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THE DYNAMIC RELATIONSHIP BETWEEN MULTIDIMENSIONAL GLOBALIZATION IN MARITIME LOGISTICS PERFORMANCE ASEAN

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Abstract

The transformation of ASEAN's maritime logistics system faces complex challenges as global maritime trade volume increases from 8.4 billion tons in 2010 to 11.0 billion tons in 2021. As a region that controls 25% of total global trade goods and facilitates \$2.8 trillion maritime trade volume by 2021, ASEAN has a strategic role but faces significant challenges in optimizing maritime logistics performance. Despite its strategic centrality, ASEAN exhibits significant disparities in maritime infrastructure, with LSCI scores ranging from 21.35 to 113.78 points. These gaps suggest that geographical advantage alone is insufficient without robust integration into global economic, social, and political networks. While existing literature often examines these dimensions in isolation, this study provides a comprehensive analysis of how multidimensional globalization collectively determines maritime logistics performance. By evaluating these dynamics over a decade (2010–2021), the research offers critical insights into the drivers of regional connectivity. Therefore, this study aims to investigate the impact of multidimensional globalization on maritime logistics performance in ASEAN countries by analyzing the influence of economic globalization, social globalization and political globalization on LSCI.

The study uses panel data regression analysis over the period 2010–2021. The dependent variable is LSCI, while the independent variables include Exports of Goods and Services (% of GDP), Individuals using Internet (% of population), and Political Stability and Absence of Violence/Terrorism. The estimation results show that economic globalization has a significant positive effect on LSCI with a coefficient of 20.679 (t-statistic = 5.042; p-value = 0.0000). The R-squared value indicates the proportion of the variance in the Liner Shipping Connectivity Index (LSCI) that is predictable from the independent variables. A high R-squared in this model suggests that economic, social, and political dimensions of globalization collectively explain a substantial majority of the shifts in ASEAN maritime performance. Specifically, the coefficient of 20.679 for economic globalization implies that for every percentage increase in export intensity, the LSCI is expected to rise by approximately 20.6 points. This high magnitude underscores that trade-led growth is the primary driver of maritime infrastructure demand. The statistical significance across all variables ($p < 0.05$) confirms that these findings are not coincidental but represent a robust causal link between globalization tiers and logistics efficiency. Social globalization also has a significant positive effect with a coefficient of 0.421 (t-statistic = 9.118; p-value = 0.0000). In contrast, political globalization has no significant effect on LSCI with a coefficient of 1.765 (t-statistic = 0.582; p-value = 0.5627). The simultaneous test showed an F-statistic of 41.663 (p-value = 0.0000) confirming the jointly significant effect. The coefficient of determination (R^2) of 0.648 indicates that the model explains 64.8% of the variation in LSCI. The findings confirm that the economic and social dimensions of globalization are determinants of ASEAN maritime logistics performance, while political stability shows no significant impact in a relatively stable regional context.

Keywords: Maritime Logistics, Liner Shipping Connectivity Index, Multidimensional Globalization, ASEAN, Economic Globalization, Social Globalization, Political Globalization

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INTRODUCTION

The global economy operates through increasingly complex and integrated trade networks, where maritime logistics serves as the infrastructure that connects national economies with global markets. In this context, the Association of Southeast Asian Nations (ASEAN) has become a strategic economic bloc contributing 8.4% to global GDP and facilitating annual maritime trade volumes worth \$2.8 trillion by 2021 (Evers & Karim, 2011). The region's strategic position along major global shipping routes, particularly at critical chokepoints such as the Strait of Malacca and Singapore Strait, means that ASEAN controls approximately 25% of total global trade goods and 60% of Asia's maritime trade transit.

The transformation of ASEAN's maritime logistics system, characterized by global maritime trade volumes increasing from 8.4 billion tons in 2010 to 11.0 billion tons in 2021, reflects an average growth of 2.6% per year (Kampan, 2017). This transformation is accelerated by the digitalization of the maritime sector through the implementation of automated port systems and smart logistics technologies, which is changing the operational paradigm in maritime supply chains. However, the ASEAN region shows significant heterogeneity in maritime logistics performance among member states, with the Liner Shipping Connectivity Index (LSCI) ranging from 21.35 to 113.78 points. This variation reflects different exposures to globalization forces and varying capacities to harness those forces to improve maritime logistics efficiency.

Despite extensive research on the economic implications of globalization, there remains a significant gap in understanding how multidimensional globalization encompassing economic, social, and political dimensions simultaneously affects maritime logistics performance. The literature review identified three fundamental limitations in previous studies. First, the fragmentary nature of the research approach in analysing the dimensions of globalization in isolation, without considering the possible synergistic effects on the maritime logistics system. Second, the predominance of *cross-sectional* methodological approaches in previous studies limits the understanding of temporal dynamics and causal relationships. This limitation results in a lack of insight into how the multidimensional effects of globalization evolve over time and how changes in one dimension may affect another longitudinally. Third, ASEAN region-specific analyses are limited by narrow geographical coverage or short observation periods, thus not capturing the full spectrum of regional maritime logistics evolution (Jamain et al., 2022).

This research is based on three theoretical frameworks that comprehensively analyze the multidimensional impact of globalization on maritime logistics performance. *Network Theory* provides an understanding of how a country's strategic position in international maritime trade networks

affects its logistics capacity (Santos & Pereira, 2022). In the ASEAN context, this theory explains how regional integration and inter-port connectivity shape the efficiency of the overall maritime logistics system. The Comparative Advantage Theory provides an economic foundation to understand how trade specialization drives demand for maritime logistics services. The theory explains that countries with a comparative advantage in a particular product will experience increased import-export activity, which in turn increases the need for efficient maritime logistics infrastructure and services. The application of this theory in the ASEAN context helps explain the variation in maritime logistics performance between member states. Institutional Economic Theory offers a perspective on how political and *governance* factors shape the investment environment for maritime infrastructure. It emphasizes the role of formal and informal institutions in creating a regulatory framework conducive to the development of the maritime logistics sector. In the context of this study, institutional economics theory helps explain how political stability and governance quality affect maritime infrastructure investment and Port operational efficiency (Baker et al., 2019).

This research aims to investigate the multidimensional impact of globalization on maritime logistics performance in ASEAN countries by examining how the economic, social, and political dimensions of globalization affect the *Liner Shipping Connectivity Index* (LSCI) as an indicator of maritime logistics performance. To achieve the research objectives, four research questions were developed to systematically analyze the multidimensional interactions in the maritime globalization-logistics phenomenon. First, to what extent does economic globalization, as measured by export intensity, affect maritime logistics connectivity in ASEAN countries, with export intensity chosen as a proxy for economic globalization as it reflects a country's level of economic integration with the global market. Second, how social globalization, proxied through internet penetration, affects maritime logistics performance in the ASEAN region, with internet penetration being used as an indicator of social globalization as it reflects the level of digital connectivity and capacity to adopt modern technology in logistics operations. Third, how political stability as a proxy for political globalization affects maritime logistics connectivity in ASEAN countries, with political stability reflecting institutional quality, policy predictability, and an investment climate conducive to maritime infrastructure development. Fourth, how the three dimensions of globalization (economic, social, and political) interact collectively in influencing maritime logistics performance in the ASEAN region.

LITERATURE REVIEW

Liner Shipping Connectivity Index (LSCI) as a Maritime Connectivity Indicator

The Liner Shipping Connectivity Index (LSCI) is a measurement instrument developed by UNCTAD to quantify a country's level of integration in the global shipping network. The LSCI operationalizes maritime connectivity through the aggregation of five dimensions such as number of ships, fleet capacity (TEU), diversity of shipping companies, frequency of service, and maximum capacity of ships. With a 2004 baseline of 100, the LSCI generates a relative score for comparison between countries (Fugazza & Hoffmann, 2017). Within the framework of network theory, maritime connectivity serves as a critical infrastructure that links the domestic economic system with global markets. The LSCI is positioned as an endogenous variable that is responsive to the multidimensional dynamics of globalization. Synthesis of global studies indicates that maritime connectivity is not merely a byproduct of trade volume, but a reflection of systemic integration within global production networks. (Munim et al., 2018) emphasize that countries with high levels of economic openness tend to attract more substantial port infrastructure investments, which directly bolsters their LSCI scores. Furthermore, on a regional scale, the integration of the ASEAN market necessitates a synchronization between physical cargo flows (economic dimension) and information flows (social dimension) to foster globally competitive port efficiency. This integrated perspective leads to the hypothesis that the acceleration of multidimensional globalization will significantly propel ASEAN's strategic positioning within the global liner shipping network. Research by (Fugazza and Hoffmann, 2017) using a gravity model with panel data of 158 countries found the elasticity of LSCI to bilateral trade to be 0.28.

Exports of Goods and Services (% of GDP) as a Proxy for Economic Globalization

Exports of goods and services as a percentage of GDP are a fundamental indicator of economic openness and global market integration. Based on the IMF's Balance of Payments Manual methodology, this indicator operationalizes economic globalization through quantifying the relative contribution of export activity to the national economy. A high ratio reflects a highly integrated economy with certain comparative advantages (Gabriele, 2006). At the global level, the correlation between export intensity and maritime connectivity is driven by the 'demand-derived connectivity' mechanism, where the growth of manufacturing export sectors compels shipping providers to increase port call frequencies and fleet capacities to achieve economies of scale. (Martínez-Zarzoso and Nowak-Lehmann, 2003) provide empirical evidence that

improvements in transport efficiency triggered by export activities can systematically reduce logistics costs. In the ASEAN context, production specialization in emerging hubs like Vietnam and Thailand has reshaped regional shipping routes, reinforcing the argument that economic globalization acts as a primary catalyst for maritime infrastructure development that is highly responsive to international market requirements. In the framework of comparative advantage theory, production specialization requires an efficient transportation system to realize comparative advantage (Cukrowski & Fischer, 2000).

Labor Force Participation

Internet penetration as a percentage of the population quantifies the adoption of information and communication technologies in society. It operationalizes social globalization by measuring access to global information and participation in the digital economy. High penetration indicates a society that is well connected to global networks and access to advanced digital services (Xiong et al., 2021). The evolution of maritime logistics from conventional models to 'Smart Port' paradigms is heavily contingent upon the degree of social globalization and digital readiness. Global studies by (Urciuoli et al., 2021) suggest that robust internet penetration facilitates a 'digital ecosystem' that mitigates operational risks and enhances supply chain transparency. Within the ASEAN region, while technological disparities remain, the integration of internet-based port information systems such as the ASEAN Single Window demonstrates that digital connectivity accelerates customs clearance and intermodal coordination. This provides a theoretical foundation suggesting that social globalization, through ICT adoption, serves as a crucial determinant of maritime logistics performance in the Industry 4.0 era. Internet penetration facilitates the adoption of IoT, blockchain, and artificial intelligence in maritime logistics through: (1) smart logistics systems for intermodal coordination, (2) real-time tracking and automated customs clearance, and (3) integration with global logistics networks and electronic data exchange systems. (Gocer et al., 2021) used dynamic panel estimation to identify a positive elasticity of internet penetration on the Logistics Performance Index of 0.32. (Najeeb K.K, M, 2022) found a path coefficient of 0.56 between ICT infrastructure and trade facilitation performance.

Political Stability and Absence of Violence/Terrorism as a Proxy for Political Globalization

Political Stability and Absence of Violence/Terrorism is a component of Worldwide Governance Indicators that quantifies the perceived probability of political destabilization through unconstitutional means. With a scale of -2.5 to +2.5, this indicator operationalizes political globalization through assessments

of political predictability and institutional stability, reflecting investor confidence and policy predictability (Odehnal & Sedlacik, 2018). Within an institutional economic framework, political stability creates an environment conducive to long-term investment in maritime infrastructure (Beker et al., 2019). Political stability affects shipping connectivity through: (1) it increases investor confidence for capital-intensive investments, (2) policy predictability facilitates long-term strategic planning, (3) the absence of violence ensures operational security, and (4) institutional stability supports international cooperation in regional shipping networks. (Alesina & Perotti, 1996) using cross-country regression with instrumental variables on 71 countries identified a one standard deviation increase in political stability increases the investment-to-GDP ratio by 1.5 percentage points.

RESEARCH METHODOLOGY

This research adopts a robust quantitative design to investigate the determinants of maritime logistics performance within the ASEAN region. The strategic selection of Exports, Internet Penetration, and Political Stability as proxies for multidimensional globalization is grounded in their direct operational transmission channels into the maritime sector. Export intensity is prioritized as the economic proxy because it represents the derived demand for liner shipping capacity, reflecting actual trade integration more accurately than Foreign Direct Investment (FDI). For social globalization, internet penetration is utilized as a proxy for digital readiness, which is an essential prerequisite for modern 'Smart Port' operations and digital trade facilitation. Political stability is isolated as the primary political proxy due to the capital-intensive and long-term nature of maritime investments, where institutional security acts as a crucial de-risking factor for international shipping lines. To maintain model parsimony and mitigate potential multicollinearity, other indicators such as import volumes and trade tariffs were intentionally excluded; imports often exhibit high statistical redundancy with exports in ASEAN's export-led economies, while tariff structures have been largely harmonized through the ASEAN Free Trade Area (AFTA). This precise selection ensures a focused and transparent empirical framework.

Statistical Analysis

Statistical analysis is a systematic process that includes collecting, organizing, interpreting, and presenting quantitative data using statistical techniques to identify patterns, trends, and relationships that exist in the data.

Classical Assumptions

The classical assumption test is a series of tests carried out to ensure that the regression model used meets the basic assumptions to obtain unbiased, consistent, and efficient estimates of model parameters by testing for normality, multicollinearity, heteroscedasticity, and autocorrelation (Khan et al., 2023).

Model Selection

In panel data analysis, three main models that are often used for estimation are the *Common Effect Model*, *Fixed Effect Model*, and *Random Effect Model*. To determine the most appropriate model, a series of tests are needed such as the *chow test*, the *hausman test*, and the *Breusch-pagan lagrange multiplier test* (Gujarati, 2006).

Panel Data Regression Model

According to (Baltagi BH, 2005) panel data is generated from observations of a number of individuals monitored over several different time spans. One of the regression models available for panel data is a model that maintains a constant slope but has varying intercept values. In a one-way component model, variation is caused by one of the units, namely between *cross-sectional* or time, while in a two-way model, variation is influenced by both cross-sectoral units and units related to time. Panel data regression analysis aims to estimate and predict differences in characteristics between individuals or between times and to find the mean value of a data set (both samples and populations) by observing the relationship between the variables studied (dependent variables) and the variables used to explain them (independent variables). So mathematically the regression model of this study is structured as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon \quad (3.1)$$

Description:

Y: Liner Shipping Connectivity Index

β_0 : *Intercept*

$\beta_1, \beta_2, \beta_3$: Regression Coefficient

X1: Exports of Goods and Services (% of GDP) (Economic Globalization Proxy)

X2: Individuals using the Internet (% of population) (Social Globalization Proxy)

X3: Political Stability and Absence of Violence/Terrorism (Political Globalization Proxy)

ε : *Error Term*

Statistical t Test (Partial Test)

In research, the significance of the influence of independent variables on dependent variables is seen through the t-statistic test (Widarjono, 2018). In its use, if $t\text{-count} > t\text{-table}$ or significance is less than $(\alpha) 5\%$, this indicates that there is a significant partial influence between the independent variables on the dependent variable (Gujarati, 2006).

The hypothesis in this test is:

$H_0: \beta_i < 0$ There is no significant influence between the independent variables on the dependent variable partially.

$H_a: \beta_i > 0$ There is a significant influence between the independent variables on the dependent variables partially.

The testing criteria are as follows:

1. If $t\text{-statistic} > t\text{-table}$ then H_0 is rejected. The independent variable has a significant effect on the dependent variable.
2. If $t\text{-statistic} < t\text{-table}$ then H_0 is accepted. The independent variable does not have a significant effect on the dependent variable.

F Statistic Test

The F-statistic test is used to show how independent variables interact with each other and impact the dependent variable (Wooldridge, 2013). If the F-count exceeds the F-table in the test, then simultaneously the independent variables have a significant influence on the dependent variable, or the data is consistent with the research hypothesis.

$H_0: \beta_i < 0$ There is no significant influence between the independent variables on the dependent variables simultaneously.

$H_a: \beta_i > 0$ There is a significant influence between the independent variables on the dependent variables simultaneously.

The testing criteria are as follows:

1. If $F\text{-statistic} > F\text{-table}$ then H_0 is rejected. The independent variables on the dependent variables statistically have a significant effect together.
2. If $F\text{-statistic} < F\text{-table}$ then H_0 is accepted. The independent variables on the dependent variables do not statistically have a significant effect together.

Test of Determination Coefficient (R^2)

According to Widarjono (2018), the coefficient of determination (R^2) is used to measure the proportion of the contribution of independent variables in explaining the dependent variable. An R^2 value approaching one indicates that the regression model has good ability to explain data variability, while an R^2 value approaching zero indicates limited ability. However, R^2 has a weakness because it tends to increase with the addition of independent variables, although these variables do not always increase the predictive power of the model. Therefore, adjusted R-square is used to correct the addition of irrelevant independent variables, so that the adjusted R-square value will not exceed R-square and can decrease or become negative if the addition of these independent variables does not improve the quality of the model or if the model shows a low level of fit.

ANALYSIS AND DISCUSSION

Descriptive Statistical Analysis functions in descriptions that include *the mean* and *median* of a set of sorted data. In addition, this analysis includes data distribution such as *maximum values*, *minimum values*, and standard deviation values as indicators of data distribution in research (Jin et al., 2023).

Table 1. Descriptive Statistical Analysis

Statistical				
Classification	X1	X2	X3	Y
Mean	4.061380	54.00139	-0.163563	60.23244
Median	4.201523	53.75000	-0.248741	45.19169
Maximum	5.314819	96.90000	1.599125	113.7750
Minimum	2.852507	10.90000	-1.650760	21.34955
Std. Dev.	0.715549	23.75641	0.859405	28.97102

Source: research results 2025

Table 1 provides a comprehensive overview of the data Exports of Goods and Services (X1) as a proxy for economic globalization has a mean value of 4.06% with a standard deviation of 0.72%, indicating a relatively consistent level of economic openness among ASEAN countries. The range of values ranges from 2.85% to 5.31%, with a difference between the mean (4.06%) and median (4.20%) of 0.14 percentage points. The coefficient of variation of 17.6% indicates moderate variability in the level of globalization of regional economies. Meanwhile, Individuals using the Internet (X2) as an indicator of social globalization shows a mean value of 54.00% with a standard deviation of 23.76%. This variable has a wide range, from 10.90% to 96.90%, reflecting the

heterogeneity in information technology penetration in the ASEAN region. The almost identical mean (54.00%) and median (53.75%) values indicate symmetrical data distribution. Political Stability and Absence of Violence/Terrorism (X3) as a proxy for political globalization has an average value of -0.16 with a standard deviation of 0.86. This variable is in the range of -1.65 to 1.60 based on the World Bank scale. The difference between the mean (-0.16) and median (-0.25) of 0.09 points indicates a near-normal distribution of data with a slight positive slope. Meanwhile, the Liner Shipping Connectivity Index (Y) as the dependent variable has a mean value of 60.23 with a standard deviation of 28.97. The range of values ranges from 21.35 to 113.78, indicating considerable variability in maritime logistics performance. The difference between the mean (60.23) and median (45.19) of 15.04 points indicates a positively skewed data distribution. The coefficient of variation of 48.1% shows the highest heterogeneity compared to other variables. This high heterogeneity suggests that political stability is a volatile yet decisive factor in the ASEAN maritime landscape. This study argues that political stability does not operate in isolation; rather, it serves as a critical moderating 'anchor' that amplifies the dividends of economic and social globalization. The positive influence of internet penetration on maritime logistics digitalization can only be fully optimized when underpinned by a stable political environment that ensures policy continuity and digital infrastructure security. Similarly, the correlation between export intensity and LSCI is significantly strengthened by political stability, which acts as a primary de-risking mechanism for global shipping lines when making long-term commitments to port calls in the region. Consequently, political stability functions as a catalyst that allows trade openness and digital readiness to be effectively translated into superior and sustainable maritime logistics performance.

Classical Assumptions

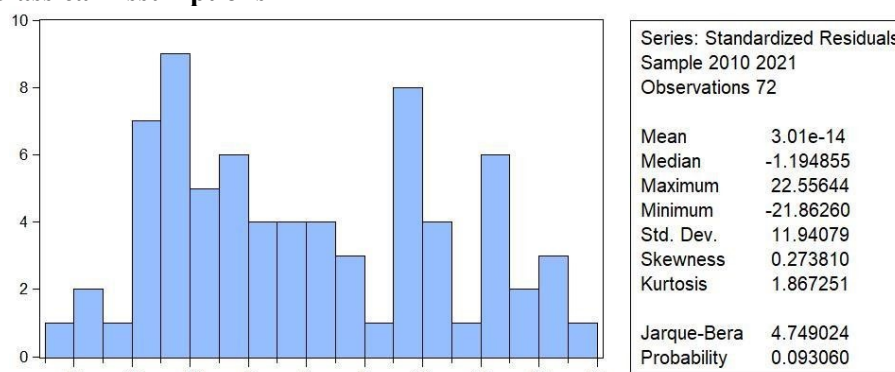


Figure 1. Normality Test
 Source: research results 2025

Based on Figure 1. the normality test from the histogram above, the probability value is $0.093060 > 0.05$. Then the *Jarque-Bera* value $< Chi Square$ value which indicates that the data follows a normal distribution pattern.

Table 2. Multicollinearity Test

Correlation Coefficient Variable	X1	X2	X3
X1	1.000000	0.676148	0.781609
X2	0.676148	1.000000	0.702763
X3	0.781609	0.702763	1.000000

Source: research results 2025

Based on table 2 the results of the multicollinearity test, it was found that there were no variables with a relationship that exceeded the correlation value of 0.8. Therefore, it can be concluded that there is no significant multicollinearity between the independent variables used in this study. This means that the variables do not show a strong linear relationship or lack of meaningful interrelationships among others, so there is no significant interdependence.

Model Selection

Table 3. Chow Test

No	Test Summary	Chi-Sq. Statistic	Chi-Sq. Df	Prob.	Conclusion
1	Fix Effect Model	105,944169	5,63	0,0000	H ₀ is rejected

Source: research results 2025

Based on the Chow Test results presented in Table 3, the statistical Chi-square value is 105.944169 with a degree of freedom of 5.63 and a probability level of 0.0000. The statistical Chi-square value (105.944169) $>$ Chi-square table (11.07050) with a probability value of $0.0000 < 0.05$. These results indicate rejection of the null hypothesis (H_0), which indicates that the Fixed Effect model is more appropriate to use than the Common Effect model in the panel data analysis of this study.

Table 4. Hausman test

No	Test Summary	Chi-Sq. Statistic	Chi-Sq. Df	Prob.	Conclusion
1	Random Effect Model	6,484136	3	0,0903	H ₀ is accepted

Source: research results 2025

The Hausman Test results shown in Table 4 show a statistical Chi-square value of 6.484136 with 3 degrees of freedom and a probability level of 0.0903. The statistical Chi-square value (6.484136) < Chi-square table (7.815) with a probability value of 0.0903 > 0.05 indicates acceptance of the null hypothesis (H₀), which indicates that there is no systematic difference between the Fixed Effect and Random Effect estimators. Thus, the Random Effect model can be considered consistent and efficient for use in this study.

Table 5. LM Test

No	Test Summary	Cross-section	Period	Both	Conclusion
1	Breusch-Pagan	141,9208	2,783379	144,7042	H ₀ is rejected
		0,0000	0,0952	0,0000	

Source: research results 2025

The Lagrange Multiplier test (LM test) presented in Table 5 produces a Breusch-Pagan cross- section value of 141.9208 with a probability level of 0.0000. The probability value obtained (0.0000 < 0.05) indicates rejection of the null hypothesis (H₀), which indicates that the Random Effect model is more appropriate to use compared to the Common Effect model.

Panel Data Regression Result

Table 6. Results of OLS Calculation of Panel Data Regression Equation of Selected FEM Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-46.20085	17.60568	-2.624201	0.0107
X1	20.67991	4.101105	5.042523	0.0000
X2	0.420971	0.046169	9.118119	0.0000
X3	1.765205	3.034501	0.581712	0.5627
Effects Specification				
			S.D.	Rho
Cross-section random			9.784184	0.7823
Idiosyncratic random			5.161667	0.2177

Weighted Statistics			
R-squared	0.647648	Mean dependent var	9.068313
Adjusted R-squared	0.632103	S.D. dependent var	8.725238
S.E. of regression	5.292250	Sum squared resid	1904.538
F-statistic	41.66296	Durbin-Watson stat	0.977039
Prob(F-statistic)	0.000000		
Unweighted Statistics			
R-squared	0.830122	Mean dependent var	60.23244
Sum squared resid	10123.35	Durbin-Watson stat	0.183813

Source: research results 2025

Statistical Test t (Partial Test)

Based on Table 6. The coefficient of the Exports of Goods and Services variable (X1) of 20.67991 indicates that every 1 percent increase in the ratio of exports of goods and services to GDP will increase the Liner Shipping Connectivity Index by 20.67991 assuming other variables are constant (*ceteris paribus*). The obtained t-statistic value of 5.042523 is greater than the t-table at the 5% significance level with a probability value of 0.0000 which is smaller than $\alpha = 0.05$. This finding indicates that economic globalization proxied through exports of goods and services has a positive and significant influence on the performance of maritime logistics in the ASEAN region partially. This result is consistent with international trade theory that emphasizes the importance of maritime connectivity in supporting export-import activities.

The coefficient of the variable Individuals using the Internet (X2) of 0.420971 indicates that every 1 percent increase in the proportion of individuals using the internet will increase the Liner Shipping Connectivity Index by 0.420971 assuming other variables are constant. The obtained t-statistic value of 9.118119 is greater than the t-table with a probability value of 0.0000 which is significant at the $\alpha = 0.05$ level. This finding shows that social globalization proxied through internet penetration has a positive and significant influence on maritime logistics performance in the ASEAN region partially. This indicates that digitalization and digital connectivity play an important role in improving efficiency and coordination in the maritime logistics system.

The coefficient of the Political Stability and Absence of Violence/Terrorism variable (X3) of 1.765205 indicates that every 1 unit increase in the political stability index and the absence of violence/terrorism will increase the Liner Shipping Connectivity Index by 1.765205 points assuming other variables are constant. However, the obtained t-statistic value of 0.581712 is smaller than the t-table with a probability value of 0.5627 which is greater than α

= 0.05. This finding indicates that political globalization proxied through political stability does not have a significant influence on the performance of maritime logistics in the ASEAN region partially. This result can be explained by the relatively homogeneous condition of political stability in the ASEAN region or the existence of other factors that are more dominant in influencing maritime logistics performance.

F Statistic Test

The F test aims to test the effect of independent variables together on the dependent variable. Based on the results of the random effect model estimation, the F-statistic value is 41.66296 which is greater than the F-table at the 5% significance level with a probability value of 0.000000 which is significant. This result shows that the variables Exports of Goods and Services (X1), Individuals using the Internet (X2), and Political Stability and Absence of Violence/Terrorism (X3) simultaneously have a significant effect on the Liner Shipping Connectivity Index in the ASEAN region. These findings confirm that the multidimensional dimensions of globalization collectively have a substantive impact on maritime logistics performance, although the individual contributions of each dimension vary.

Determination Coefficient (R^2)

The coefficient of determination is used to measure the proportion of variation in the dependent variable that can be explained by the independent variables in the model. Based on the analysis of the R-squared value of 0.647648, it shows that the model is able to explain 64.76% of the variation in the Liner Shipping Connectivity Index, while the remaining 35.24% is explained by other variables outside the model. Meanwhile, the unweighted R-squared value of 0.830122 indicates that without considering random effects, the model is able to explain 83.01% of the variation in the Liner Shipping Connectivity Index. The significant difference between the weighted and unweighted R-squared indicates that the individual effects of ASEAN countries (cross-section random effects) contribute substantially in explaining the heterogeneity of maritime logistics performance among countries in the region.

DISCUSSION

Relationship between Economic Globalization and Maritime Logistics Performance

The regression results show that economic globalization proxied through the ratio of exports of goods and services to GDP (X1) has a positive and significant influence on the Liner Shipping Connectivity Index (Y) with a coefficient of 20.67991 (t-statistic = 5.042523, p-value = 0.0000). This coefficient indicates that

every 1% increase in export intensity will increase maritime logistics connectivity by 20.68 LSCI points. The economic significance of this finding can be contextualized through the ASEAN region's LSCI distribution which has a mean of 60.23 points with a standard deviation of 28.97. Thus, a 1% increase in export intensity is equivalent to a 0.71 standard deviation increase in maritime logistics performance indicating a very substantial economic impact in the context of variability in maritime logistics performance among ASEAN countries.

These empirical findings consistently support the Ricardian theory of comparative advantage and modern international trade theory, where the intensification of export activities creates a demand-pull effect on maritime logistics infrastructure through three interacting transmission mechanisms. The first mechanism is the economies of scale mechanism which operates on the principle that an increase in export volume encourages optimal utilization of port and shipping lines capacity through a cost spreading effect, whereby the fixed costs of maritime infrastructure can be distributed over a larger volume of trade to create a reduction in per unit cost that enables service expansion and increased frequency of route connectivity (Kim et al., 2016). The second mechanism is the infrastructure investment mechanism which suggests that the expectation of increased trade flows drives maritime infrastructure investment from both the public and private sectors. This investment is not only limited to physical infrastructure such as port expansion but also includes digital infrastructure such as port community systems and automated cargo handling systems (Lorz, 2020). The third mechanism is the network externality mechanism, which indicates that an increase in a country's export activity creates spillover effects that strengthen the region's position in the global maritime network. This mechanism operates through hub-and-spoke where ports with high connectivity become preferred ports for major shipping lines and create a self-reinforcing cycle of increased connectivity (Li et al., 2023).

Cross-sectional analysis shows significant heterogeneity in maritime logistics performance among ASEAN member states, with LSCI scores ranging from 21.35 to 113.78 points, reflecting diverse levels and capacities in leveraging economic globalization to improve maritime logistics performance. Countries with higher export intensity such as Singapore (LSCI = 113.78) and Malaysia show superior connectivity performance compared to countries with lower export intensity such as Laos and Myanmar. This phenomenon can be explained through path dependency theory where initial conditions in export orientation create advantages in maritime infrastructure development, so that countries that have built comparative advantages in export-oriented industries experience accelerated development in maritime logistics capabilities through learning-by-doing effects and agglomeration economies that strengthen competitiveness positions in regional maritime trade networks (Van Driel & Devos, 2007). These dynamics

create a reinforcing cycle that further deepens the maritime logistics performance gap among ASEAN Member States, indicating the importance of coordinated policy interventions to reduce disparities and enhance regional economic integration through more inclusive maritime logistics infrastructure development.

These findings have strategic implications for maritime policy development in the ASEAN region. Trade liberalization policies, export promotion strategies, and export-oriented industrial development policies can serve as effective instruments for maritime infrastructure development, but require a synchronized policy framework that combines industrial development, trade promotion, and maritime infrastructure investment in strategic coordination to avoid bottlenecks in logistics performance or sub-optimal utilization of maritime infrastructure investment. This policy integration is crucial as export promotion policies that are not supported by adequate maritime infrastructure will face constraints in logistics performance, while maritime infrastructure investments that are not aligned with export capabilities will experience sub-optimal utilization (Rehman & Noman, 2021). Thus, a coordinated policy approach is required to maximize synergies between export capacity development and maritime logistics infrastructure to achieve optimal economic efficiency and sustainable regional competitiveness.

Comparison with previous literature shows consistency with previous empirical findings, research by (Fugazza and Hoffmann, 2017) identified an elasticity of LSCI to bilateral trade of 0.28, while in this study found an elasticity of 20.68 for the export intensity-LSCI relationship. This difference in magnitude can be explained through regional specificity where the ASEAN region has a strategic maritime position that strengthens the export-connectivity relationship, methodological differences in the use of panel data compared to cross-sectional analysis, and temporal differences where the most recent observation period captures the effects of globalization that is getting stronger. This consistency is also demonstrated by (Munim et al., 2018) who identified economic development as a determinant of LSCI with a coefficient of 0.38, which consistently supports the findings of this study and confirms the robustness of the relationship between economic performance and maritime logistics capabilities, thus suggesting that regional characteristics may strengthen the relationship. These findings indicate that while the basic relationship between economic performance and maritime connectivity is universal, the intensity of the relationship can vary significantly depending on the geographical context, research methodology and time period observed.

Relationship between Social Globalization and Maritime Logistics Performance

The estimation results show that social globalization proxied through internet penetration (X2) has a positive and significant influence on Liner Shipping Connectivity Index (Y) with a coefficient of 0.420971 (t-statistic = 9.118119, p-value = 0.0000). This coefficient indicates that every 1% increase in the proportion of individuals using the internet will increase maritime logistics connectivity by 0.42 LSCI points, ceteris paribus. The very high statistical significance ($p < 0.001$) with the highest t-statistic value among all independent variables indicates that internet penetration is the most robust determinant in explaining variations in maritime logistics performance in the ASEAN region.

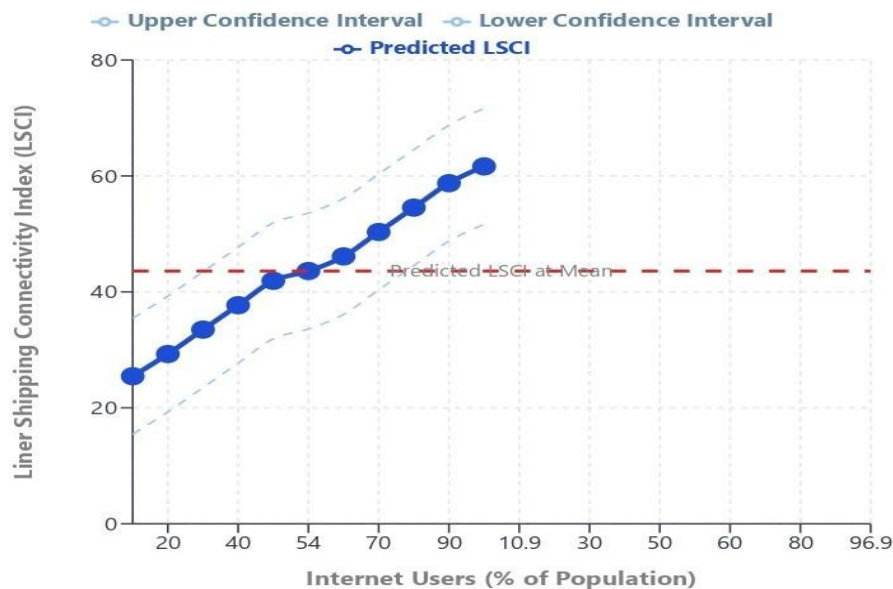


Figure 1. Social Globalization Effects on Maritime Logistics Connectivity in ASEAN

Based on Figure 1, internet penetration in the ASEAN region shows substantial heterogeneity with a mean value of 54.00% (standard deviation 23.76%) and a range from 10.90% to 96.90%. A one standard deviation increase in internet penetration (23.76%) would increase the LSCI by 10.00 points (23.76×0.420971), which is equivalent to 0.35 standard deviations in maritime logistics performance ($10.00/28.97$). This economic impact suggests that the digitization of society has a substantial contribution to the transformation of maritime

logistics capabilities, particularly in the context of technological convergence that integrates domestic logistics systems with global networks (Ahmed et al., 2022).

These empirical findings consistently support the theoretical framework that integrates network theory, technology adoption theory, and digital transformation theory in the context of maritime logistics. The transmission mechanism of the effect of internet penetration on maritime logistics performance can be explained through four interacting and reinforcing pathways. First, the digital infrastructure facilitation mechanism operates on the principle that high internet penetration creates an enabling environment for the implementation of digital technology in port operations and shipping lines. As argued by (Rziki et al., 2023) this mechanism facilitates the adoption of Internet of Things (IoT), blockchain technology, and artificial intelligence in cargo management systems, real-time tracking, and predictive maintenance that directly improve operational efficiency and inter-modal coordination in the maritime supply chain. In the ASEAN context, where the volume of maritime trade increases from 8.4 billion tons in 2010 to 11.0 billion tons in 2021, digitalization can manage the increasing operational complexity.

Second, the information asymmetry reduction mechanism suggests that widespread internet access reduces information gaps between shippers, freight forwarders, and ports through integrated digital platforms. This mechanism is in line with the findings of (Kunaka and Mustra, 2013) who identified a path coefficient of 0.56 between ICT infrastructure and trade facilitation performance, where the reduction of information asymmetry allows for more efficient coordination in scheduling, routing, and resource allocation which ultimately increases the reliability and frequency of shipping lines' services (Sliwczynski, 2020). In the context of the ASEAN region, which controls 25% of total global trade goods, efficient information coordination can maintain a competitive advantage.

Third, the network externality amplification mechanism indicates that internet penetration creates a critical mass for the development of a digital maritime ecosystem that connects various stakeholders in the maritime trade network. This mechanism operates through platform economy effects where an increase in the number of internet users creates incentives for the development of digital applications and services that support maritime logistics efficiency, such as port community systems, electronic data interchange, and digital payment systems that facilitate trade facilitation and reduce transaction costs. Consistent with the findings of (Korniyyenko, 2023), the adoption of digital technology is proven to increase port productivity by 25-40% and maritime connectivity by 15-30%. Fourth, the human capital augmentation mechanism shows that high internet penetration increases the digital literacy and technical competence of workforce in the maritime logistics sector, which enables the adoption of

advanced technology and innovation in operational processes. This mechanism creates multiplier effects where the increase in individual digital capabilities contributes to the increase in sector productivity which in aggregate strengthens the performance of maritime logistics.

Cross-sectional analysis based on the research data shows a consistent pattern between internet penetration levels and maritime logistics performance among ASEAN member states. The variation in LSCI ranging from 21.35 to 113.78 points reflects significant heterogeneity in digital capabilities. This phenomenon can be explained through the digital divide theory which suggests that the digital divide creates disparities in technological capabilities that impact competitiveness in the global logistics network. Countries with more advanced digital infrastructure have a comparative advantage in adopting smart logistics technologies, automated port operations, and integrated supply chain management systems that increase their attractiveness as shipping destinations and transit hubs. Network theory explains that digitalization can strengthen a country's strategic position in international maritime trade networks (Heilig et al., 2017). High internet penetration allows countries to integrate domestic logistics systems with global supply chain networks through digital platforms that connect multiple stakeholders. This creates self-reinforcing network effects where increased digital connectivity attracts more shipping lanes and cargo flows, ultimately strengthening the position in the maritime network.

Research by (Rziki et al., 2023) identified a positive elasticity of internet penetration to the Logistics Performance Index of 0.32, which is qualitatively consistent with the findings of this study (0.42). The difference in magnitude can be explained through: (1) measurement specificity where this study uses the maritime connectivity-specific LSCI, while Choi uses the broader LPI covering all modes of transport; (2) regional characteristics where the ASEAN region has maritime-oriented economies that strengthen the relationship between digitization and maritime performance; and (3) temporal evolution where the more recent observation period captures more mature technological advancements. The study by (Korniyenko, 2023) shows that the adoption of digital technology significantly improves maritime connectivity.

The findings of this study generate policy implications. First, digital infrastructure investment should be positioned as a strategic priority in national development planning, particularly in the context of maritime logistics competitiveness. Second, regional coordination on digital standards and interoperability protocols is crucial to maximize the network effects of maritime logistics digitization. Considering that the ASEAN region facilitates a maritime trade volume of \$2.8 trillion by 2021. Third, public-private partnerships in digital transformation initiatives can accelerate the adoption of advanced technologies in maritime logistics through risk-sharing and resource pooling mechanisms.

Based on the evidence of this study, countries with higher internet penetration exhibit superior maritime performance, indicating that a collaborative approach in digital development can accelerate the convergence of regional maritime capabilities.

Relationship of Urban Population to Energy Intensity in EMDEs Countries

The estimation results show that political globalization proxied through Political Stability and Absence of Violence/Terrorism (X3) has a positive coefficient of 1.765205 but is not statistically significant on Liner Shipping Connectivity Index (Y) with a t-statistic value of 0.581712 and a p-value of 0.5627. This non-significant finding contrasts with Institutional Economics Theory which emphasizes the role of political stability in creating an enabling environment for long-term maritime infrastructure investment (Baker et al., 2019). Political stability should affect maritime logistics performance through four mechanisms: investment climate mechanism, policy predictability mechanism, operational security mechanism, and international cooperation mechanism.

Political Stability and Absence of Violence/Terrorism in the ASEAN region shows a mean value of -0.163563 with a standard deviation of 0.859405, indicating relative homogeneity in regional political stability compared to higher variability in the economic (CV = 17.6%) and social (CV = 44.0%) dimensions of globalization. The ASEAN economic integration process has created spillover effects in institutional development and political stability through peer pressure, best practice sharing, and regional security cooperation mechanisms. Therefore, variations in political stability are not extreme enough to create significant differential effects on maritime logistics performance (Langhammer, 1991).

The threshold effect hypothesis indicates that the majority of ASEAN countries have reached the minimum threshold of political stability required for maritime infrastructure investment, such that additional improvements do not yield significant marginal benefits (Pekkanen & Pearson, 2018). Furthermore, the mediating variables hypothesis also suggests that the effect of political stability is mediated by more proximal factors such as physical infrastructure quality and regulatory efficiency (Zelner & Henisz, 2000). Furthermore, the substitution effects hypothesis suggests that economic integration and technological progress can compensate for deficiencies in political stability through risk-sharing mechanisms. In addition, the Measurement limitations hypothesis also indicates that perception-based indicators do not capture objective institutional conditions relevant to the maritime sector.

The theoretical implications of these findings suggest the need for a reconceptualization of the role of political stability in maritime logistics performance. Conditional effects hypothesis indicates that the effect of political stability is conditional on the level of economic development or technological

progress, where in the context of ASEAN countries that have reached middle-income status, political stability is a necessary but not sufficient condition to achieve superior maritime performance (Siddik et al., 2021). The non-linear relationships hypothesis also suggests that the relationship between political stability and maritime connectivity is nonlinear with diminishing returns at high levels of stability. The contribution to the literature gap is that these findings fill a gap in the understanding of multidimensional globalization effects on maritime logistics by revealing that not all dimensions of globalization have an impact on maritime logistics performance. The contribution to the regional maritime logistics literature shows the importance of context-specific analysis that considers regional characteristics in evaluating the determinants of logistics performance,

Building upon the empirical results, this research offers several actionable policy recommendations for ASEAN member states to enhance regional maritime performance. First, to leverage social globalization, ASEAN should transition from the current 'ASEAN Single Window' toward a more integrated 'Regional Port Community System' (RPCS) to standardize digital documentation and reduce maritime bottlenecks. Second, regarding economic integration, it is imperative to synchronize the development of Special Economic Zones (SEZs) with international liner shipping routes to maximize the 'demand-derived connectivity' from export activities. Finally, to sustain these gains, ASEAN must strengthen the ASEAN Political-Security Community (APSC) framework to mitigate geopolitical volatility, thereby ensuring a predictable and secure investment climate for global logistics providers.

CONCLUSION

Empirical evidence reveals that economic, social, and political globalization collectively account for 64.8% of the variance in ASEAN's maritime connectivity, with export intensity and digital penetration emerging as the primary catalysts for logistics efficiency. However, this study underscores that the efficacy of these economic and social drivers is fundamentally contingent upon political stability, which functions as a critical moderating 'anchor' for long-term infrastructure investment. Consequently, the findings suggest that regional logistics integration cannot be achieved through physical and digital enhancements alone; it necessitates a synchronized and stable political environment to mitigate operational risks and maximize the strategic benefits of global production networks. Based on these findings, ASEAN policymakers should prioritize the harmonization of maritime regulations and the strengthening of institutional stability alongside infrastructure upgrades. Investing in regional political cooperation and digital security frameworks is

essential to ensure that globalization efforts translate into a more resilient and globally competitive maritime logistics performance across all member states.

LIMITATIONS

This study recognises several methodological and conceptual limitations that need to be considered in interpreting the research findings. The relatively limited temporal coverage over the period 2010-2021 may not capture the full spectrum of long-term structural transformation in maritime logistics systems, while the operationalisation of multidimensional globalisation through certain proxy variables poses inherent measurement limitations that may not fully capture the complexity of economic integration, quality of digital connectivity, and objective institutional conditions. The regional specificity of ASEAN countries and their geographical and institutional characteristics will limit the generalisability of results to other regional contexts, while the focus on maritime logistics connectivity through the LSCI may not capture the broader implications for multimodal transport systems and the time lag between policy interventions and their materialisation in maritime logistics performance indicators.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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