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DO FINANCIAL DEVELOPMENT AND DIGITAL INFRASTRUCTURE FOSTER TOURISM PERFORMANCE IN ASEAN COUNTRIES?

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ABSTRACT

This study examines whether financial development and digital infrastructure foster tourism performance in ASEAN countries. Despite the growing literature on tourism development, limited studies jointly analyze the roles of financial systems and digital infrastructure in shaping tourism outcomes in developing regions. Using panel data for selected ASEAN economies covering the period 2005–2024, tourism performance is proxied by international tourism revenues, while financial development indicators, digital infrastructure variables, and macroeconomic fundamentals are incorporated as explanatory factors. The empirical analysis employs panel data econometric techniques, including pooled regression, fixed effects, and random effects models, to account for unobserved country-specific heterogeneity. The Hausman specification test is applied to determine the appropriate model, and robust standard errors are used to address potential heteroskedasticity. In addition, marginal effects are estimated to evaluate the economic significance of key variables influencing tourism revenues. The results indicate that digital infrastructure, particularly fixed broadband penetration, has a positive and statistically significant effect on tourism revenues, highlighting the importance of digital connectivity in facilitating tourism services and market access. In contrast, traditional financial development indicators, such as market capitalization and domestic credit, show weaker and less consistent effects once country-specific heterogeneity is controlled for. Economic development emerges as a strong driver of tourism performance, while the COVID-19 dummy variable confirms a significant negative shock to tourism activity during the pandemic period. Overall, the findings suggest that tourism performance in ASEAN countries is more strongly associated with improvements in digital infrastructure and economic development than with financial deepening alone.

Keywords: Tourism Performance; Digital Infrastructure; Financial Development; ASEAN; Panel Data Analysis

ABSTRAK

Penelitian ini bertujuan untuk menganalisis pengaruh perkembangan keuangan dan infrastruktur digital terhadap kinerja pariwisata di negara-negara ASEAN selama periode 2005–2024. Meskipun literatur mengenai pengembangan pariwisata terus berkembang, masih terbatas penelitian yang mengkaji secara simultan peran sistem keuangan dan infrastruktur digital dalam meningkatkan kinerja sektor pariwisata di kawasan berkembang. Penelitian ini menggunakan data panel dari beberapa negara ASEAN dengan penerimaan pariwisata internasional sebagai proksi kinerja pariwisata, sementara indikator perkembangan keuangan, infrastruktur digital, dan faktor-faktor makroekonomi digunakan sebagai variabel penjelas. Analisis empiris dilakukan menggunakan model regresi data panel, meliputi pooled regression, fixed effects, dan random

effects, dengan uji Hausman untuk menentukan model yang paling sesuai serta robust standard errors untuk mengatasi potensi heteroskedastisitas. Selain itu, analisis marginal effects digunakan untuk mengevaluasi signifikansi ekonomi dari variabel-variabel utama. Hasil penelitian menunjukkan bahwa infrastruktur digital, khususnya penetrasi fixed broadband, berpengaruh positif dan signifikan terhadap penerimaan pariwisata, yang menegaskan pentingnya konektivitas digital dalam mendukung layanan pariwisata dan memperluas akses pasar. Sebaliknya, indikator perkembangan keuangan tradisional seperti kapitalisasi pasar dan kredit domestik menunjukkan pengaruh yang relatif lemah setelah memperhitungkan heterogenitas antarnegara. Pembangunan ekonomi terbukti menjadi faktor utama yang mendorong kinerja pariwisata, sedangkan variabel dummy COVID-19 menunjukkan dampak negatif yang signifikan terhadap aktivitas pariwisata selama periode pandemi. Secara keseluruhan, temuan penelitian menunjukkan bahwa kinerja pariwisata di negara-negara ASEAN lebih dipengaruhi oleh peningkatan infrastruktur digital dan pembangunan ekonomi dibandingkan dengan pendalaman sektor keuangan semata.

Kata Kunci: *Kinerja Pariwisata; Infrastruktur Digital; Perkembangan Keuangan; ASEAN; Analisis Data Panel.*

INTRODUCTION

Tourism has become one of the most important drivers of economic growth, employment generation, and regional development, particularly in emerging and developing economies. The sector contributes significantly to income creation, foreign exchange earnings, and local business development. Tourism also stimulates investment in infrastructure, promotes entrepreneurship, and supports the development of small and medium-sized enterprises. For many countries, tourism represents a strategic sector that can accelerate economic diversification and strengthen global economic integration.

Despite these benefits, the sustainability and resilience of tourism growth depend on several structural factors. Among the most important are the quality of financial systems, the level of digital infrastructure, and the stability of macroeconomic conditions. Efficient financial markets facilitate investment in tourism infrastructure and enable tourism firms to access credit. At the same time, digital technologies have transformed tourism services by improving connectivity, reducing information asymmetry, and enhancing the overall efficiency of tourism markets.

Digitalization has recently emerged as a major force reshaping the global tourism industry. Online travel platforms, digital payment systems, and mobile applications have changed how tourism services are produced, distributed, and consumed. These technologies reduce transaction costs and expand market access for both tourism firms and travellers. For example, online booking platforms such as Booking.com or Airbnb allow tourists to access accommodation services instantly across countries. Digital financial inclusion also improves access to financial services, particularly for small tourism businesses and entrepreneurs operating in developing regions. Empirical evidence shows that digital financial inclusion can stimulate tourism activity by facilitating payments, supporting tourism-related investments, and increasing tourist spending (Luo et al., 2023; Zhang et al., 2023).

The development of digital infrastructure is equally important for tourism performance. Reliable internet connectivity, broadband penetration, and digital communication networks enhance tourism efficiency and service quality. Tourists

increasingly rely on digital information, online booking systems, and digital navigation tools when planning and conducting travel activities. As a result, countries with stronger digital infrastructure tend to experience higher tourism demand and improved tourism revenues. Recent studies provide evidence that internet penetration and digital connectivity significantly contribute to tourism performance and revenue generation (Ruan et al., 2025; Sun et al. 2025).

The benefits of digitalization extend beyond connectivity alone. Digital platforms, online travel agencies, and digital marketing tools have become increasingly important in enhancing destination competitiveness and improving tourism service delivery. Diaz-Castillo et al. (2025) emphasize that digital tourism platforms contribute to sustainable regional tourism development by improving market accessibility and operational efficiency. Similarly, Cudai et al. (2023) argue that digital tourism strategies enable governments to promote destinations more effectively through online channels. Evidence from rural regions also suggests that digital transformation increases tourism income by improving information accessibility and supporting digital tourism services (Zhang et al., 2024). These findings collectively indicate that digitalization strengthens tourism performance through improved information flows, enhanced marketing capabilities, and more efficient service provision.

Alongside digital transformation, financial development remains a critical factor in tourism expansion. Well-functioning financial systems provide the resources necessary to finance tourism infrastructure, including transportation networks, hotel development, and tourism facilities. Financial development also promotes investment diversification and supports risk sharing in tourism-related projects. Furthermore, financial innovation and digital finance mechanisms have expanded the range of financial services available to tourism enterprises and investors. Empirical studies indicate that financial innovation and financial inclusion can enhance tourism inflows and sectoral performance, especially when supported by effective institutional frameworks (Haq et al., 2024; Julianti & Pimpak, 2024).

Recent empirical studies provide further evidence on the importance of financial innovation and digital finance for tourism development. Beyond improving access to credit and investment opportunities, digital financial services can stimulate tourism demand by facilitating transactions and reducing financial barriers. For example, Qu and Wang (2025) show that the expansion of digital finance increases household tourism expenditure, while Wang et al. (2022) find that digital finance improves the efficiency of tourism resource allocation and supports tourism-related entrepreneurial activities. More recently, Xu et al. (2024) argue that the interaction between fintech development, foreign direct investment, and digitalization contributes significantly to tourism expansion, highlighting the growing integration between financial and digital ecosystems in supporting tourism growth.

At the same time, sustainability concerns have become increasingly central in tourism research and policy discussions. Rapid tourism expansion may create environmental pressures through increased resource consumption, waste generation, and carbon emissions. Consequently, policymakers and researchers have increasingly focused on sustainable tourism development. Sustainable tourism aims to balance economic benefits with environmental protection and social inclusiveness. Green finance, renewable energy investments, and environmental governance mechanisms are viewed as key instruments for aligning tourism growth with environmental sustainability. Evidence

suggests that green finance can support sustainable tourism by improving infrastructure quality while reducing environmental externalities (Chen et al., 2025). Similarly, ecotourism policies and environmental regulations can enhance tourism performance while contributing to broader sustainable development objectives (Rafee & Ramadhani, 2024; Sulistiyowati & Rahmayani, 2024).

Tourism performance is also sensitive to macroeconomic conditions and external shocks. Economic instability, security concerns, and global crises can significantly affect tourism demand. Stable macroeconomic environments improve investor confidence and facilitate long-term tourism investment. Recent cross-country studies suggest that macroeconomic stability strengthens the positive effects of digital infrastructure and technological development on tourism growth (Sun et al., 2025). The COVID-19 pandemic further demonstrated the vulnerability of tourism-dependent economies. At the same time, the crisis highlighted the importance of digital transformation in supporting tourism resilience and recovery (EŞİTTİ, 2023).

From a theoretical perspective, tourism performance is influenced by broader economic, financial, and technological conditions. Financial development facilitates capital mobilization, improves access to financing, and supports investment in tourism-related infrastructure and services. At the same time, digital infrastructure reduces transaction costs, enhances information accessibility, improves market efficiency, and strengthens connectivity between tourism providers and consumers. These mechanisms suggest that both financial development and digital infrastructure can improve tourism competitiveness and increase tourism revenues through investment, efficiency, and market-access channels. Therefore, improvements in financial systems and digital connectivity are expected to play complementary roles in fostering tourism performance.

Despite the growing literature on tourism development, most existing studies analyze digitalization, financial development, or sustainability separately. Limited empirical research jointly examines how financial development and digital infrastructure interact to influence tourism performance, particularly in cross-country contexts. This gap is important because financial systems and digital connectivity often evolve simultaneously and may produce complementary effects on tourism activity. The ASEAN region provides a relevant context for investigating these relationships. ASEAN countries have experienced rapid tourism expansion over the past two decades. At the same time, the region has undergone significant financial and digital transformation. Several ASEAN economies have invested heavily in digital connectivity, financial innovation, and tourism infrastructure. However, the extent to which financial development and digital infrastructure jointly contribute to tourism performance remains insufficiently explored.

Against this background, this study examines the role of financial development and digital infrastructure in fostering tourism performance in ASEAN countries. The analysis also considers broader macroeconomic and sustainability-related factors that may influence tourism outcomes. This study contributes to the literature in three main ways. First, it jointly examines the roles of financial development and digital infrastructure in explaining tourism performance within a unified empirical framework. Second, it provides new cross-country evidence from ASEAN economies, a region characterized by rapid tourism expansion and significant digital transformation. Third, the study evaluates the relative importance of digital and financial factors while controlling for macroeconomic conditions and external shocks such as the COVID-19 pandemic.

Based on these considerations, this study seeks to address three key research questions: (i) whether financial development and digital infrastructure foster tourism performance in ASEAN countries; (ii) which factor plays a stronger role in explaining tourism revenues, namely financial development or digital infrastructure; and (iii) how macroeconomic conditions and external shocks influence tourism performance in the region. Answering these questions is important for both academic research and policy design. A better understanding of the relative contributions of financial and digital development can help policymakers formulate more effective tourism strategies. Strengthening digital infrastructure and improving financial systems may enhance tourism competitiveness, support sustainable tourism development, and promote long-term economic resilience across ASEAN economies.

RESEARCH METHODS

Research Design

This study adopts a quantitative econometric research design to investigate whether financial development and digital infrastructure contribute to tourism performance in ASEAN countries. The empirical analysis employs panel data techniques, which combine both cross-sectional and time-series dimensions. Panel data methods are widely used in empirical economic research because they allow researchers to control for unobserved heterogeneity across countries while improving estimation efficiency compared with purely cross-sectional or time-series approaches. Previous studies emphasize that panel models provide stronger inferential power when examining macroeconomic relationships across countries and over time.

The research framework models tourism performance as a function of digital infrastructure indicators, financial development variables, and macroeconomic control factors. Tourism performance is proxied by the natural logarithm of international tourism revenues, while digital infrastructure is measured using internet usage and fixed broadband subscriptions. Financial development is represented by market capitalization, domestic credit to the private sector, and banking stability indicators. In addition, several macroeconomic control variables such as GDP per capita, exchange rate, foreign direct investment, and human capital are included to capture broader economic conditions influencing tourism demand and sector performance.

Overall, the research design follows a structured empirical process commonly applied in applied econometric studies. The analysis begins with data collection and preparation, followed by descriptive statistical analysis and correlation diagnostics. Subsequently, econometric estimations are conducted using pooled regression and panel data models. Finally, specification tests and robustness checks are implemented to verify the validity and stability of the empirical results. This systematic approach ensures methodological transparency and scientific rigor.

Data Acquisition and Sample

The empirical analysis relies on secondary data collected from internationally recognized databases, primarily the World Bank's World Development Indicators (WDI) and the Global Financial Development Database. These sources provide standardized

macroeconomic, financial, and digital indicators widely used in empirical economic research.

The dataset covers the period 2005–2024 and focuses on five ASEAN economies for which consistent data are available: Indonesia, Malaysia, Thailand, the Philippines, and Vietnam. These countries represent major tourism destinations in Southeast Asia and have experienced significant improvements in both digital infrastructure and financial sector development over the past two decades. Therefore, they provide an appropriate empirical context for examining the interaction between financial development, digital infrastructure, and tourism performance.

Due to variations in data availability across countries and variables, the dataset is structured as an unbalanced panel. After data cleaning, alignment across variables, and removal of missing observations, the final estimation sample consists of 67 country–year observations. Tourism performance is measured using the natural logarithm of international tourism receipts, which reflects tourism revenues generated by inbound visitors. Logarithmic transformation is applied to stabilize variance and allow coefficient interpretation in elasticity terms. Digital infrastructure variables include internet penetration rates and fixed broadband subscriptions, which capture technological connectivity supporting tourism services and digital transactions.

Financial development indicators include market capitalization of listed companies, domestic credit to the private sector, and the banking system Z-score, representing financial market depth, financial intermediation, and banking stability, respectively. Several control variables are also incorporated to capture broader macroeconomic influences on tourism performance. These include GDP per capita, exchange rate, foreign direct investment (FDI), and tertiary education enrollment as a proxy for human capital. Additionally, a COVID-19 dummy variable is included to capture the structural disruption to tourism activity during the pandemic period.

Table 1: Variables Measurement and Definitions

Variable	Definition	Measurement	Source
ln_tour_rev	Tourism performance	Natural logarithm of international tourism receipts	World Bank, World Development Indicators
internet	Digital connectivity	Percentage of individuals using the internet (% of population)	World Bank (WDI)
fix_broad	Digital infrastructure	Fixed broadband subscriptions per 100 people	World Bank (WDI)
mkt_cap	Financial market development	Market capitalization of listed companies (% of GDP)	World Bank (WDI)
dom_credit	Financial intermediation	Domestic credit to private sector by banks (% of GDP)	World Bank (WDI)
bank_z	Banking stability	Bank Z-score measuring distance from insolvency	World Bank Global Financial Development Database
ln_exchrate	Exchange rate competitiveness	Natural logarithm of official exchange rate (LCU per USD)	World Bank (WDI)
ln_gdp_pc	Economic development	Natural logarithm of GDP per capita (constant USD)	World Bank (WDI)
FDI	International capital inflows	Foreign direct investment net inflows (% of GDP)	World Bank (WDI)

Variable	Definition	Measurement	Source
school_ter	Human capital	Gross enrollment ratio in tertiary education (%)	World Bank (WDI)
covid	Pandemic shock	Dummy variable (1 for COVID-19 period, 0 otherwise)	Author construction

Source: World Development Indicators & World Bank Global Financial Development Database

Research Procedure

The empirical analysis follows a systematic sequence of analytical steps designed to ensure transparency and replicability. The process begins with the collection of macroeconomic, financial, and digital infrastructure data for the selected ASEAN countries covering the period 2005–2024. The dataset is organized into a panel structure, and observations with missing or inconsistent values are reviewed to construct a reliable estimation sample. Logarithmic transformations are applied to selected variables such as tourism revenues, GDP per capita, and exchange rates to stabilize variance and facilitate economic interpretation.

After preparing the dataset, exploratory data analysis is conducted. Descriptive statistics are calculated to summarize the distribution, mean values, and variability of the variables included in the model. In addition, pairwise correlation analysis is performed to examine preliminary relationships between tourism performance, digital infrastructure indicators, financial development variables, and macroeconomic controls.

Following the preliminary diagnostics, several econometric estimations are conducted. First, a pooled ordinary least squares (OLS) regression is estimated as a baseline specification. Next, panel data estimations are implemented using both fixed effects (FE) and random effects (RE) models to account for unobserved country-specific heterogeneity. To determine the most appropriate estimator, the Hausman specification test is applied. The preferred model is then estimated using robust standard errors to address potential heteroskedasticity. Finally, average marginal effects are computed for key variables particularly fixed broadband infrastructure and GDP per capita to provide a clearer economic interpretation of their impact on tourism revenues.

Model Specification and Hypothesis Testing

To evaluate the relationship between digital infrastructure, financial development, and tourism performance, the following panel regression model is specified:

$$\ln(tour_rev_{it}) = \beta_0 + \beta_1 internet_{it} + \beta_2 fix_broad_{it} + \beta_3 mkt_cap_{it} + \beta_4 dom_credit_{it} + \beta_5 bank_z_{it} + \beta_6 \ln(exchrate_{it}) + \beta_7 \ln(gdp_pc_{it}) + \beta_8 FDI_{it} + \beta_9 school_ter_{it} + \beta_{10} covid_{it} + \mu_i + \varepsilon_{it}$$

Where i represents the country and t denotes the time period. The term μ_i captures unobserved country-specific characteristics that remain constant over time, while ε_{it} represents the random error term. Hypothesis testing is conducted using standard econometric significance tests. The statistical significance of each coefficient is evaluated using t-statistics and corresponding p-values. The joint significance of explanatory variables is assessed using F-tests in the pooled and fixed effects models, while the overall significance of the random effects model is evaluated using the Wald chi-square statistic. Model selection between fixed effects and random effects estimators is determined using the Hausman specification test. The null hypothesis assumes that the random effects estimator is consistent and efficient. If the null hypothesis is rejected, the fixed effects

model is preferred because it accounts for potential correlation between explanatory variables and unobserved country effects.

Robustness and Validation

To ensure the reliability and robustness of the empirical findings, several validation procedures are implemented. First, the preferred fixed effects model is re-estimated using heteroskedasticity-robust standard errors, which address potential violations of classical regression assumptions that may arise in panel data settings. Second, alternative model specifications, including random effects estimations, are reported for comparison. Although the Hausman test determines the preferred estimator, presenting alternative specifications allows evaluation of the sensitivity of the results to different econometric assumptions. Consistency in coefficient signs and statistical significance across models strengthens confidence in the empirical findings.

Finally, average marginal effects are calculated for key explanatory variables, particularly fixed broadband infrastructure and GDP per capita. Marginal effect analysis provides a more intuitive interpretation of the estimated relationships by quantifying how changes in digital infrastructure and income levels influence tourism revenues. This step enhances the policy relevance of the empirical results and offers clearer insights into the role of digital and financial development in supporting tourism growth.

RESULTS AND DISCUSSION

Results

This section presents the empirical results of the study. It begins with descriptive statistics and correlation analysis to provide an overview of the data and the relationships among the variables. The section then reports the fixed-effects regression results and robustness checks to examine the impact of digitalization, financial development, and macroeconomic factors on tourism revenues in ASEAN countries. Finally, the marginal effects analysis is presented to further interpret the magnitude and economic significance of the key variables influencing tourism performance.

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ln tour rev	80	23.07	.842	21.556	24.888
internet	99	46.37	27.259	3.602	98.021
fix broad	94	6.323	5.35	.047	22.681
mkt cap	96	73.962	38.048	12.474	168.066
dom credit	92	84.983	43.077	27.253	164.095
bank z	85	13.11	6.581	3.419	24.133
ln exchrate	100	5.604	3.441	1.118	10.093
ln gdp pc	100	8.28	.653	6.566	9.382
FDI	100	2.903	1.667	-.858	9.663
school ter	96	35.078	9.238	15.876	52.733
covid	100	.3	.461	0	1

Source: Author's Calculation

Table 2 presents the descriptive statistics of the variables used in the analysis. Tourism r ln tour rev exhibits sufficient variation across ASEAN countries over the study period, indicating heterogeneous tourism performance within the region. Digitalization indicators show notable dispersion, particularly internet usage and fixed broadband subscriptions, reflecting uneven digital infrastructure development across countries. Financial development variables market capitalization, domestic credit, and bank stability also display substantial cross-country variation. GDP per capita and tertiary education levels suggest differences in income and human capital, which are expected to influence tourism demand and service quality. The COVID-19 dummy captures the exogenous shock affecting tourism during the pandemic period.

Table 3: Correction and Multicollinearity analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	VIF
ln_tour_rev	1.000										—
internet	0.378***	1.000									10.801
fix_broad	0.467***	0.799***	1.000								6.260
mkt_cap	0.524***	0.490***	0.316***	1.000							8.639
dom_credit	0.660***	0.546***	0.740***	0.550***	1.000						7.767
bank_z	-0.351***	0.344***	0.132	0.284**	-0.104	1.000					7.482
ln_exchrate	-0.448***	-0.299***	-0.120	-0.820***	-0.401***	-0.389***	1.000				13.645
ln_gdp_pc	0.764***	0.723***	0.540***	0.791***	0.596***	-0.005	-0.620***	1.000			11.906
FDI	-0.116	0.091	0.128	-0.120	0.229**	0.219**	0.233**	-0.154	1.000		2.412
school_ter	0.790***	0.490***	0.491***	0.448***	0.557***	-0.170	-0.483***	0.705***	-0.228**	1.000	3.764

Mean VIF = 7.454, * *p*<.05

Source: Author's Calculation

Table 3 reports the correlation matrix and multicollinearity diagnostics. Tourism revenue (ln_tour_rev) is positively and significantly associated with key variables, including internet penetration (r = 0.378), broadband (r = 0.467), market capitalization (r = 0.524), domestic credit (r = 0.660), GDP per capita (r = 0.764), and tertiary education (r = 0.790), all at the 1% level. These results suggest that digital infrastructure, financial development, economic prosperity, and human capital are linked to higher tourism revenues. In contrast, tourism revenue is negatively correlated with bank stability (r = −0.351) and the exchange rate (r = −0.448). Strong correlations among explanatory variables such as internet and broadband (r = 0.799), market capitalization and GDP per capita (r = 0.791), and credit and broadband (r = 0.740) reflect overlapping dimensions of development.

Multicollinearity diagnostics show VIF values ranging from 2.412 to 13.645, with a mean of 7.454. Although the exchange rate, GDP per capita, and internet penetration exceed the threshold of 10, they are retained due to their theoretical importance in capturing competitiveness, economic development, and digital infrastructure. Overall, the results indicate moderate multicollinearity that does not undermine the reliability of the estimates.

Table 4: Baseline fixed effect model

ln_tour_rev	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
internet	-.014	.008	-1.77	.083	-.03	.002	*
fix_broad	.045	.036	1.25	.216	-.027	.116	
mkt_cap	.004	.003	1.27	.211	-.002	.01	
dom_credit	-.004	.007	-0.62	.541	-.018	.01	
bank_z	.029	.026	1.09	.281	-.024	.082	
ln_exchrate	1.618	.567	2.86	.006	.481	2.755	***
ln_gdp_pc	1.69	.392	4.31	0	.903	2.476	***
FDI	.073	.038	1.94	.058	-.003	.149	*
school_ter	-.021	.015	-1.39	.17	-.052	.009	
covid	-.5	.175	-2.86	.006	-.85	-.149	***
Constant	1.398	4.959	0.28	.779	-8.553	11.349	

Mean dependent var	23.197	SD dependent var	0.827
R-squared	0.580	Number of obs	67
F-test	7.183	Prob > F	0.000
Akaike crit. (AIC)	44.150	Bayesian crit. (BIC)	68.402

**** p<.01, ** p<.05, * p<.1*
Source: Author's Calculation

The baseline fixed effects model examines the determinants of tourism revenues while controlling for country-specific heterogeneity across ASEAN economies. The results show that GDP per capita (ln_gdp_pc) has a strong positive and statistically significant effect on tourism revenues ($\beta = 1.69$, $p < 0.01$), indicating that higher economic development significantly supports tourism performance. Similarly, the exchange rate (ln_exchrate) is positive and significant ($\beta = 1.618$, $p < 0.01$), suggesting that exchange rate movements influence tourism demand. The COVID-19 dummy shows a significant negative effect ($\beta = -0.50$, $p < 0.01$), confirming the severe impact of the pandemic on tourism activity. Among the remaining variables, internet usage and FDI display weak significance at the 10% level, while fixed broadband, financial development indicators (market capitalization, domestic credit, bank stability), and human capital are not statistically significant in this specification. Overall, the model explains a moderate proportion of the variation in tourism revenues ($R^2 = 0.58$), and the joint significance of the variables is confirmed by the F-test ($p < 0.001$).

Table: 5 Fixed Effects Model with Robustness Check

ln_tour_rev	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
internet	-.014	.007	-2.11	.102	-.032	.004	
fix_broad	.045	.015	2.97	.041	.003	.086	**
mkt_cap	.004	.002	1.84	.139	-.002	.01	
dom_credit	-.004	.003	-1.35	.248	-.013	.004	
bank_z	.029	.033	0.88	.427	-.062	.119	
ln_exchrate	1.618	.562	2.88	.045	.059	3.177	**
ln_gdp_pc	1.69	.262	6.46	.003	.963	2.416	***
FDI	.073	.025	2.88	.045	.003	.144	**

school_ter	-.021	.006	-3.30	.03	-.039	-.003	**
covid	-.5	.141	-3.54	.024	-.891	-.108	**
Constant	1.398	4.881	0.29	.789	-12.154	14.95	

Mean dependent var	23.197	SD dependent var	0.827
R-squared	0.580	Number of obs	67
F-test	.	Prob > F	.
Akaike crit. (AIC)	30.150	Bayesian crit. (BIC)	38.969

**** p<.01, ** p<.05, * p<.1*
Source: Author's Calculation

Table 5 reports the fixed-effects regression results using robust standard errors. The Hausman test supports the use of the fixed-effects specification, indicating that unobserved country-specific characteristics are correlated with the explanatory variables. The results show that fixed broadband penetration has a positive and statistically significant effect on tourism revenue, suggesting that high-quality digital infrastructure enhances tourism performance. GDP per capita exerts a strong and positive impact, confirming the importance of overall economic development in supporting tourism demand.

The exchange rate is positively significant, implying that currency movements play a role in shaping tourism revenues once country-specific effects are controlled for. Foreign direct investment exhibits a weakly positive effect, while tertiary education and some financial development indicators are not statistically significant in the fixed-effects specification. The COVID-19 dummy has a large and statistically significant negative coefficient, confirming the severe contraction in tourism revenues during the pandemic period.

Table 6: Average Marginal Effects (Robust Standard Errors)

Variables	Marginal Effect (dy/dx)	Robust Std. Error	z-value	p-value	95% Confidence Interval
fix_broad	0.045	0.015	2.970	0.003	[0.015, 0.074]
ln_gdp_pc	1.690	0.262	6.460	0.000	[1.177, 2.202]

Number of observations = 67
Notes
• The table reports average marginal effects estimated using robust standard errors.
• Marginal effects are computed from the fitted regression model using the Delta Method.

Table 6 reports the average marginal effects of key explanatory variables on tourism revenues using robust standard errors. The results indicate that fixed broadband infrastructure (fix_broad) has a positive and statistically significant marginal effect on tourism performance (dy/dx = 0.045, p = 0.003). This implies that an increase in broadband penetration is associated with a measurable rise in the logarithm of tourism revenues, highlighting the importance of digital connectivity in facilitating tourism services, online bookings, and information access. Similarly, GDP per capita (ln_gdp_pc) shows a strong and highly significant positive marginal effect (dy/dx = 1.690, p < 0.001), indicating that higher income levels substantially increase tourism revenues. This result suggests that economic development plays a crucial role in strengthening tourism demand and supporting sectoral growth. Overall, the marginal effects confirm that both digital

infrastructure and economic prosperity are key drivers of tourism performance in ASEAN countries.

Discussion

The empirical findings provide important insights into the relationship between digitalization, financial development, and tourism performance across ASEAN economies. The descriptive statistics reveal substantial variation in tourism revenues and explanatory variables across countries, reflecting heterogeneous levels of digital infrastructure, financial development, and economic capacity within the region. Such variation is expected in a multi-country panel framework and highlights the relevance of controlling for country-specific characteristics through the fixed-effects estimation approach. The correlation analysis further indicates that tourism revenue is positively associated with digital connectivity, financial development indicators, and income levels. These relationships are consistent with recent literature emphasizing the growing importance of digital ecosystems and financial access in supporting tourism sector expansion (Zhang et al., 2023; Xu et. al., 2024).

The regression results provide additional evidence on the determinants of tourism revenue. The baseline fixed-effects model indicates that GDP per capita is one of the strongest drivers of tourism performance. Higher income levels generally reflect stronger infrastructure, better services, and greater investment capacity in tourism-related industries. This result aligns with several recent studies which emphasize that economic development enhances tourism competitiveness by improving service quality and destination attractiveness (Sun et al. 2025; Keşanlı et. al., 2025). Similarly, the exchange rate variable exhibits a positive and statistically significant relationship with tourism revenue, suggesting that currency movements influence tourism demand. Favourable exchange rate conditions can increase the purchasing power of international visitors and stimulate inbound tourism flows.

Digital infrastructure also plays a meaningful role in shaping tourism performance. While internet penetration shows a weak statistical effect in the baseline model, the robustness analysis reveals that fixed broadband penetration has a positive and significant impact on tourism revenue. This finding suggests that the quality and stability of digital connectivity may be more important than simple internet access in facilitating tourism activities. High-speed broadband enables online booking platforms, digital marketing, real-time information sharing, and seamless travel planning, all of which enhance the overall tourism experience. These results are consistent with recent empirical studies demonstrating that digital technologies and internet infrastructure significantly stimulate tourism growth by improving service efficiency and accessibility (Ruan et al., 2025; Khosravi e. al., 2025).

The positive relationship between broadband infrastructure and tourism revenue is also supported by research on digital transformation in tourism markets. For instance, Ruan et al., (2025) show that digital technology improves tourism-related economic performance by enhancing operational efficiency and supporting digital service platforms. Similarly, Diaz-Castillo et. al. (2025) highlight the importance of digital channels and online travel agencies in strengthening regional tourism competitiveness and improving the efficiency of tourism services. In addition, the development of digital infrastructure can reduce information asymmetry between tourism providers and

consumers, thereby facilitating better market coordination and increasing tourist arrivals Khosravi e. al., 2025.

Financial development variables exhibit mixed effects in the empirical results. Foreign direct investment shows a positive and statistically significant influence on tourism revenue in the robustness specification, suggesting that external capital inflows can support tourism infrastructure development and improve service quality. This result is consistent with findings by Xu et. al., 2024, who demonstrate that the interaction between financial innovation, digitalization, and foreign investment contributes to tourism expansion. Likewise, studies on digital financial inclusion indicate that improved access to financial services encourages entrepreneurship in tourism-related industries and stimulates tourism consumption (Luo et al., 2023; Qu & Wang, 2025). However, other financial indicators such as market capitalization and domestic credit do not show statistically significant effects in the regression models, indicating that traditional financial development measures may influence tourism indirectly rather than directly.

The insignificance of these indicators may reflect the structural characteristics of ASEAN economies, where tourism activities are largely dominated by small and medium-sized enterprises (SMEs) and informal businesses that rely less on formal financial markets. Additionally, the rapid expansion of digital finance and fintech services may have reduced the relative importance of conventional financial intermediation. This suggests that digital infrastructure may play a more critical role than traditional financial depth in supporting tourism growth in the region.

Human capital also appears to play a nuanced role in tourism performance. Although tertiary education does not consistently show a positive coefficient in the regression models, human capital remains an important enabling factor for tourism development. Education contributes to workforce skills, service quality, and innovation capacity in tourism-related industries. Previous research has emphasized that skilled human resources and digital literacy are essential for effectively utilizing digital technologies in tourism management and marketing (Cudai et. al., 2023; Amaniyah et. al., 2025). The insignificant coefficient observed in the regression results may therefore reflect structural differences in education systems or labor market dynamics across ASEAN economies.

The empirical results also highlight the strong negative impact of the COVID-19 pandemic on tourism revenues. The COVID-19 dummy variable is consistently negative and statistically significant across all model specifications, confirming the severe contraction experienced by the tourism sector during the pandemic period. Global travel restrictions, mobility limitations, and uncertainty significantly reduced international tourism flows and tourism-related economic activity. These findings are consistent with existing literature documenting the profound disruptions caused by the pandemic to global tourism markets EŞİTTİ (2023). At the same time, several studies suggest that digital technologies played a crucial role in supporting tourism sector resilience and recovery by enabling digital marketing, online services, and contactless transactions (Chen et al., 2025).

The marginal effects analysis further reinforces the importance of digital infrastructure and economic development. The results show that increases in fixed broadband penetration have a positive and statistically significant marginal effect on tourism revenue, although the magnitude of the effect remains relatively moderate. In contrast, GDP per capita exhibits a substantially larger marginal impact, indicating that overall economic prosperity remains the most influential driver of tourism sector

performance. These findings support the argument that digital infrastructure acts as a complementary factor that enhances tourism competitiveness when combined with strong economic fundamentals. Similar conclusions are reported by (Wang et. al., 2022), who highlight that digital finance and technological development improve tourism sector efficiency and resource allocation.

Overall, the empirical findings suggest that tourism development in ASEAN economies is shaped by a combination of economic conditions, digital infrastructure, and financial development factors. Digitalization plays an increasingly important role in facilitating tourism services and improving market accessibility, while economic development remains a fundamental driver of tourism demand. Strengthening broadband infrastructure, promoting digital financial services, and attracting foreign investment may therefore contribute to sustainable tourism growth in the region. These results also highlight the importance of integrating digital transformation strategies into tourism development policies in order to enhance competitiveness and resilience in an increasingly technology-driven global tourism market.

CONCLUSIONS

This study examined the role of digital infrastructure, financial development, and macroeconomic factors in shaping tourism revenues across ASEAN countries using panel data analysis. The empirical results indicate that economic development, represented by GDP per capita, is a key driver of tourism performance, exerting a strong and consistently positive effect on tourism revenues. In addition, digital infrastructure particularly fixed broadband penetration shows a significant positive impact when robust estimation techniques are applied, highlighting the importance of reliable digital connectivity for tourism services, online platforms, and information accessibility. The exchange rate also appears to influence tourism revenues, while the COVID-19 pandemic had a substantial negative effect, reflecting the severe disruption experienced by the tourism sector during the crisis.

Overall, the findings suggest that strengthening digital infrastructure and supporting economic growth are crucial for enhancing tourism competitiveness in ASEAN economies. Policies aimed at expanding broadband access, promoting digital transformation in tourism services, and facilitating digital financial systems can improve the efficiency and accessibility of tourism markets. Furthermore, the results emphasize the need for resilient tourism strategies capable of mitigating external shocks such as global pandemics. Future research may extend this analysis by incorporating additional indicators of digital finance, sustainability, and institutional quality to provide a more comprehensive understanding of the long-term drivers of tourism development.

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