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Available online at http://www.e-navi.kr/
e-Navigation Journal

Original article

Sustainable Development Goals and Logistics Performance: Insights from ASEAN countries

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Abstract

Sustainable development is a critical global priority, as showed by United Nations' Sustainable Development Goals (SDGs). Effective logistics are crucial for achieving several SDGs so that improvements in Logistics Performance Index (LPI) often align with progress in SDG scores. For ASEAN countries, they may fall short of achieving 90% of their targeted SDGs and struggle to challenges of LPI fluctuations. By calculating the correlation between LPI and SDG scores in R software, this study seeks to explore the relationship between logistics performance and progress toward the SDGs in ASEAN countries from 64 secondary observations. As a result, the increasing logistics performance can greatly impact on the population well-being, accessibility, new energy approach, infrastructure formation, and sustainable production and consumption (G1, G3, G7, G9, G12) in ASEAN countries. The study contributes a background for national policymakers in the region to develop the sustainable logistics.

Keywords: Sustainable Development Goals, Logistics Performance Index, Correlation analysis, ASEAN.

https://doi.org/10.52820/j.enavi.2024.23.036

1. Introduction

Sustainable development is a critical global priority, as outlined by the United Nations' Sustainable Development Goals (SDGs), which aim to balance economic growth, environmental sustainability, and social well-being (Loucanova et al., 2018). For ASEAN countries, achieving these goals is increasingly challenging due to fluctuations in their Logistics Performance Index (LPI). Logistics performance is a vital driver of trade efficiency and economic development, yet its volatility poses risks to sustainable growth (Rosario et al., 2019). Current projections indicate that ASEAN nations may fall short of achieving 90% of their targeted SDGs, which raises significant concerns about the region's development trajectory (Muyasyaroh, 2023). Figure 1 shows an increasing trend in both SDG (Sustainable Development Goals) scores and LPI (Logistics Performance Index) from 2007 to 2018, with a notable sharp rise in LPI after 2014 (Sachs et al., 2024; World Bank, 2023).

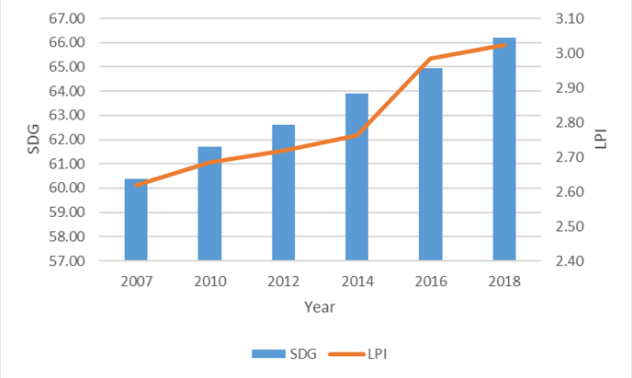

Figure 1: The tendency of SDGs performance index an d LPI in ASEAN countries from 2007 to 2018

Source: Sachs et al. (2024), World Bank (2023)

This study seeks to explore the relationship between logistics performance and progress toward the SDGs in ASEAN countries. It addresses two key research questions: (1) What SGDs are affected by LPI? (2) How do fluctuations in LPI impact the attainment of SDGs in ASEAN nations? The paper includes such 05 main parts as an introduction of the research, a review of SDGs and LPI, methodologies, results and conclusions.

2. Literature review

The Sustainable Development Goals (SDGs) and the Logistics Performance Index (LPI) are interconnected metrics that reflect global development and logistical efficiency. The SDGs, adopted by the United Nations, aim to address 17 critical issues, broadly summarized into four main aspects: humanity, economy, society, and the environment (Lafortune et al., 2018; Matantseva et al., 2021). Meanwhile, the LPI, developed by the World Bank, assesses the efficiency of a country's logistics upon to 06 components (infrastructure, customs, shipment, service quality, tracking & tracing, timeliness) (Word Bank, 2023).

Effective logistics are crucial for achieving several SDGs so that improvements in LPI scores often align with progress in SDGs, demonstrating the importance of robust logistics for sustainable development. Matantseva et al. (2021) claim 11 causalities between logistics performance and SDGs, particularly, Goal 1-Goal 3 and Goal 6-Goal 13. With the same perspective, Spangenberg (2019) agrees logistics impacts on Goal 3, Goal 11-Goal 13, not mention to Goal 4. Nguyen (2022) and Nguyen (2022) accept that Goal 9 and Goal 10 are mostly impacted by logistics activities. Additionally, logistics activities greatly enhance sustainable production (Goal 12) (Grzybowska and Awasthi, 2020). Rosario et al. (2019) reveal significant relationships between Goal 9, Goal 12 and LPI, while Vilalta-Perdomo et al. (2023) emphasize that achieving Goal 2 is facilitated by improved logistics performance. Loucanova et al. (2024) and Le (2024) conclude that the LPI are basically related to SDG scores.

Although there is growing research on the relationship between logistics (LPI) and sustainable development (SDGs), existing studies predominantly rely on qualitative methods or limited empirical data, leading to gaps in conclusions. Qualitative studies, such as those by Matantseva et al. (2021), Spangenberg (2019), Nguyen (2022), Nguyen (2022), highlight important causal links but lack empirical validation. On the other hand, quantitative studies, such as those by Grzybowska and Awasthi (2020), Rosario et al. (2019), Vilalta-Perdomo et al. (2023), Loucanova et al. (2024) and Le (2024), use limited or detailed datasets. Therefore, there is a need for comprehensive empirical research with diverse datasets to validate the LPI-SDG relationship more reliably and provide actionable insights.

3. Methodology

In many correlation methodologies, the Pearson

correlation is the most popular, which widely used in scientific fields such as psychology, finance, and biology to identify relationships between variables and inform decision-making. The Pearson correlation coefficient (r) measures the strength and direction of a linear relationship between two continuous variables. It ranges from -1 to 1, where -1 indicates a perfect negative correlation, 0 indicates no correlation, and 1 indicates a perfect positive correlation. The formula for Pearson correlation is:

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2 \sum_{i=1}^{n}(y_i-\bar{y})^2}} \quad (1)$$

where xi and yi are individual data points, $\bar{x}$ and $\bar{y}$ are their respective means. It uses actual data values, making it sensitive to magnitude and proportional changes, so its result is better than lots of correlation tests (Nguyen, 2020; Tran, 2021).

In this study, a secondary input dataset of SDG scores (G1-G3, G6-G13) and LPI's components is chosen upon to the above literature review and collected in 10 ASEAN nations over a period 2007-2023, sourced from World Bank and United Nations. Variables are coded as follows: Cus (customs), Infr (infrastructure), Ship (shipment), Qual (service quality), Trac (tracking&tracing), Time (timeliness). Then, r-values and p-values are calculated by R software respectively.

Table 1: The statistical description of the input dataset

Var.	Min.	Max.	Mean	Var.	Min.	Max.	Mean	Var.	Min.	Max.	Mean
Cus	1.85	4.20	2.82	**G1**	34.86	98.89	76.40	**G9**	12.28	93.12	44.40
Infr	1.69	4.60	2.85	**G2**	45.99	75.93	61.12	**G10**	22.25	87.24	55.46
Ship	1.73	4.04	3.03	**G3**	34.98	95.02	66.25	**G11**	51.54	98.95	68.40
Qual	2.00	4.40	2.95	**G6**	51.17	75.28	66.55	**G12**	40.95	94.89	80.72
Trac	1.57	4.40	3.06	**G7**	18.61	75.25	57.89	**G13**	8.74	98.81	85.08
Time	2.08	4.53	3.42	**G8**	54.25	79.00	70.22				

Source: Sachs et al. (2024), World Bank (2023)

Table 2: The Pearson correlation test

r-value	G1	G2	G3	G6	G7	G8	G9	G10	G11	G12	G13
Cus	0.79	0.32	0.90	0.36	0.72	0.24	0.86	-0.30	0.74	-0.87	-0.63
p-value	2.5e-11	0.01	2.2e-16	0.00	1.5e-11	0.05	2.2e-16	0.04	2.9e-12	2.2e-16	2.8e-08
Infr	0.84	0.27	0.89	0.42	0.73	0.29	0.88	-0.24	0.70	-0.85	-0.60
p-value	1.4e-13	0.03	2.2e-16	0.00	4.8e-12	0.02	2.2e-16	0.09	1.2e-10	2.2e-16	1.4e-07
Ship	0.73	0.24	0.83	0.48	0.77	0.38	0.79	-0.35	0.61	-0.72	-0.48
p-value	3.2e-09	0.06	2.2e-16	5.6e-05	1.6e-13	0.00	5.7e-15	0.02	1.2e-07	2.6e-11	5.2e-05
Qual	0.76	0.29	0.86	0.40	0.72	0.29	0.84	-0.32	0.69	-0.81	-0.56
p-value	3.3e-10	0.02	2.2e-16	0.00	2.7e-11	0.02	2.2e-16	0.03	3.9e-10	2.8e-16	1.4e-06
Trac	0.73	0.31	0.86	0.42	0.71	0.29	0.81	-0.33	0.63	-0.76	-0.53
p-value	3.3e-09	0.01	2.2e-16	0.00	6.3e-11	0.02	9.0e-16	0.02	2.2e-08	4.6e-13	7.6e-06
Time	0.69	0.26	0.82	0.39	0.70	0.32	0.74	-0.27	0.58	-0.76	-0.51
p-value	7.6e-08	0.03	2.2e-16	0.00	1.7e-10	0.01	2.5e-12	0.07	4.6e-07	3.6e-13	1.5e-05

4. Results

Table 1 statistics a description of 64 observations in the input dataset. The data collection is synchronized from 07 available years of SDG scores and LPI in 10 ASEAN nations, excluding missing values. The table compares variables (Var.) from two groups (Cus–Time and G1–G13) based on their minimum, maximum, and mean values.

In the first group (Cus to Time), Time has the highest mean (3.42), followed closely by Trac (3.06), while Cus has the lowest (2.82). The range of values in this group is relatively narrow, with the highest maximum (4.60) observed in Infr and the lowest minimum (1.57) in Trac.

In the second group (G1 to G13), G13 has the highest mean (85.08) and the widest range (8.74–98.81), suggesting significant variability. G9 has the lowest mean (44.40), while G11 records the highest maximum (98.95). Compared to the first group, variables in this group exhibit much higher means and ranges, indicating greater dispersion and different scales.

Besides, the description indicates 16 non-available values in G1 and G10, so that R results in these variables are calculated within 48 observations in details.

Table 2 compares correlations between variables (Cus, Infr, Ship, Qual, Trac, and Time) and columns G1 to G13. It can be seen that most p-values are lower than 0.50, falling within the 95% confidence interval, making them statistically significant. Overall, based on the correlated strength criteria, G1, G3, G7, G9, G11, and G12 stand out due to consistently strong relationships (positive or negative), while G2, G6, G8, G10 and G13 show more limited and variable connections. Some groups are showed as follows:

Very Strong correlations (≥ 0.70 or ≤ -0.70): G1, G3, G7, G9 show very strong positive correlations with most variables (Cus, Infr, Ship, Qual, Trac, Time), indicating consistent relationships. G12 exhibits very strong negative correlations with most variables, reflecting inversely proportional relationships. Considerably, the unexpected result in G12 is caused by the normalized dataset of low values from Brunei Darussalem, Malaysia, Thailand, especially Singapore. To gain deeper insight, Singapore is famous for an international transshipment hub of the world but its extensive port activities and the environmental footprint of resource imports through maritime logistics are key factors behind its poor performance in achieving SDG12. Brunei Darussalem's low SDG12 score is primarily due to its heavy reliance on imported goods and significant food waste during the import process. Besides, Thailand and Malaysia's low SDG12 scores stem from their focus on agricultural production, reliance on non-recyclable packaging, and limited adoption of renewable energy. Therefore, the negative correlations in SDG Goal 12 indicate that logistics activities related to production and consumption in ASEAN are narrowly focused on development and remain unsustainable.

Strong correlations (0.50 to 0.69 or -0.50 to -0.69): G11, G13 have strong positive and negative correlations with some variables (Cus and Time).

Weak correlations (0.20 to 0.49 or -0.20 to -0.49): G2, G6, G8, G10 is weakly correlated across variables.

Based on the above results, it is concluded that the increasing logistics performance can greatly impact on the population well-being, accessibility, new energy approach, infrastructure formation, and sustainable production and consumption (G1, G3, G7, G9, G12) in ASEAN countries. Some recommendations are proposed to promote sustainable logistics in ASEAN, including: (1) building green logistics models with transport networks powered by renewable energy; (2) adopting digitalization through modern technologies; (3) fostering the circular economy; and (4) enhancing regional integration in environmental policies.

5. Discussions

The study contributes to solve two key research questions. Accordingly, the increasing logistics performance can greatly impact on the population well-being, accessibility, new energy approach, infrastructure formation, and sustainable production and consumption (G1, G3, G7, G9, G12) in ASEAN countries. However, it is surprising that G12 shows the very strong negative correlations, which means logistics performance decreases sustainable production and consumption in ASEAN.

The study not only contributes the review of SDGs and LPI but also a background for national policymakers in the region to develop the sustainable logistics. Moreover, the study needs further research due to the limitation of

the input data in ASEAN countries.

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Received **07 December 2024**

1st Revised **30 December 2024**

Accepted **30 December 2024**