Digital Infrastructure and Income Level: Drivers of E-Commerce in Southeast Asian Countries

ABSTRACT

Southeast Asia is entering the digital decade, where the digital economy is growing rapidly due to shifts in consumer and business behavior, with an estimated impact on the internet economy reaching US$1 trillion by 2030. E-commerce is one form of representation of the digitalization of the economy that has successfully created a multiplier effect. The progress of the digital economy that is not accompanied by an increase in digital infrastructure has the potential to create a digital divide.
Aims: This study aims to determine and analyze the effect of GDP per capita and digital infrastructure e-commerce in six Southeast Asian countries.
Study design: This research applies a descriptive quantitative approach.
Methodology: Researchers included internet, fixed broadband, mobile broadband, and mobile cellular as indicators of digital infrastructure. The research transformed the data into logarithmic form and used panel data regression with a fixed effect model (FEM). This research uses secondary data by taking annual data from 2017 to 2023 in six Southeast Asian countries such as Indonesia, Malaysia, Singapore, Thailand, Philippines, Vietnam.
Results: The results of this study indicate that GDP per capita, internet and fixed broadband have a positive and statistically significant effect on e-commerce. Mobile cellular have a positive but no statistically significant effect on e-commerce. Meanwhile, mobile broadband has no positive effect on e-commerce.
Conclusion: This research is expected to be a consideration for governments in the six Southeast Asian countries to reduce technological backwardness by improving the equity and quality of ICT access to maximize the potential of e-commerce in the digital economy.

Keywords: Digital Economy, E-Commerce, GDP per Capita, Internet, ICT

1. INTRODUCTION

The digital revolution that began at the beginning of the 21st century became the essence of the birth of the industrial era 4.0, which significantly changed how people work and interact (Schwab, 2017). This transformation not only replaces physical machines with digital systems but also overhauls consumption patterns and business models and creates new economic opportunities that are more efficient and effective. Southeast Asia (SEA) is entering the “Digital Decade”, where the digital economy is growing rapidly due to consumer and business behavior shifts. This is marked by the massive digital transformation by innovative MSME players utilizing technology and the emergence of “Unicorn” technology companies such as Shopee, Lazada, Tokopedia, Gojek, and Traveloka (World Bank, 2019). Temasek (2022) estimates that the impact of the internet economy could reach US$1 trillion by 2030. The

government launched the “ASEAN Digital Masterplan 2025,” which focuses on improving digital infrastructure and ICT access to catch up with industry 4.0 and accelerate post-pandemic economic recovery (World Bank, 2019). E-commerce is one form of representation of economic digitalization that has successfully created a multiplier effect (Armunanto et al., 2021). The ability of e-commerce to increase efficiency and productivity and expand market share gives it the potential to become a new driver of economic growth (Kinda, 2019).

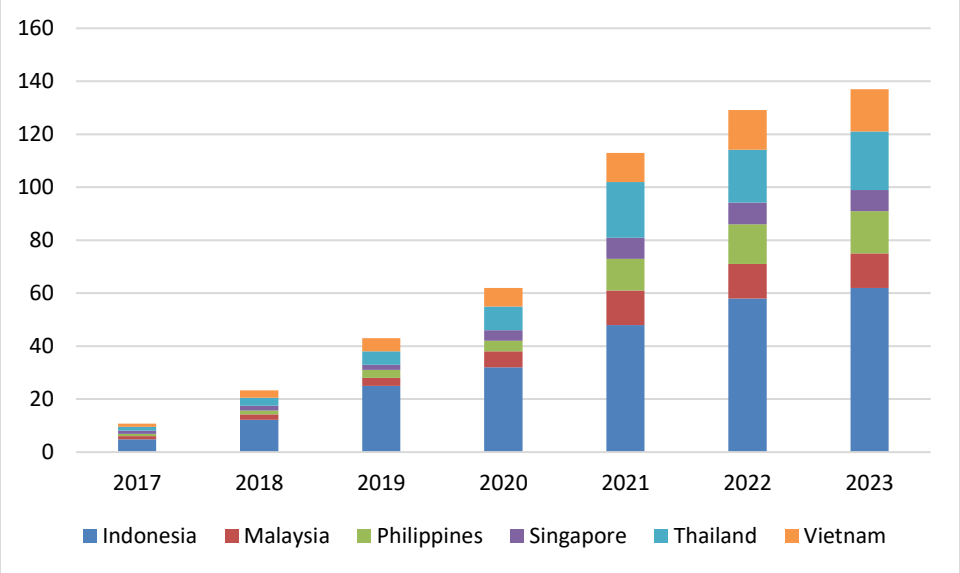

Figure 1. E-Commerce Transaction Value in SEA Countries (in billion US$)
Source: Google, Temasek Holdings, dan Bain & Company (2025)

E-commerce has been the most significantly growing sector in the last seven years and contributes the most to the digital economy in Southeast Asia (Temasek, 2023). Figure 1 shows that the value of e-commerce transactions grew rapidly from only US$10.9 billion in 2017 to US$137 billion by 2023. Indonesia has been the country that has contributed the most to e-commerce transactions in Southeast Asia over the past seven years. The restrictions on physical activity during the COVID pandemic have made people reduce their shopping activities directly to offline stores and choose online through e-commerce (Kemenlu RI, 2022). Temasek (2022) projects that the transaction value of the e-commerce sector will exceed US$200 billion by 2025. The level of e-commerce progress in a country can be determined by technological factors seen from the development of telecommunications infrastructure and also economic factors that can be seen from GDP and average income. Developing countries face significant challenges in implementing e-commerce due to inadequate telecommunications infrastructure, such as low internet speed, poor network quality, and the high cost of access to internet services (Mthembu, 2018).

The progress of the digital economy sector should be followed by an increase in digital infrastructure, if this is not fulfilled, it can cause a digital divide. The digital divide refers to the gap between people with adequate access to Information Communication and Technology (ICT) and those with poor access to ICT or even no access at all (Soomro et al., 2020). The digital divide phenomenon in Southeast Asia indicates that the current rapid development of ICT is not accompanied by equitable access to all levels of society. In fact, having a superior telecommunications infrastructure is the substance of digital transformation (ASEAN, 2022). The diffusion of ICT has significantly reduced production costs, improved resource allocation

efficiency, and encouraged more significant investment into economic sectors. However, the impact of ICT still depends on each country's level of development (Habibi & Zabardast, 2020).

Digital infrastructure plays a vital role in developing technologies that support a region's e-commerce ecosystem. Hussein et al. (2020) stated that the main factors in achieving success in adopting e-commerce are infrastructure adaptability and technology compatibility. If the available technological infrastructure is inadequate, other factors, such as internet connectivity cannot function optimally, potentially hindering the implementation and adoption of e-commerce in a region (Kabir et al., 2020; UNCTAD, 2019). The International Monetary Fund (IMF) states five main priorities in encouraging digital economic growth, one of which is that the internet must be widely accessible and affordable (IMF, 2018). Broadband can be divided into two types, namely fixed and mobile. Broadband services in Southeast Asia are more than 90% dominated by mobile networks than fixed. The quality of digital infrastructure in a country can be measured by the internet penetration rate, which is the percentage of the total population that can access the internet, this can be seen in Figure 2 below:

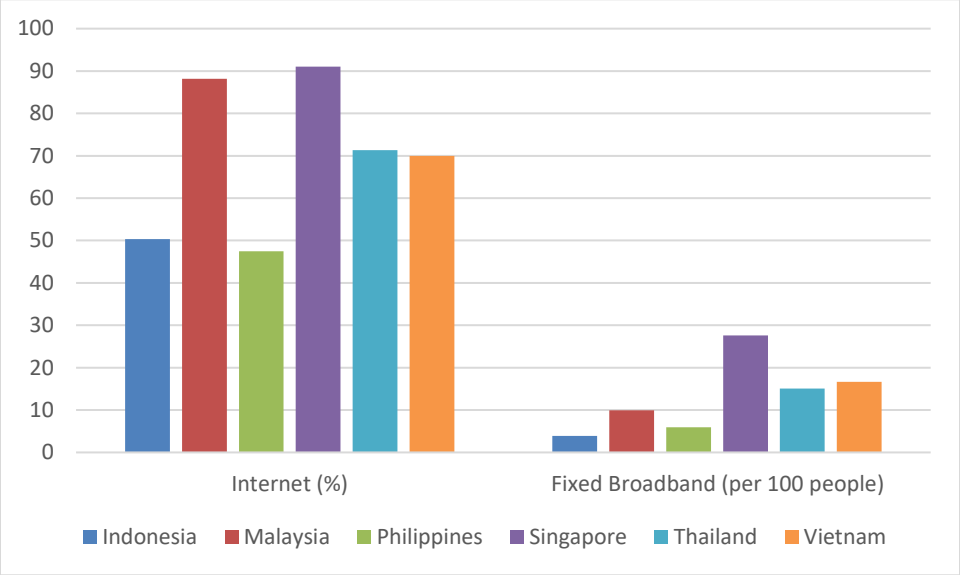

Figure 2. Average Internet Access in SEA Countries 2017-2023
Source: World Bank (2025)

Figure 2 shows the average internet access measured by internet penetration rate and fixed broadband subscriptions per 100 people in six Southeast Asian countries over the last seven years. The internet penetration rate in Singapore reaches 91%, which means that almost all of its people have access to the internet. In contrast, the Philippines has the lowest internet penetration rate at 52%, meaning that only half of the total population has access to the internet. This indicates a gap between countries where some people still do not have access to the internet. Fixed broadband subscriptions per 100 people in Figure 2 above show low usage rates, with the exception of Singapore. This is because the average price to subscribe to this service in ASEAN countries is still relatively expensive (ITU, 2020). This makes most people in developing countries prefer to use mobile broadband services rather than fixed broadband (Oloyede et al., 2023).

Broadband infrastructure has a role in expanding internet access and supporting the development of the digital economy in various regions (DJPPI, 2024). High-quality broadband connectivity triggers innovation, promotes economic growth, efficient exchange of goods and services, and so on. Fixed broadband has a more stable connection than mobile broadband, making it more suitable for business and trade activities. Developing countries such as the Philippines, Vietnam, Indonesia, Malaysia, and Thailand certainly face more complex challenges in transitioning to a digital economy than developed countries such as Singapore due to limited telecommunications and financial infrastructure (Oloyede et al., 2023). Infrastructure challenges are often found in developing countries where the internet network quality is low and unstable, the cost of subscription to internet access is high, and the logistics network has not been integrated. In fact, internet infrastructure is a crucial element in operating e-commerce platforms, including smooth transactions. Therefore, efforts to transform the digital economy in developing countries must prioritize increased investment in developing and distributing digital infrastructure throughout the region (Mthembu et al., 2018; UNCTAD, 2019).

The International Monetary Fund (IMF) states that there is a correlation between GDP per capita and the Digital Adoption Index. The higher the level of GDP per capita of a country, the higher the digital adoption index, and vice versa (IMF, 2018). According to Jula et al., (2024) GDP per capita is an important determinant in influencing consumer behavior, market dynamics, technological innovation, and the overall expansion of digital trade. Income levels can specifically influence the structure of consumer preferences that potentially determine their decisions in making purchases such as shopping for digital products and services through e-commerce platforms (Lola & Bakeev, 2021). People with high incomes are more able to afford digital access such as electronic devices and high-speed internet services, and are more likely to fulfill their needs for goods and services through e-commerce than people with low incomes (Olumekor et al., 2024). Countries with higher GDP per capita have greater access to digital infrastructure and internet connectivity, fostering an enabling environment for e-commerce adoption and engagement. An increase in income levels can increase market accessibility and affordability, which drives the penetration rate and volume of e-commerce transactions (Jula et al., 2024). Therefore, this research model adds GDP per capita as one of the fundamental economic factors that is expected to drive e-commerce growth.

Most other studies like (Appiah-Otoo & Song, 2021; Bahrini & Qaffas, 2019; Haftu, 2019; Myovella et al., 2020; Ximei et al., 2024) focus on analyzing the effect of ICT infrastructure on economic growth as proxied by GDP and GDP per capita. Based on these studies, there are still inconsistencies in the research results. Appiah-Otoo & Song (2021) recommend that future researchers raise topics related to e-commerce due to the ICT revolution. Therefore, we conduct research related to the effect of income and ICT infrastructure on the value of e-commerce transactions, which, to our knowledge, has not been done by many other researchers, especially in the Southeast Asia region, so that it can be a novelty in this study.

There are still limited theories that can comprehensively explain the differences in the growth rate and spread of e-commerce between countries. Therefore, the study conducted by Ho et al. (2007) becomes one of the references in this research where the study offers a new theoretical perspective using growth theory as the basis of exploration in its research to explain the growth and spread of B2C e-commerce across countries. Ho et al. (2007) adapted and adjusted the thinking of endogenous and exogenous growth theory to the context of e-commerce thus providing a new and different theoretical perspective. This theoretical approach has not been widely applied and has the potential to be refined and developed further. The research results of Ho et al. (2007) mentioned that endogenous growth theory is more effective in explaining the growth of B2C e-commerce in Europe than exogenous growth theory. Meanwhile, the study of Ariansyah et al. (2021) mentioned that the diffusion of

innovation theory popularized by Rogers (2003) can explain that e-commerce adoption in a country is influenced by various factors, including access to digital infrastructure.

2. METHODOLOGY

This study uses secondary data by taking annual data on e-commerce, GDP per capita, internet, fixed broadband, mobile broadband, and mobile cellular for the period 2017-2023 in SEA countries namely Indonesia, Malaysia, Singapore, Thailand, Philippines, and Vietnam sourced from the World Bank database, ITU, and the "e-Conomy SEA" report from Google, Temasek, and Bain Company. The total data in this study is 42. Referring to the research problems and hypotheses that have been formulated, the following table 1 shows the operational definitions of the variables that will be used in this study:

Table 1. Operational Definitions of Variables

Variables	Definition	Data Source
E-Commerce (EC)	Gross merchandise value of Business to Consumer (B2C) and SMEs on marketplaces (US$)	Google, Temasek, and Bain Company
GDP per Capita (GDPPC)	Gross domestic product divided by population in mid-year. Based on constant 2015 prices US$	World Bank
Internet (INT)	Percentage of individuals using the internet	World Bank
Fixed Broadband (FB)	Fixed broadband subscriptions per 100 people	International Telecommunications Union (ITU)
Mobile Broadband (MB)	Mobile broadband subscriptions per 100 people	International Telecommunications Union (ITU)
Mobile Cellular (MC)	Mobile cellular subscriptions per 100 people	International Telecommunications Union (ITU)

Source: Authors (2025)

The mathematical panel data regression equation based on the dependent and independent variables used in this study is as follows:

$$EC = \beta 0 + \beta 1\ GDPPCit + \beta 2\ INTit + \beta 3\ FB\ it + \beta 4\ MB\ it + \beta 5\ MC\ it + \varepsilon\ it \dots\dots\dots\dots\dots (1)$$

Logarithm transformation aims to reduce skewness and heteroscedasticity because economic variables generally tend to be positive and heteroscedastic (Gujarati & Porter, 2009). This study uses a log-log model where the dependent and independent variables are transformed into natural logarithms to form a new equation as follows:

$$LN\_EC_{it} = \beta 0 + \beta 1\ LN\_GDPPC_{it} + \beta 2\ INT\ it + \beta 3\ LN\_FB_{it} + \beta 4\ LN\_MB_{it} + \beta 5\ LN\_MC_{it} + \varepsilon it \dots (2)$$

where LN is the natural logarithm; EC is e-commerce; GDPPC is GDP per capita; INT is the internet; FB is fixed broadband; MB is mobile broadband; MC is mobile cellular; β0 is constant; β1,2,3,4,5 is coefficient; ε is an error term; i is a cross-section; t is time-series.

The econometric approach in this study uses panel data regression analysis techniques with the statistical software, E-Views. This regression analysis aims to estimate the average or population value of the dependent variable based on the values of the independent variables (Gujarati & Porter, 2009). The estimation model in panel data regression consists of three models: Common Effect Model, Fixed Effect Model, and Random Effect Model.
The t-statistic test needs to be done to measure how the effect of the independent variables partially explains the variation in the dependent variable. This is done by comparing the t-count value with the t-table value and also the probability value whether it is in accordance with the specified significance level (α) of 0.05. If the regression results show that the t-count value is smaller than the t-table and the probability value is greater than 0.05, Ha is accepted while Hb is rejected. Meanwhile, when the t-count value is greater than the t-table and the probability value is smaller than 0.05, Ha is rejected while Hb is accepted.

3. RESULTS AND DISCUSSION

Choosing the right model in panel data regression needs to be done so that the resulting estimates are more accurate and valid. The stages in determining which regression model is best through three tests, namely the chow test, hausman test, and lagrange multiplier test.

Table 2. Chow Test and Hausman Test Result

	Prob
Chow Test	0.0000
Hausman Test	0.0000

Source: EViews Output (2025)

Table 2 above shows the results of the chow test and hausman test have a probability value of 0.0000 which is smaller than α (0.05) so that the best regression model is selected, namely the fixed effect model (FEM) and does not need to proceed to the lagrange multiplier test. Then, the classical assumption test needs to be done to see whether the selected FEM estimation model can be the best estimator or Best Linear Unbiased Estimation (BLUE). Classical assumption testing on panel data regression according to Napitupulu et al. (2021) only includes multicollinearity test and heteroscedasticity test.

Table 3. Multikolinearity Test Result

	LN_GDPPC	INT	LN_FB	LN_MB	LN_MC
LN_GDPPC	1.000000	0.663013	0.628699	0.822114	0.416291
INT	0.663013	1.000000	0.754875	0.716500	0.306035
LN_FB	0.628699	0.754875	1.000000	0.479568	0.580007
LN_MB	0.822114	0.716500	0.479584	1.000000	0.336877
LN_MC	0.416291	0.306035	0.580007	0.336877	1.000000

Table 4. Heterokedastisity Test Result

Variable	Prob.
C	0.2090
LN_GDPPC	0.4001
INT	0.4136
LN_FB	0.8176

LN_MB	0.8335
LN_MC	0.3913

Source: EViews Output (2025)

Based on the results of multicollinearity testing in table 3 above, it shows that all correlation values between independent variables are still below the threshold of 0.90 so it can be concluded that it is free from multicollinearity symptoms. Table 4 above shows that all independent variables have a probability value of more than 0.05, which means they are free from symptoms of heteroscedasticity.

The model can already be tested to determine the significance of the regression coefficient produced in the table below. The t-table value in this study is determined based on a one-sided right test at a significance level of 0.05 with a degree of freedom (df = n-k-1), where n is the number of observations, namely 42, k is the number of independent variables, namely 5, then the result is 36. Therefore, the critical value of t based on the t distribution table is 1.688298. If the regression results show that the t-count value is smaller than the t-table and the probability value is greater than 0.05, Ha is accepted while Hb is rejected.

Table 5 T-statistic Test Results

Variables	t-statistic	Critical Value	Probability	Notes
LN_GDPPC	2.302397	1.688298	0.0282	Positive and significant
INT	5.922081	1.688298	0.0000	Positive and significant
LN_FB	3.092264	1.688298	0.0042	Positive and significant
LN_MB	0.195330	1.688298	0.8464	No positive effect
LN_MC	1.781540	1.688298	0.0846	Positive but not significant

Based on the t-statistic test results in Table 6 above, it shows that the GDP per capita (LN_GDPPC), internet (INT), fixed broadband (LN_FB) variables have a t-statistic value greater than the critical value and the resulting probability value is less than the significance level (0.05). Mobile cellular (LN_MC) variable have a t-statistic and the resulting probability value greater than the critical value and significance level (0.05). In contrast, the mobile broadband (LN_MB) variable have t-statistic values smaller than the t-table and the resulting probability value greater than the critical value and significance level (0.05).

The research results of Jula et al. (2024) are in line with the results of this study which state that GDP per capita has a positive and significant effect on e-commerce growth in the long run. Higher income levels can increase people's purchasing power and form an environment that supports the application of digital technology. Transacting in e-commerce basically requires digital devices and high-speed internet, which is more accessible to individuals with higher incomes. The research conducted by Lola & Bakeev (2021) is also in line with the results in this study, where GDP per capita has a positive and significant effect on e-commerce adoption in Russia. Income levels can determine the structure of consumption where households with higher incomes can fulfill their various needs through e-commerce, thus encouraging a shift in consumption patterns to digital platforms. Meanwhile, households with lower incomes tend to prioritize the purchase of basic necessities, making them more suitable for transactions in physical stores rather than e-commerce.

E-Commerce is one of the innovative results of the development of digital technology that depends on the existence of fast and affordable internet access. The internet has become a necessity for the majority of people who have a significant impact on communicating, doing business, learning, shopping, and other purposes. Increasing internet penetration rates can

affect shopping behavior and consumer preferences. Younger generations who grew up in the digitalization era tend to do online shopping more often through e-commerce platforms.

The results of research conducted by Zhou et al. (2022) support the results of this study, which found that broadband infrastructure significantly positively affects export trade growth in Chinese cities. Economic activities such as international trade require supporting infrastructure in the form of high-speed internet to support the smooth operation of the system. Broadband infrastructure directly helps improve information efficiency, which in turn leads to lower logistics costs and reduced trade barriers. Broadband infrastructure also affects exports indirectly through industrial structure and technological innovation.

The results of this study are consistent with the research of Edquist (2022) and ITU (2020b) which states that mobile broadband shows a diminishing return effect on the economy when it has passed the saturation point. The use of technologies such as mobile broadband during the diffusion process forms a non-linear (inverted U) pattern between the penetration rate and economic output. This diminishing return effect explains that once the penetration rate of mobile broadband in the six ASEAN countries has passed the saturation point, any additional adoption afterward will no longer have a significant impact on e-commerce. As new users increase, the pattern of use of mobile broadband technology also expands for entertainment and communication and is not limited to online transactions. This shift in technology usage can certainly have an impact on e-commerce

4. CONCLUSION

Based on the panel data regression analysis, the findings are as follows: GDP per capita, Internet, Fixed Broadband, dan Mobile Cellular has a positive and significant effect on e-commerce. Meanwhile, mobile broadband has no positive effect on e-commerce. The findings of this study have several implications for policymakers, particularly for governments to further promote e-commerce transactions and the growth of the digital economy:

a) Increasing Employment Opportunities and Social Welfare: Higher income levels can stimulate consumer purchasing power for goods and services. Improved social welfare can drive demand for more diverse and high-quality products.
b) Expanding Internet Access: Allocating budgets and technical support to expand internet networks to rural and underdeveloped areas to reduce technological disparities, ensuring equal access to e-commerce.
c) Formulating Effective Policies to Reduce Digital Divide: Improving technology accessibility, equalizing digital infrastructure across regions, and enhancing network quality to create an inclusive e-commerce ecosystem and maximize the potential of digital commerce to promote sustainable economic development.

This study still has limitations, despite including several explanatory variables that have previously been used as proxies for digital infrastructure. This study has not included several digital technology variables such as social media and smartphone devices, as well as digital gap variables such as digital literacy, digital skills, government policies, and so on. In addition, this study only covers a limited object and period of research, namely six ASEAN countries with a fairly short time span. This is due to limited data, especially in developing countries because digitalization is still at an early stage. Future studies can analyze other factors that influence e-commerce that exist in other regional areas around the world. Future studies are also expected to consider a new type of online commerce with the rapid development of social media, namely social-commerce, which can be interpreted as a form of e-commerce available on social media platforms such as Facebook, Instagram, and TikTok.

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AUTHORS' CONTRIBUTIONS

Wardatun Nisaa' was primarily responsible for conducting the research, collecting and analyzing the data, and drafting the manuscript. Karsinah supervised the research, provided critical insights into the interpretation of the results, and contributed to revising the manuscript for important intellectual content. Both authors have read and approved the final version of the manuscript.

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