors. Pradhan et al. [12] looked at the long-term relationship between road infrastructure, foreign direct investment, and economic development in India from 1970 to 2012. Rail and road infrastructure serve as examples of transportation infrastructure in this research. The research was undertaken in two ways: individually, where rail infrastructure and road infrastructure are handled independently, and in groups using a composite index concept based on Principal Component Analysis (PCA) that connects rail infrastructure and road infrastructure. The findings indicate that there is a long-term equilibrium connection between the variables. In addition, there is a two-way link

between FDI and economic development and a one-way causal relationship between transportation infrastructure and FDI. 2015 Pradhan et al. examined the causal link between ICT infrastructure, finance development, and economic growth in 21 Asian nations from 1991 to 2012. The PCA method was again applied to create a composite index of ICT infrastructure consisting of telephone landlines, mobile phones, and internet users. The findings indicate a causal association between the short and long-term variables. Still, the results differ for each Asian region, possibly due to economic systems, infrastructure development, political stability, and cultural differences.

The following researchers applied the use of infrastructure measurement indicators in monetary units. Gholami et al. [13] investigated the simultaneous causal link between ICT investment and FDI flows and the influence on economic growth. The empirical investigation analyzed data from 23 nations with varying economic levels from 1976 to 1999. The findings indicate a causal link between ICT and FDI in developed nations, implying that the higher the ICT investment, the greater the growth in FDI inflows. ICT can indirectly help economic growth by attracting more foreign direct investment (FDI).

In contrast, in the case of developing nations, there is some evidence of a causal link between FDI and ICT, which implies that FDI inflows generate an increase in ICT investment. Meanwhile, Tripathy et al. [14] investigated the long- and short-term relationships between infrastructure investment and economic development in India. Gross Domestic Capital Formation (GDCF) was employed as an indicator for measuring infrastructure investment. The findings reveal a long-term link between infrastructure investment and economic development.

These studies were conducted based on case studies in countries with different economic dynamics, so the results should not be generalized to countries with similar economic levels. The research that the author will conduct differs from previous studies in terms of scope because it includes ICT and transportation infrastructure that represent logistics infrastructure. In addition, not many studies discuss the significance of logistics infrastructure to ASEAN's overall economic growth. The closest previous research reference is a study by Novianti et al. [15]. This study uses several variables that represent ICT infrastructure and transportation infrastructure, namely the number of telephone service subscribers (per 1000 people), the number of domestic seaports, the number of international seaports, Liner Shipping Connectivity Index (LSCI), and the number of domestic airports. The results show that all variables, except the number of domestic seaports, have a considerable and consequential influence on economic development. The research to be conducted by the author is different in terms of the variables used as indicators of logistics infrastructure measurement. Hopefully, this research can

contribute positively as a more representative reference as ASEAN countries strive to build and develop logistics infrastructure that supports regional connectivity.

3. Materials and Method

3.1. Independent variable

In this study, logistics infrastructure is set as an independent variable divided into transportation infrastructure and ICT infrastructure. Transportation infrastructure is divided into four variables, namely land transportation infrastructure variable (TRANSLAND), sea transportation infrastructure variable (PORT), and air transportation infrastructure variable (AIRPORT). The TRANSLAND variable is a composite index of road infrastructure (ROADLENGHT) and railroad infrastructure (RAILLENGHT) obtained through the Principal Component Analysis (PCA) method. Meanwhile, the ICT infrastructure variable is a composite index of three indicators, namely fixed-broadband subscriptions (FXBRD), mobile cellular subscriptions (MBCEL), and fixed-telephone subscriptions (FXTLP), which are also obtained through the PCA method. These variables describe the physical aspects of logistics infrastructure. The operational definition of each variable is shown in Table 1. The selection of these variables as indicators of logistics infrastructure based on their physical characteristics is based on past research on the influence of transportation or ICT infrastructure on the economy's growth.

The authors have also considered the opinion of Calderon and Serven [16] in Kodongo and Ojah [17], Infrastructure measurement based on a single variable, whether in physical or monetary terms, fails to apprehend the multidimensional nature and heterogeneity of infrastructure over time and across countries, as well as the distinction among quality or productivity and quantity. Kodongo and Ojah [17] responded to these critiques with an index of several infrastructure metrics. It is the basis for the author to create a composite index of TRANSLAND and ICT variables using the PCA method. Meanwhile, the PORT and AIRPORT variables were decided to use a single variable due to limited references for indexing the two infrastructures. The author uses data from 2021 – 2022 to research eight ASEAN countries, except Brunei and Laos, due to the limited data sources for several logistics infrastructure variables in these two countries.

The Gross Fixed Capital Formation (GFCF) variable is a proxy variable that represents the domestic infrastructure investment of each ASEAN country. This variable describes

Table 1: Operational Definition of Logistics Infrastructure Variables

Variable	Descriptions
FXBRD	Number of high-speed cable-based public internet access subscribers, including residents and organizations
MBCEL	Number of public cellular telephone service subscribers, including postpaid subscribers and the total amount of active prepaid accounts.
FXTLP	The number of active analog landline telephone lines, voice-over-IP subscriptions, fixed wireless local loops (WLLs), ISDN voice-channel equivalents, and public phones.
ICT	Composite index of ICT infrastructure (comprising FXBRD, MBCEL, and FXTLP variables) obtained through the PCA method.
RAILLENGHT	Total length of rail network (in kilometers) operational in a country in a given year.
ROADLENGHT	Total network length of all road types/classifications (in kilometers) in a country in a given year.
TRANSLAND	Composite index of land transportation infrastructure (consisting of RAILLENGHT and ROADLENGHT variables) obtained through PCA.
PORT	The number of ports used for international maritime transportation or for merchant vessels providing transportation services between ports in two or more countries.
AIRPORT	The number of airports designated by the state as international airports, including airports used for both domestic and international air traffic.

Source: The World Bank dan ASEAN Statistical Yearbook

the monetary aspect of infrastructure included in the study to capture the multidimensional nature of infrastructure better. The GFCF data of ASEAN countries for 1997 - 2017 (in percentage of GDP) was obtained from The World Bank.

3.2. Dependent variable

GDP is a proxy variable representing each ASEAN country's economic growth. This variable is set as the dependent variable. The research data will be used as GDP growth data (constant 2010 prices) of ASEAN countries from 1997 - 2017 (in US$) from The World Bank. In addition to the main variables that are the focus of the research, the author also includes four control variables set as independent variables. Based on Sandjaja and Heriyanto [18], control variables neutralize their influence on the dependent variable. In addition, it is also based on the consideration that infrastructure can affect economic growth indirectly through several macroeconomic indicators.

This study analyzes panel data (pooled data) from eight ASEAN nations (Cambodia, Indonesia, Malaysia, Myanmar, the Philippines, Thailand, Singapore, and Vietnam) from

1997 to 2017. According to Baltagi [19], using panel data has several statistical and economic speculations. This study uses STATA Version 14 statistical software to process and analyze panel data based on the regression analysis method with 3 (three) estimation models, namely Pooled (Ordinary Least Square, OLS), Fixed Effect Model (FEM), and Random Effect Model (REM). Furthermore, the authors conducted an estimation model selection to determine a statistically suitable model for the research objectives and data characteristics so that the estimation process provides more precise results. The authors conducted model testing to ensure that the selected model can provide good and unbiased estimation results. Some criteria used in the model testing process are statistical, economic, and econometric.

4. Result

4.1. Regression result

Based on the regression results using the Fixed Effect model in STATA (Table 2), it is known that of the four independent variables representing logistics infrastructure, only one independent variable shows statistically significant results on ASEAN economic growth, namely the AIRPORT variable (air transportation infrastructure).

4.2. Logistics infrastructure variable

Inadequate logistics infrastructure in most ASEAN countries contributes to the low significance of logistics infrastructure in ASEAN economic growth. The level of logistics infrastructure development of ASEAN countries varies significantly from one another, affecting each country's logistics performance level, which in turn affects its competitiveness. Ultimately, the level of competitiveness correlates with each ASEAN country's classification by income level. ASEAN countries with better logistics infrastructure have better logistics performance and competitiveness levels and a higher classification of countries by income level. The research results are by the hypothesis.

5. Discussion

5.1. Regression result

AIRPORT variable (air transportation infrastructure) substantially impacts the dependent variable at the 95% confidence level or at the α = 0.05 confidence level. Meanwhile,

Table 2: Fixed Effect Model Regression Result.

Variables	**(1)**
	Fixed Effect
GFCF	-0.341***
	(0.111)
TRD	0.0315*
	(0.0159)
INFL	-0.0761
	(0.0930)
LFPR	-0.352*
	(0.200)
LnFDI_NI	1.687***
	(0.409)
LnPORT	3.760
	(2.266)
LnAIRPORT	-5.135***
	(2.473)
ICT	0.277
	(0.502)
TRANSLAND	1.367
	(1.244)
Constant	-5.896)
	(14.13)
Rho	0.9098
Observations	79
Number of countrynum	8
R-squared	0.3111

Standard errors in parentheses, * show significant: *** p<0.01, ** p<0.05, * p<0.1.

three other logistics infrastructure variables, namely TRANSLAND (land transportation infrastructure), PORT (sea transportation infrastructure), and ICT (ICT infrastructure), do not significantly affect ASEAN economic development. The regression results also displayed that the GFCF variable, which indicates public sector infrastructure investment, has a major effect on the economic growth of ASEAN nations at the α = 0.01 confidence level. It should be noted that the AIRPORT and GFCF variables have negative coefficient signs, which means they have an inverse relationship with ASEAN economic growth.

In contrast, the other logistics infrastructure variables have positive coefficient signs, meaning they have a potential relationship with ASEAN economic growth.

This study also includes control variables in consideration of the assumption that logistics infrastructure affects economic growth indirectly through the spillover effect of other variables. The framework has four control variables: foreign direct investment (FDI), international trade (TRD), labor participation rate (LFPR), and annual inflation rate (INFL). The estimation results show that three of the four control variables, namely FDI, TRD, and LFPR, substantially impact the economic progress of nations in the ASEAN area. FDI and TRD have positive coefficient signs, while LFPR has negative ones. On the other hand, the INFL variable does not significantly affect the economic development of countries in the ASEAN region and has a negative coefficient sign.

Overall, the Fixed Effect estimation model has a small adjusted R-squared (R2) value of only 0.311. It suggests that the independent variables in the Fixed Effect model can explain the dependent variable by 31.1%, while non-model factors explain the remaining 68.9%. R2 in the cross-sectional data estimation model tends to have a smaller value than the R2 value in the time series data estimation model, so in the panel data estimation model, a small R2 value is common. The author also considered that the impact of infrastructure factors on the economic growth of nations in the ASEAN area did not occur directly but through spillover effects. In this research, the authors incorporate variables of control that are most closely connected to logistical infrastructure into the model. The model did not include other factors, resulting in a small R2 value. However, the small R2 value is not an issue in this study, given that the aim of this research is to ascertain the significance of the main variables at the individual level and the model as a whole rather than using the model to estimate or predict.

The regression result output also has a rho value of 0.9098. The greater the rho value, the closer it is to 1, and this indicates that there is a very strong average difference in the value of the dependent variable between cross sections. In this regression result, the rho value indicates that 90.98% of the difference in ASEAN economic growth rates is due to the average difference between ASEAN countries. These differences affect the contribution of each ASEAN country's logistics infrastructure to the overall ASEAN economic growth rate.

5.2. Logistics infrastructure variable

Overall, ASEAN still has many issues in the logistics sector. Poor transportation infrastructure, underdeveloped transportation and logistics services, slow and costly bureaucratic procedures in transporting goods, inadequate road infrastructure to seaports, low quality of seaport infrastructure, and suboptimal shipping networks are just some of the problems in the sector. This results in consequent barriers to entry and high operating costs that prevent logistics companies from serving the ASEAN region as a whole. The absence of logistics service providers at the regional level reinforces the fragmented nature of the transportation system in the ASEAN region, ultimately adding to overall transportation costs [2]. Meanwhile, in terms of the ICT sector, although this sector tends to experience significant improvements in each ASEAN country, digital inequalities between ASEAN countries still exist. This circumstance poses a challenge for ASEAN in fostering the integrated use of ICT in the logistics industry to boost the efficiency and competitiveness of logistics services in the digital era.

5.3. Domestic infrastructure investment variable

The GFCF variable represented domestic infrastructure investment. It is known that the GFCF variable significantly affects the GDP variable. However, the GFCF variable has a negative elasticity to the GDP variable of 0.341, which means that any increase in domestic infrastructure investment of ASEAN countries to support regional connectivity by 1% harms ASEAN economic growth by 0.341%. This can be caused by the suboptimal domestic infrastructure investment of ASEAN countries, including logistics infrastructure, as indicated by the existence of an infrastructure investment gap, which is the difference between infrastructure investment needs and infrastructure investment realization of US$ 102 billion per year during the period 2016-2020 [5]. With this condition, it can be concluded that ASEAN is losing money and opportunities to increase the region's overall economic growth. The research results are by the hypothesis.

6. Conclusion

According to the regression findings of the logistics infrastructure contribution to ASEAN economic expansion, it can be concluded that the logistics infrastructure of ASEAN countries, consisting of transportation infrastructure (land, sea, and air) and ICT infrastructure, has yet to affect ASEAN economic growth optimally. Land transportation

infrastructure, sea transportation infrastructure, and ICT infrastructure have positive but insignificant potential in driving ASEAN economic growth. Meanwhile, air transportation infrastructure significantly negatively impacts ASEAN's economic expansion due to the unequal level of logistics infrastructure development among ASEAN countries, with their respective issues and priorities hindering the development of regional connectivity to achieve potential economic growth levels.

ASEAN countries' domestic infrastructure investment significantly and negatively affects ASEAN economic growth due to the gap between ASEAN countries' domestic infrastructure investment realization and the region's infrastructure investment needs. Some factors that affect most ASEAN countries' infrastructure investment capability include weak domestic funding sources, supporting regulations that limit private sector participation, limited use of intra-ASEAN funding sources, and reliance on funding sources from outside ASEAN.

The result implied some policy suggestions and recommendations. For example, ASEAN governments need to prioritize logistics infrastructure development at both the country's national and regional levels within ASEAN, especially to support the creation of regional connectivity to achieve the potential for sustainable ASEAN economic growth rates. ASEAN governments must also coordinate more intensively and continuously to harmonize their logistics infrastructure development policies. Furthermore, ASEAN governments need to optimize further regional financial integration efforts to finance logistics infrastructure development that supports regional connectivity. ASEAN governments must also identify other potential funding sources, considering that a single funding source cannot adequately fund ASEAN's large infrastructure investment needs. In addition, ASEAN governments need to identify and evaluate regulations limiting private sector participation to optimize private sector investment in infrastructure development, including through Public-Private Partnership (PPP).

The limitation of this research is that it uses economic growth variable data. It would help if you also tried to use sustainable economic growth. The definition and logistics data used is infrastructure logistics. Using the definition of information technology infrastructure variables is a good idea.

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