

The Role of Institutional Factors on The Growth Impact of Digitalization: A Case of ASEAN Economies

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ABSTRACT

This study examined the relationship between digitalization and economic growth in ASEAN economies, with a particular focus on the role of institutional quality from a governance and management perspective. Using panel data from eight ASEAN countries over the period 2000–2023, the study applied Pooled OLS, Fixed Effects, and Random Effects models. The findings showed that digitalization had a statistically significant negative effect on economic growth, which may reflect inefficiencies, capability gaps, and challenges in integrating digital technologies effectively. The interaction between digitalization and institutional quality was not statistically significant, suggesting that existing institutional frameworks may not yet be effective in supporting decision-making and performance outcomes in digital environments. These findings pointed to a mismatch between rapid digital adoption and institutional readiness. The study contributes by highlighting the importance of governance and institutional support in shaping how digitalization translates into economic and organisational outcomes.

1. INTRODUCTION

Digitalization has emerged as a key driver for economic growth, enabling countries to enhance productivity, strengthen innovation, and expand market access (Mia et al., 2024). In ASEAN, the rapid adoption of technologies such as mobile payments, e-commerce, and Artificial Intelligent (AI)-driven services lead the transformation of the ASEAN economies (World Economic Forum, 2025). Despite improvements in digital infrastructure and increasing digital trade evidenced by ASEAN's digital economy growing from USD 4

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billion in 2022 to USD 11 billion in 2024, the impact on national growth rates remains mixed (World Economic Forum, 2025).

For ASEAN economies, digitalization offers immense potential for economic transformation. However, the region faces diverse institutional challenges, including governance issues, regulatory constraints, and socio-economic disparities. The link between digitalization and economic growth is shaping productivity, innovation, job creation, and socio-economic inclusion (Dayan, 2024). While economic growth has traditionally been attributed to factors such as capital accumulation and labour force expansion, the role of structural and institutional factors in shaping economic outcomes has gained recognition over time.

Despite significant strides in digital adoption across ASEAN, the region has yet to fully realize the economic benefits of digitalization. While numerous studies have highlighted productivity gains and efficiency improvements at the firm level, macro-level productivity growth remained subdued and often referred to as the 'productivity puzzle' (Labhard & Lehtimäki, 2022). One key factor that remained underexplored is the role of institutions in facilitating or hindering the digital transformation process. Several studies highlight that weak governance, fragmented regulatory frameworks, and inadequate digital infrastructure significantly deepen the digital divide across ASEAN. Zhang et al. (2025) identified government effectiveness, regulatory quality, and FDI as critical enablers of digital trade - while corruption and weak civic discourse hindered it. Le (2025a) found that fixed broadband and telephone penetration strongly support trade openness, whereas reliance on mobile-only infrastructure and uneven internet use can negatively affect economic integration. Moreover, regional studies have pointed to insufficient harmonization of e-commerce laws, poor cybersecurity, and weak consumer protections as key barriers to expanding the digital economy. As ASEAN's digital economy approaches the US \$1 trillion mark by 2030, experts warn that without integrated security-by-design frameworks, digitalization efforts risk major cyber vulnerabilities and legal fragmentation. Without effective institutional frameworks, the potential of digital technologies to drive economic growth and reduce disparities remains unrealized. Strong institutions are essential for ensuring that digitalization enhances productivity, encourages innovation, and contributes to sustainable economic development.

Institutional quality plays a crucial role in determining the effectiveness of digitalization. Information and communication technology (ICT) has the potential to improve government functions by enhancing interactions, information flows, and service delivery. Digital tools such as e-Government, e-Administration, and e-Governance facilitate policy coordination, knowledge management, and citizen engagement, leading to greater efficiency, transparency, and accountability (Olofin, 2023). These improvements can drive economic progress by simplifying government processes and empowering citizens. However, weak institutional frameworks may obstruct these benefits, reducing the impact of digitalization on governance and economic development. If institutions are ineffective, digital transformation may fail to enhance public sector efficiency or could even reinforce existing inefficiencies. Therefore, examining the interaction between digitalization and institutional quality is critical, as strong institutions can amplify the benefits of digital transformation, while weak institutions may limit its potential to drive sustainable economic growth.

This study aimed to examine the role of institutional quality in shaping the growth impact of digitalization within ASEAN countries. It sought to identify specific institutional factors that either enhance or hinder the economic benefits derived from digital transformation. The findings provided insights into how governance

structures can enhance the growth impact of digitalization. Given the uneven digital development within ASEAN, understanding the relationship between digitalization and institutional quality is important and timely. This study sought to explore how institutional factors moderate the growth impact of digital technologies across ASEAN economies. By investigating these dynamics, the research aimed to shed light on how institutional reforms can bridge the digital divide and ensure that digital transformation translates into inclusive and sustained economic growth for the region.

Beyond macroeconomic outcomes, the relationship between digitalization and institutional quality has important implications for managerial decision-making and organisational performance. Digital transformation affects how firms allocate resources, optimise operations, and respond to market dynamics. In this context, institutional quality plays a critical role in shaping the efficiency of these decisions by influencing regulatory clarity, governance structures, and coordination mechanisms. Weak institutional environments may lead to misallocation of digital investments, operational inefficiencies, and suboptimal performance outcomes, thereby limiting the economic benefits of digitalization. Therefore, examining this relationship from a management and governance perspective provides a more comprehensive understanding of how digital transformation translates into performance at both macro and organisational levels.

The study presents macro level insights of how governance structures influence broader digital transformation process. This analysis is particularly important given the persistent productivity puzzle in the region, where digital adoption has not consistently translated into measurable economic gains as highlighted by Labhard & Lehtimäki (2022). This study also identified institutional weakness that constrained the effective integration of digital technologies across the region.

2. LITERATURE REVIEW

2.1 Digital Divide in ASEAN

The Association of Southeast Asian Nations (ASEAN), established in 1967 through the Bangkok Declaration, has grown from its five founding members to encompass ten diverse economies, united by a common vision of promoting economic growth, social progress, and cultural development in Southeast Asia. Over decades, ASEAN has prioritized regional peace, stability, and collaboration across economic, social, and technical dimensions, ensuring mutual support in education, research, and professional development.

ASEAN's economic trajectory has seen significant variability among its member states, reflecting differences in natural resources, institutional frameworks, and technological advancement. From 2013 to 2022, countries like Vietnam, Lao PDR, and Cambodia consistently achieved robust growth, while others, such as Brunei and Thailand, faced challenges, with ASEAN averaging an annual growth rate of 4.1% during this period. Despite these disparities, the region has increasingly embraced the digital economy, with digitalization emerging as a critical driver of productivity, innovation, and economic performance. The ASEAN digital economy, initially forecasted to reach a gross merchandise value of \$200 billion by 2025, achieved this milestone three years early and is now projected to expand at an annual rate of 6%, potentially reaching \$1 trillion by 2030 (Liu, Jingting & Ulrike, 2024).

However, the region faces pronounced disparities in digital readiness, with countries like Singapore and Malaysia excelling in digital adoption, while others struggle with infrastructure gaps and limited internet penetration. This digital divide not only reflects existing economic inequalities but also perpetuates them, emphasizing the urgency for coordinated efforts to ensure equitable digital transformation. Addressing these issues is crucial for encouraging inclusive growth and minimizing economic disparities across ASEAN's diverse economies.

While digitalization has undoubtedly transformed ASEAN's economic landscape, its growth impact is not uniformly distributed across the region. Beyond variations in infrastructure and digital adoption, institutional quality has emerged as a critical determinant in shaping the outcomes of digitalization. Institutions play a pivotal role in shaping the growth impact of digitalization by influencing the effectiveness of digital policies, the adaptability of markets, and the equitable distribution of digital benefits. Strong governance and regulatory frameworks enable the development of robust digital infrastructure and ensure equitable access to digital services, while weak institutional settings can exacerbate disparities in digital adoption and outcomes (Zhang et al., 2025). For example, the uneven digital readiness within ASEAN, where countries like Singapore and Malaysia excel while others face infrastructural and policy constraints, highlights how institutional quality impacts digital transformation outcomes.

2.2 Hypothesis Development

Institutions are fundamental in establishing the rules of economic transactions, overseeing market functions, and shaping total factor productivity (TFP). TFP, commonly viewed as the unexplained component in growth models, reflects efficiency and innovation, both of which are increasingly linked to the quality of institutions (Gashe, Sime & Mada, 2024). In the digital age, the rapid proliferation of information and communication technologies (ICT) has transformed production, consumption, and market interactions. While digitalization is a recognized driver of innovation and efficiency gains (Radicic, & Petković, 2023), its broader economic impact is mediated by the institutional environment in which it operates. Strong institutions can reduce transaction costs, facilitate coordination among stakeholders, and enhance the adoption of digital technologies. Conversely, weak institutions may hinder these processes, exacerbating inefficiencies and economic disparities.

This study contextualised this relationship from the perspective of the New Institutional Economics (NIE). From a managerial perspective, New Institutional Economics (NIE) explained how institutional structures influence organisational efficiency, transaction costs, and decision-making processes (North, 1990). This perspective was further supported by Acemoglu and Robinson (2012), who argued that inclusive and effective institutions enhanced innovation, investment, and long-term economic prosperity, while weak institutions constrain economic development and productivity. Strong institutions reduced uncertainty and enabled firms to make more effective investment and operational decisions, particularly in digital environments where coordination and information flows are critical. This theory expanded from traditional growth theories by emphasising that both formal institutions (e.g., regulations and governance quality) and informal institutions, such as trust and norms, govern economic interactions and influence development outcomes (Olofin, 2023). The Theory of New Institutional Economics posits that institutions shape the structure of incentives in society and reduce the transaction and information costs involved in economic exchanges. In the context of digital transformation, NIE provides a critical understanding of how

institutional quality determines the effectiveness of digital adoption. For instance, Hossain and Yousaf (2024) found that in developing regions, digital investments yielded significant economic benefits only when institutional threshold, such as legal enforcement and regulatory quality are met. Similarly, Santos and Wu (2025) demonstrated that institutional coherence across digital and economic governance significantly enhanced the productivity effects of digitalisation in Southeast Asia. This implied that in ASEAN economies, the success of digital transformation depends on the quality, adaptability, and coherence of their institutional frameworks.

Studies have emphasized the dual role of institutions in promoting growth: first, by enabling efficient resource allocation, and second, by mitigating risks associated with investment and innovation (Cristofaro et al., 2025). Digital technologies, as general-purpose technologies, drove innovation across sectors and amplified productivity (Pascale, Pronti & Zoboli, 2024). This view was reinforced by the OECD (2020), which highlighted that digital transformation enhanced productivity, competitiveness, and economic resilience when supported by appropriate regulatory frameworks, human capital development, and innovation ecosystems. However, their growth impact depended on their integration into economic systems, which was significantly influenced by institutional and governance frameworks. Labhard and Lehtimäki (2022) highlighted that digitalization, when coupled with robust institutions, enhanced market efficiency, accountability, and enforcement mechanisms.

Furthermore, digitalization has emerged as a transformative force in economic growth, acting as a catalyst for innovation, market expansion, and financial inclusion. By providing essential tools and platforms for problem-solving, digitalization enhanced entrepreneurship and lowered entry barriers, enabling startups and small businesses to compete in global markets (Dayan, 2024). At the organisational level, Bloom, Sadun, and Van Reenen (2012) demonstrated that effective management practices significantly improved productivity and organisational performance, highlighting the importance of governance, strategic leadership, and efficient resource allocation in maximizing the benefits of technological adoption. E-commerce and digital ecosystems further enhanced economic diversification by facilitating cross-border trade and global value chain integration. Developing economies, in particular, can leverage digitalization to bypass traditional industrialization processes, positioning themselves within the digital services and technology outsourcing sectors.

Nevertheless, Le (2025b) highlighted that the digital economy was still in its formative stages, with its impact on productivity becoming evident only as digital technologies reached a more advanced stage of development. This emphasized the critical role of the interaction between digitalization and institutional quality in assessing their impact on productivity and growth, as the development of advanced digital technologies was often a reflection of strong institutional quality. Conversely, weak institutions may enhance inequalities and inefficiencies. For example, Nguyen (2021) found that while digitalization and governance independently contributed to economic growth, their interaction may hinder growth in regions with poor governance. Evidence from Bangladesh, Ethiopia, Kenya, and Nigeria using the feasible generalized least squares (FGLS) method (1985–2017) suggested that while digital economy development generally promoted growth, its interaction with institutional quality had a negative effect (Olofin, 2023). This suggested that weak institutions and low digitalization levels may undermine the potential benefits of digital transformation.

The impact on employment is dual-faceted, generating demand for high-skilled labor while displacing routine jobs through automation and artificial intelligence. This necessitated reskilling initiatives to equip

the workforce with digital competencies (Morandini et al. 2023) Furthermore, digitalization promoted socio-economic inclusivity by expanding access to education, healthcare, and financial services. According to the World Bank (2021, 2023), digital technologies contributed to inclusive economic growth by enhancing connectivity, improving public service delivery, and strengthening innovation, particularly when supported by robust institutional and regulatory frameworks. Mobile banking and digital wallets, for instance, empowered underserved populations by providing credit and payment systems, inducing grassroots economic growth.

In the ASEAN context, governance quality varied widely, influencing the adoption and integration of digital technologies. While some countries have made significant advancements in digital infrastructure and policy frameworks, others lag due to institutional inefficiencies, regulatory constraints, and socio-economic disparities (Huong & Chuah, 2023). Mia, Hossain & Sangwan (2024) emphasized the state's role in developing a digital ecosystem through policies, infrastructure investment, and developing innovation networks. Furthermore, governments need to build institutional capacities that evolved in connection with technological advancements and economic demands.

Regulatory measures that promote fair competition, prevent anti-competitive practices, and protect consumer rights are essential for ensuring that digitalization supports sustainable economic growth. Digitalization also raises ethical and privacy concerns (Dayan, 2024), making institutional quality critical in shaping its economic outcomes. Strong institutions provide regulatory frameworks that balance innovation with consumer protection, enabling digital transformation to contribute to equitable and sustainable growth. Conversely, weak institutions may struggle to enforce regulations, leading to market inefficiencies, data security risks, and unequal digital benefits. As Dayan (2024) noted, the relationship between digitalization and economic growth is multifaceted, operating through productivity, innovation, and economic inclusivity, highlighting the need to address structural challenges to fully realise its potential.

3. METHODOLOGY

This study applied panel models to examine the relationship between digitalisation on economic growth and moderating role of institutional quality in the relationship between digitalization and economic growth across ASEAN economies. The study formulated two equations for the analysis. Equation (2) described the base model, where institutional quality variable was represented by a composite institutional quality index. Subsequently, in Equation (3), the institutional quality index was analysed individually, namely governance, institutions, regulatory quality, and government effectiveness. Digitalization was captured using two key indicators: internet usage and fixed broadband subscriptions, both of which are widely recognized as proxies for digital access and infrastructure.

This study employed three static panel data methods, namely, Pooled OLS, Fixed Effects (FE), and Random Effects (RE) to investigate the impact of digitalization and institutional quality on economic growth in ASEAN economies. Panel models effectively addressed cross-sectional heterogeneity and limited data availability, enabling identification of relationships obscured in pure cross-sectional analysis (Wooldridge, 2010). This study began with Pooled OLS, which assumed uniform intercepts and slopes across countries and time. Subsequently, the implementation of an FE estimator, which allowed for country-specific intercepts and thereby controlled for unobserved, time-invariant heterogeneity (Baltagi, Feng & Kao, 2012). Next, a RE model was estimated under the assumption that these individual effects were random and uncorrelated with explanatory variables. A Hausman test was conducted to compare FE and RE; rejection

of the null hypothesis ($H_0: \alpha_i = \alpha$) supports the FE model, signalling that country-specific effects are correlated with regressors. The Wooldridge test indicated the presence of serial correlation; therefore, robust standard errors were applied to ensure consistent estimation.

This framework mirrored recent approaches in emerging economy digitalization research. For example, static panel specifications have been used to link digital transformation to trade openness in ASEAN-6 countries (Le, 2025b), while others found that static panel models detected significant institutional effects on digital growth (Adu-Darko & You, 2025). Meanwhile, a study by Le (2025b) analysed digital infrastructure's macroeconomic effects using this static panel approach. The study ensured reliable estimation of how digitalization and institutional quality jointly shaped growth dynamics in ASEAN using the robust panel techniques.

3.1 Model Specification

This study employed a growth framework to analyse the role of institutional factors in the economic impact of digitalization. The growth equation was specified as:

$$\Delta \ln y_{it} = \alpha_{it} \Delta \ln k_{it} + (1 - \alpha) \Delta \ln hc_{it} + \Delta \ln A_{it} \quad (1)$$

where y_{it} is output per capita. K_{it} is physical capital per capita, hc_{it} is human capital per capita, and A_{it} total factor productivity. The model extended to include variables representing digitalization (DIG), institutional factor (IF), and their interaction to capture the role of digitalization and institutions:

$$GDP_{it} = \lambda_0 + \lambda_1 DIG_{it} + \lambda_2 IF_{it} + Z_{it} \lambda' + \mu_i + \zeta_{it} \quad (2)$$

$$GDP_{it} = \lambda_0 + \lambda_1 GDP_{it-1} + \lambda_2 DIG_{it} + \lambda_3 IF_{it} + \lambda_4 (DIG \times IF)_{it} + Z_{it} \lambda' + \mu_i + \zeta_{it} \quad (3)$$

where DIG is Digitalization, measured by internet usage rates or ICT penetration. IF was Institutional factor(s) such as institutions, government effectiveness and DIG×IF was an interaction term to capture the combined effect of digitalization and institutions. Z was control variables including trade openness, foreign direct investment, education and employment. μ_i was unobserved country-specific effects. ζ_{it} is error term.

The present study conceptualized the Institutional Quality Index (IQI) as in Pescale et. al (2024), to represent an aggregate measure comprising five key sub-dimensions, as outlined by the United Nations' World Governance Indicators. These sub-dimensions included (i) Voice and Accountability; this aspect assessed societal engagement, solidarity, and cultural participation through metrics such as voter turnout in public elections, the presence of citizens' associations, the number of social cooperatives, and cultural vibrancy, which is reflected in the publication and sales of books. (ii) Government Effectiveness; this dimension evaluated the capacity of public administrations to manage social and economic structures, particularly in areas such as healthcare, waste management, and the implementation of health and environmental policies. (iii) Regulatory Quality, this indicator measured the ability of institutions to foster, support, and safeguard business activities and the local economy. (iv) Rule of Law; this component gauged the enforcement of laws by considering factors such as crime rates against individuals and property, levels of tax evasion and the informal economy, as well as the efficiency of the judiciary, including judicial productivity and the speed of legal proceedings. (v) Corruption; this evaluated the prevalence of illegal

activities, financial misconduct, and corruption within public administration. Given the high correlation among institutional variables, they were not included simultaneously in the same regression model to avoid multicollinearity issues.

3.2 Data

Data for this analysis were obtained for eight ASEAN member countries, namely Brunei, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand, and Vietnam, excluding Myanmar and Cambodia due to limitations in data availability and consistency. The panel dataset spanned the period from 2000 to 2023, a timeframe that captured major phases of digital transformation and institutional reform across the region. This timeframe enabled a comprehensive examination of long-term trends and structural changes. Key variables, including indicators of digitalization, economic growth, and institutional quality, were sourced from the World Bank and the International Telecommunication Union of the United Nations (ITU), both of which provided standardized and internationally recognized data. The selection of these sources ensured the reliability, comparability, and credibility of the data used for empirical estimation in the study.

4. RESULTS AND DISCUSSION

Table 1 presents the descriptive statistics of the digitalization variables used in the study. The percentage of individuals using the Internet and fixed broadband subscriptions per 100 people were both specified in logarithmic form. The statistics are reported at the overall, spatial, and over-time.

Table 1. Descriptive Statistics of Digitalisation Variables

Variable		Mean	SDev.	Min	Max
Individual using the Internet (% of population, log)	overall	3.122926	1.559108	-3.05713	4.59512
	spatial		0.954778	1.151365	4.260431
	over time		1.03125	0.791085	4.405823
Fixed Broadband subscriptions (per 100 people, log)	overall	0.395662	2.695507	-8.11173	3.351282
	spatial		1.467649	-2.3106	2.904797
	over time		2.079611	-4.52625	2.428498

The mean for log percentage of individuals using the Internet across all observations was 3.12, with a standard deviation of 1.56. The minimum and maximum values ranging from -3.06 to 4.60 indicated significant variation in Internet usage across countries and time. At the spatial level, which captured cross-sectional variation, the mean was 0.95, with a standard deviation of 1.15. This suggested distinctive differences in Internet adoption across countries. Within spatial variation, the range of values extended to 4.26, reflecting disparities in digital access across regions. This pattern was anticipated within ASEAN, given the notable disparities in income levels across member countries, which influence differences in

access to digital infrastructure. Robust economic growth in the last two decades had lifted millions of Asians out of poverty. Yet, income disparities and unequal access to economic opportunities and social services remained an issue (Ayyah, Sek & Kole, 2025). At the over-time level which captured the temporal variation within countries, the mean was 1.03 and standard deviation, 0.79. The highest value was 4.41, suggesting a general trend of increasing Internet penetration over time, though variation existed within countries. These statistics reflected the digital divide within ASEAN. As these economies continued to develop, the increasing disposable incomes and greater investment in telecommunications infrastructure were expected to drive further digital adoption.

For fixed broadband subscriptions, the overall mean was 0.40, with a relatively high standard deviation of 2.70. The wide range of values from -8.11 to 3.35 exhibited extreme disparities in broadband access. At the spatial level, the mean was 1.47, with a standard deviation of 2.31, highlighting variations in broadband adoption across countries. The maximum spatial value of 2.90 suggested that while some ASEAN economies had developed broadband infrastructure, others still lag. At the over-time level, the mean was 2.08, with a standard deviation of 4.53. The range reached 2.43, indicating a growth trend in broadband subscriptions over time. Thus, broadband access seemed to gradually expand within countries, likely driven by economic growth and increasing investment in digital infrastructure.

Overall, these statistics highlighted significant variations in digitalization across ASEAN countries and time periods. While Internet adoption appeared to be increasing steadily, broadband penetration remains highly uneven. This implied the need for further investigation into infrastructural and policy-related determinants to ensure more equitable digital access across the region.

Table 2. Descriptive Statistics for Economic Growth, Institutions, Governance and Control Variables

Variable		Mean	SDev.	Min	Max
GDP growth (annual %)	overall	4.56203	3.347764	-9.51829	14.51975
	spatial		1.760424	0.768056	6.892252
	overtime		2.111801	-3.25719	7.250204
Government Effectiveness	overall	0.41615	0.8931	-1.00211	2.46966
	spatial		0.869903	-0.77086	2.183362
	overtime		0.135578	0.181165	0.665168
Regulatory Quality	overall	0.297035	0.821821	-0.8661	2.308591
	spatial		0.80198	-0.5494	1.996426
	overtime		0.07945	0.190059	0.43788
Institutions	overall	-0.133	1.804465	-2.99124	3.676264

Variable		Mean	SDev.	Min	Max
Governance	spatial		1.720921	-2.07202	3.376048
	overtime		0.23931	-0.47762	0.435213
	overall	0.278985	2.597647	-3.11524	6.18587
Institutional Quality Index	spatial		2.559433	-2.73206	5.800501
	overtime		0.236162	-0.09375	0.733595
	overall	0.133716	4.369237	-5.69626	9.73686
Trade Volume (% of GDP)	spatial		4.272553	-4.81554	9.169077
	overtime		0.442321	-0.57137	0.936907
	overall	142.5496	91.56915	32.97218	437.3267
FDI, net inflows (% of GDP)	spatial		89.12895	49.82467	359.5196
	overtime		9.821192	126.1965	159.9256
	overall	5.877495	7.076048	-2.75744	34.94852
School Enrollment, primary (% gross)	spatial		6.349283	1.353566	21.3141
	overtime		1.297426	3.182548	7.939319
	overall	105.9007	9.379802	90.60991	144.7325
Employment (%)	spatial		7.099038	98.90091	122.4227
	overtime		1.846009	102.8258	109.327
	overall	64.84032	8.059987	21.3847	76.481
	spatial		6.407422	54.11002	73.18259
	overtime		1.612691	61.22171	66.544
Observations	N= 192	n=8	T=24		

As shown in Table 2, the descriptive statistics revealed that ASEAN economies exhibited substantial variation in key economic indicators. These statistics revealed substantial cross-country differences in economic performance, institutional quality, and governance within ASEAN. While economic indicators such as GDP growth, trade volume, and FDI inflows exhibited high overall variation, they showed relatively stable trends within countries over time. Similarly, governance and institutional measures demonstrated significant cross-country differences, suggesting that structural reforms and policy effectiveness varied widely across ASEAN member states. Given the region's ongoing economic integration, these disparities highlighted the importance of targeted policy interventions to enhance institutional quality and digital infrastructure, particularly in lower-income ASEAN economies.

Table 3 presents the correlation coefficients between each two variables examined in the study, quantifying the strength and direction of the relationship between them. As such, any potential linkages not implying causation between these variables could be ascertained. The pairwise correlation analysis revealed that all pairs of variables were significantly correlated at 1% except a few with significance at 5%. With the exceptions of trade openness and economic growth, fixed broadband subscription and employment, and foreign direct investment and school enrolment, all pairs of variables were significantly correlated. The lack of significance between the three pairs of variables implied that these relationships may be weak or influenced by other underlying factors.

The Levin–Lin–Chu (2002) test was conducted to assess whether the series contained a unit root, with the null hypothesis of non-stationarity and the alternative of stationarity. The test assumed a common autoregressive parameter across all panels and required that the number of time periods grow faster than the number of panels. It estimated an augmented Dickey–Fuller regression for each panel, selecting lags based on the AIC. The long-run variance was estimated using the Bartlett kernel with 9 lags, as proposed by LLC. The results are presented in Table 4. The results from the LLC panel unit root test showed that all series were stationary at level, which meant it contained no unit root.

Next, the study estimated the model to examine whether institutional factors moderated the growth impact of digitalization across ASEAN economies. Given the use of multiple proxies for digitalization such as internet usage and fixed broadband subscription, several models were estimated to ensure robustness. Institutional factors were also analyzed at different levels: overall institutional quality, broader governance indicators, and more specific components like government effectiveness and regulatory quality. The selection of both aggregate and disaggregated proxies allowed for a comprehensive analysis, discovering the overarching role of institutions while also identifying the specific mechanisms through which institutional or governance quality influences the digitalization-growth relationship.

Table 3. Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) GDP growth (annual %)	1											
(2) Individual using the Internet (% of population, log)	-0.350	1										
(3) Fixed Broadband subscriptions (per 100 people, log)	-0.310	0.899	1									
(4) Government Effectiveness	-0.258	0.638	0.601	1								
(5) Regulatory Quality	-0.261	0.490	0.490	0.940	1							
(6) Institutions	-0.238	0.565	0.501	0.954	0.949	1						
(7) Governance	-0.246	0.536	0.522	0.972	0.978	0.968	1					
(8) Institutional Quality Index	-0.244	0.550	0.516	0.972	0.974	0.988	0.995	1				
(9) Trade Volume (% of GDP)	0.087	0.300	0.344	0.743	0.721	0.707	0.774	0.753	1			
(10) FDI, net inflows (% of GDP)	0.147	0.216	0.293	0.513	0.567	0.537	0.572	0.562	0.78	1		

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(11) School Enrolment, primary (% gross)	0.329	-0.65	-0.45	-0.57	-0.45	-0.50	-0.48	-0.49	-0.17	-0.02	1	
(12) Employment (%)	0.157	-0.19	-0.01	-0.31	-0.25	-0.28	-0.23	-0.25	0.018	0.223	0.34	1

Table 4. Panel Unit Root Test

Variable	LLC (level)	LLC (1 st difference)	Order of integration
GDP growth (annual %)	-5.7643***	-7.8295***	I(0)
Individual using the Internet (% of population, log)	-2.4694***	-1.0565	I(0)
Fixed Broadband subscriptions (per 100 people, log)	-11.108***	-4.3552***	I(0)
Government Effectiveness	-2.4834***	-5.5793***	I(0)
Regulatory Quality	-3.1082***	-5.1399***	I(0)
Institutions	-2.8822***	-6.003***	I(0)
Governance	-2.8127***	-5.7166***	I(0)
Institutional Quality Index	-2.5303***	-4.0514***	I(0)
Trade Volume (% of GDP)	-3.3872***	-5.6153***	I(0)
FDI, net inflows (% of GDP)	-3.1400***	-6.8332***	I(0)
School Enrollment, primary (% gross)	-3.1400***	-3.8168***	I(0)
Employment (%)	-2.037**	-3.8291***	I(0)

Note: *** and ** denote significance at 1% and 5% respectively.

Furthermore, since the present study focused on digitalization and economic growth, Regulatory Quality (RQ) might be the most directly relevant, as it covered the regulatory environment's impact on markets and innovation. Another specific indicator of institutional quality chosen is Government Effectiveness (GE) to represent quality of public services, policy formulation, and implementation. It was also best for assessing how the quality of governance drives efficiency in markets and digital adoption.

Table 5 presents the regression results for Equation (2). Panel A (i) consisted of economic growth as the dependent variable, while internet usage, institutional quality, the relationship between internet usage and institutional quality, trade openness, foreign direct investment, school enrolment, and employment acted as the independent and control variables. The model formulated in Panel A (ii) was the same except that the proxy for digitalization was fixed broadband subscription. As demonstrated by the Hausman test results in each panel, there was indeed a significant difference between fixed effects and random effects, suggesting the fixed effects models were preferred. As such, the study discussed only the findings from fixed effects models. The relatively low R-squared values in the fixed effects models suggested that while

the models captured within-country variation, a substantial proportion of variation in economic growth remained unexplained, indicating the influence of other structural factors.

Table 5. Regression Results for Institutional Quality Index

Panel A (i)				Panel A (ii)		
Dependent variable: GDP growth (annual %)						
Independent variable:	Pooled OLS	Fixed Effect (robust std error)	Random Effect	Pooled OLS	Fixed Effect (robust std error)	Random Effect
Individual using the Internet (% of population, log)	-0.7719***	-0.9110**	-0.7719***			
Fixed Broadband subscriptions (per 100 people, log)				-0.2879**	-0.3859***	-0.2879**
Institutional Quality Index	-0.0455	0.3743*	-0.0455	-0.4053***	0.0046	-0.4053***
Interaction term (a x b)	-0.1011	-0.0705	-0.1011	-0.0206	-0.0178	-0.0206
Trade Volume (% of GDP)	0.0165***	0.0439**	0.0165***	0.0167***	0.0457**	0.0167***
FDI, net inflows (% of GDP)	0.1079**	0.2073**	0.1079**	0.0997*	0.2041**	0.0997*
School Enrollment, primary (% gross)	0.0248	0.0379	0.0248	0.0283	0.0600	0.0283
Employment (%)	-0.0380	0.0961***	-0.0380	-0.0219	0.1294***	-0.0219
Constant	4.2472	-10.0667	4.2472	0.3129	-17.6353**	0.3129
R-squared	0.2860	0.0386	0.2860	0.2820	0.0550	0.2820
F (7,184)	10.53***			10.32***		
F (7,7)		11.65***			35.60***	
Wald Chi-squared(7)			73.69***			72.26***
Hausman test		29.72***		30.25***		
Woolridge test		5.27*		4.94*		

Note: ***, ** and * indicate significance at 1%, 5% and 10% respectively

In Panel A (i), the coefficient for digitalization exhibited a significant negative relationship with economic growth which suggested that increased digital adoption may not always translate into higher economic performance. This could indicate diminishing returns, inefficiencies in digital infrastructure, or potential structural challenges in integrating digital technologies into productive activities. From a managerial standpoint, the negative effect of digitalization may reflect inefficiencies in the adoption process, including capability gaps, poor alignment between digital investments and organizational needs, and inadequate supporting infrastructure. Firms may invest in digital technologies without the necessary skills or governance mechanisms to utilize them effectively, leading to suboptimal performance outcomes. Policymakers may need to consider complementary factors such as digital literacy, regulatory frameworks, and innovation ecosystems to maximize the benefits of digitalization. Trade openness and foreign direct investment were significant positive drivers of economic growth. These findings reinforced the argument that economic integration through trade and capital flows enhances technological spillovers, efficiency gains, and overall productivity improvements. This reflected the importance of maintaining policies that facilitated trade liberalization and attract high-quality FDI. While institutional quality (iqindex) was positively associated with growth, its effect was only statistically significant at 10%. Additionally, the interaction term between institutional quality and digital usage did not show evidence of a moderating effect under the current model specification. This suggested that while institutions likely played a role in shaping economic outcomes, their influence on digitalization-driven growth may require further investigation, particularly through alternative indicators or more specific institutional measures. Lastly, employment and education did not exhibit significant effects on economic growth in this model. This could potentially mean the impact of human capital development operated through more indirect channels not fully captured in this model.

When another proxy for digitalization was used i.e. fixed broadband subscription, the overall results from the model estimates (see Panel A (ii)) were generally the same as the previous model. The coefficient for digitalization was smaller, -0.3859, indicating that the digitalization impact on economic growth was lesser with this indicator. The effect of institutional quality on economic growth was insignificant and its interaction with digital access did not indicate a moderating effect on growth. This suggested that no significant moderating effect was observed under the current model specification. It also indicated that the influence of institutional quality on digitalization-driven growth needs further examination. Therefore, the study proceeded with estimating digitalization-driven growth using more granular institutional measures such as institutions and governance indicators.

Table 6 presents the regression results using two proxies of digitalization. For each model, the study defined institutional quality into four variables, Institutions, Governance, Regulatory quality and Government effectiveness and the interaction effect of these variables and economic growth. In Panel B (i), the role of institutions was examined to see if it moderated the effect of digital adoption on economic growth. While institutions positively and significantly influenced economic growth with a coefficient of 0.8507, they did not show a moderating effect of digital adoption on economic growth, indicating that no significant moderating effect was observed under the current model specification. This suggested that institutions likely influenced economic growth, but their role in digitalization-driven growth may require further examination using alternative measures. Panel B (ii) examined a similar model but with digitalization's effect on economic growth measured through the digital access channel. The effect of digitalization on economic growth was negative but significant, signifying that there could be decreasing

benefits, issues with digital infrastructure, or challenges in effectively using digital technologies for economic growth. Meanwhile, the role of institutions was surprisingly insignificant in this model. This outcome may be caused by multicollinearity issues as the institution indicator is highly correlated with other explanatory variables such as trade openness and FDI, making its effect difficult to isolate and statistically insignificant. As such, the insignificant moderating effect of institutions on digitalization-driven growth was not a surprise. As in the previous three models, trade openness, foreign direct investment, and employment were statistically significant.

In Panel C (i) and (ii) models, both the digitalization indicators were consistent in showing significant but negative effects on economic growth. Again, this could be due to various reasons such as uneven digital adoption, weak institutional frameworks, and market concentration. The digital divide between urban and rural areas can widen inequality, limiting inclusive growth. Weak regulatory environments may lead to monopolistic digital markets, reducing competition and innovation. Additionally, rapid automation without adequate workforce reskilling can displace jobs, increasing unemployment and social instability. Without strong governance and policies to ensure equitable digital transformation, the benefits of digitalization may be concentrated among a few, exacerbating structural economic challenges. The isolated effect of governance on economic growth and its interaction with digitalization proxies in both models were insignificant. This finding may imply the presence of weak governance, yielding insignificant effect on economic growth which additionally explains why digitalization exerts negative effect on growth in Panel C (i) and (ii). Trade openness, foreign direct investment and employment similarly yielded positive and significant effects on economic growth as expected and found in Panel A and B.

Given the fact that more specific measures of institutional quality and their interaction could potentially yield significant effects on economic growth, the study next employed regulatory quality and governance effectiveness as proxies for institutional quality. The results derived from the fixed effect models shown in Panels D and E were consistent with those shown in most of the earlier models, specifically, models in Panel B (ii), C and D. The only exception wherein institutional quality index and a more disaggregated measure i.e. institutions reflect institutional quality that yielded significant effects on economic growth could be seen in Panel A (i) and Panel B (ii) albeit at 10% and 5% significant level respectively.

Since a large number of models showed a muted moderating effect of institutional quality either using various overall and specific measures on digitalization-driven economic growth, this suggested that institutional frameworks in ASEAN may not be sufficiently robust or adaptive to maximize the benefits of digital transformation. Several plausible reasons could explain this insignificant effect. First, institutional improvements may lag behind the rapid pace of digital adoption, limiting their ability to influence economic outcomes effectively. Second, the presence of entrenched regulatory inefficiencies and bureaucratic hurdles may dilute the intended impact of governance reforms. Third, digitalization in ASEAN often advanced in a market-driven rather than institution-led manner, reducing the role of formal institutions in shaping its economic effects. Finally, institutional quality may be more influential in mitigating risks rather than directly enhancing the growth effects of digitalization, particularly in economies where structural constraints and digital divides persist. Nevertheless, the study took note of the possibility of the choice of proxies used. As mentioned by Pascale et. al (2024), finding effective proxies of the institutional quality was not easy.

The findings of this study aligned with existing studies on the relationship between digitalization and institutional quality, and the interaction of institutional quality with economic growth. Similar to Nguyen (2021), who found that while digitalization and governance independently induced economic growth, their interaction could be detrimental in regions with weak governance, The findings indicated that the benefits of digitalization may be constrained by institutional weaknesses. Likewise, Olofin (2023) provided evidence from Bangladesh, Ethiopia, Kenya, and Nigeria, showing that although digital economy development generally promoted growth, its interaction with institutional quality had a negative effect. The results supported this pattern, suggesting that in contexts where institutional quality was weak, digitalization alone may not lead to optimal economic outcomes and may even exacerbate inefficiencies. These findings reinforced the argument that strengthening institutional frameworks was essential to maximizing the economic benefits of digital transformation in the case of ASEAN economies.

Table 6. Regression Results for Disaggregated Institutional Quality Indicators

Dependent variable: GDP growth (annual %)	Panel B (i)	Panel B (ii)	Panel C (i)	Panel C (ii)	Panel D (i)	Panel D (ii)	Panel E (i)	Panel E (ii)
Independent variable:	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)
Individual using the Internet (% of population, log)	-0.9186**		-0.8525**		-0.7879**		-0.7036**	
Fixed Broadband subscriptions (per 100 people, log)		-0.3818***		-0.3757***		-0.3770***		-0.3217***
Institutions	0.8507**	0.1677						
Governance			0.4407	-0.1540				
Regulatory Quality					1.4551	-0.3863		
Government Effectiveness							0.2542	-0.8028
Interaction term (a x b)	-0.1315	-0.0285	-0.1179	-0.0304	-0.5111	-0.2123	-0.1686	-0.0324
Trade Volume (% of GDP)	0.0451**	0.0461**	0.0434***	0.0457***	0.0405**	0.0425**	0.0450**	0.0475**
FDI, net inflows (% of GDP)	0.2030**	0.2014**	0.2123***	0.2073***	0.2238***	0.2153**	0.2100***	0.2076**
School Enrollment, primary (% gross)	0.0371	0.0617	0.0379	0.0594	0.0386	0.0638	0.0308	0.0511
Employment (%)	0.0992***	0.1276***	0.0949***	0.1297***	0.0899***	0.1327***	0.0979***	0.1269***

Dependent variable: GDP growth (annual %)	Panel B (i)	Panel B (ii)	Panel C (i)	Panel C (ii)	Panel D (i)	Panel D (ii)	Panel E (i)	Panel E (ii)
Independent variable:	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)	Fixed Effect (robust std error)
Constant	-10.2983	-17.7672**	-10.1498	-17.5692**	-9.6230	-17.5952**	-10.2265	- 16.5544**
R-squared	0.0353	0.0455	0.0520	0.0701	0.0715	0.0819	0.0579	0.0710
F (7,184)								
F (7,7)	21.72***	86.88***	7.81***	19.19***	6.52**	54.28***	17.04***	22.14***
Wald Chi-squared								
Hausman test	36.86***	38.64***	25.70***	24.68***	27.73***	26.61***	32.33***	33.14***
Woolridge test	9.33**	4.94*	9.33**	9.33**	4.82*	4.82*	4.82*	4.82*

Note: ***, ** and * indicate significance at 1%, 5% and 10% respectively

5. CONCLUSION

This study examined the impact of digitalization on economic growth in ASEAN economies while assessing whether institutional quality moderates this relationship. The findings revealed a statistically significant negative relationship between digitalization and economic growth, suggesting that digital transformation in the region has not yet translated into improved macroeconomic performance. Although institutional quality is theoretically important, its moderating effect was largely insignificant across the estimated models. Descriptive evidence further highlighted persistent digital divides, substantial institutional heterogeneity, and uneven development across ASEAN, implying that digitalization alone is insufficient to generate sustained economic growth without complementary institutional reforms. These findings support the view of Acemoglu and Robinson (2012) that strong and inclusive institutions are fundamental to long-term productivity and economic development.

From a management and governance perspective, the findings suggest that investments in digital technologies do not automatically improve organisational or economic performance unless supported by effective governance, institutional capacity, and sound management practices. Consistent with Bloom, Sadun, and Van Reenen (2012), organisations require appropriate governance structures, strategic resource allocation, and institutional support to fully realise the productivity gains from digital transformation. The findings also carry important policy implications. Strengthening regulatory quality, government effectiveness, and the rule of law should accompany digital transformation initiatives to improve their economic impact. At the same time, reducing the digital divide through continued investment in digital infrastructure, digital skills, and innovation ecosystems remains essential. Greater regional cooperation in harmonising digital policies and governance standards would further support inclusive and sustainable digital development across ASEAN.

This study has several limitations. It relied on broad proxies for digitalization and institutional quality, was constrained by data availability, and employed a fixed effects approach that does not fully address endogeneity or establish causality. Future research should employ dynamic panel techniques such as System GMM, examine sector-specific effects of digitalization, incorporate broader dimensions of institutional quality, and explore nonlinear or threshold relationships to better understand the mechanisms linking digitalization, governance, and economic growth.

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7. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

8. AUTHORS' CONTRIBUTIONS

Azlina Hanif: Conceptualisation, methodology, formal analysis, investigation and writing-original draft; **Ruhaini Muda:** Conceptualisation, methodology and review; **Roland Szabo:** Conceptualisation, supervision and validation; **Arlinah Abd Rashid:** Conceptualisation and literature review.

9. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The datasets generated during the current study are available in the Zenodo repository at <https://doi.org/10.5281/zenodo.14808272>

10. ETHICS STATEMENT

This study used publicly available secondary data from the World Bank, Worldwide Governance Indicators (WGI), and the International Telecommunication Union (ITU). Ethical approval and informed consent were therefore not required.

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