Decision Science Letters 12 (2023) 671–684

Contents lists available at GrowingScience

Decision Science Letters

homepage: www.GrowingScience.com/dsl

The impact of the logistics performance index on global trade volume between the republic of Korea and major GVC reconfiguration participants in ASEAN

Seongsuk Park[a,b*], Edhie Budi Setiawan[c], Zaenal Abidin[d] and Prasadja Ricardianto[e]

[a]*Master's Student of Institute of Transportation and Logistics Trisakti, Jakarta, Indonesia*
[b]*Manager of Korea Trade-Investment Promotion Agency (KOTRA), The Republic of Korea*
[c]*Head of Ph.D Program of Institute of Transportation and Logistics Trisakti Graduate School, Jakarta, Indonesia*
[d] *Secretary of Magister Management Program of Institute of Transportation and Logistics Trisakti Graduate School, Jakarta, Indonesia*
[e]*Director of Institute of Transportation and Logistics Trisakti, Jakarta, Indonesia*

C H R O N I C L E

Article history:
Received: June 2, 2023
Received in revised format: August 1 , 2023
Accepted: August 12, 2023
Available online: August 12, 2023

Keywords:
Logistics performance index (LPI)
Global value chain (GVC)
Reconfiguration
Gravity model
International Trade

A B S T R A C T

Logistics' significance in international trade is being noted more and more frequently. This study was conducted to analyze the influence of logistics performance on trade volume between the Republic of Korea (ROK) and member states of the Association of Southeast Asian Nations (ASEAN) in order to identify the areas of the Indonesian logistics industry that require improvement to increase trade volume between Indonesia and the ROK. This study focuses on Indonesia, Vietnam, Malaysia, Thailand, and the Philippines, which are actively responding to the reconfiguration of the global value chain (GVC). The report also includes Cambodia, Laos, and Myanmar, which can be viewed as potential GVC competitors of Indonesia due to their considerable manufacturing growth potential. Based on the gravity model, which explains trade volume between regions, this study looked into the effect of the logistics performance index (LPI) of these ASEAN nations on trade with the ROK by analyzing panel data. This study utilized previously published (secondary) data to derive new outcomes. Most of the statistical data were extracted from the World Bank database, IHS Markit, and Euromonitor. The results show that an improvement of LPI can lead to growth in the trade volume between ROK and ASEAN Nations including Indonesia. The study's insights suggest which logistical areas Indonesia should focus on developing in order to boost trade with ROK and obtain a competitive edge in the GVC reconfiguration.

© 2023 by the authors; licensee Growing Science, Canada.

1. Introduction

This study aims to analyze whether gravity model factors and logistic model factors affect the trade volume between ROK and ASEAN GVC countries. Logistics' significance in international trade is being noted more and more frequently. The global turnover of the trade-related logistics sector generates $4.3 trillion each year. Specifically, logistics is one of the most influential elements on national competitiveness and economic growth (Arvis et al., 2018). Since the proportion of logistics costs in trade transactions is very high, the establishment of an efficient logistics system can reduce trade costs and expand commerce. Logistics can also play a role in strengthening weaker parts of the supply chain. Hence, it is critical to evaluate and institutionalize how efficiently products are being shipped abroad. In particular, the Organization for Economic Co-operation and Development (OECD) predicts that the GVC will expand further due to the increase in the middle class's consumption power in emerging countries and the appearance of new low-cost producing countries in the manufacturing sector (De Backer & Flaig, 2017).

* Corresponding author. Tel.: +6281228127141
E-mail address: abidin.zaenal103@gmail.com (Z. Abidin)

© 2023 by the authors; licensee Growing Science, Canada.
doi: 10.5267/dsl.2023.8.002

In this situation of GVC reconfiguration, countries that have achieved logistics innovation will attract more investment from global companies in the future. This is because establishing an efficient logistics environment and system in global commerce makes it possible to reduce trade costs and increase trade volume. A large portion of the costs of international trade is spent on transportation and logistics activities to transport goods (KO HEECHAE, 2019). In order to establish an efficient logistics environment and system, an accurate assessment of the logistics environment should be prioritized. The World Bank publishes a logistics index that qualitatively evaluates each nation's logistics performance by surveying its trade and logistics experts (WORLD BANK, 2022).

There are two types of logistics performance indexes (LPIs): the domestic and the international. In this study, international indicators were used to analyze the effect on international trade. The international LPI is composed of 6 sub-categories and a total score. Details include customs clearance, logistics infrastructure, shipment, logistics services, punctuality, and item tracking. This study examined the logistics environment of major ASEAN countries that are emerging as the Republic of Korea (ROK)'s leading economic partners in the context of GVC reconfiguration using the LPI provided by the World Bank from 2007 to 2021. The results analyze the effect of logistics performance on trade volume between ROK and major ASEAN countries, including Indonesia, Vietnam, Thailand, Malaysia, the Philippines, Cambodia, Laos, and Myanmar, which are in the spotlight as part of the process of GVC reconfiguration (KO HEECHAE, 2019). For the sake of convenience, the relevant country was defined as the "ASEAN GVC" country.

There are not many previous studies on trade volume between ROK and ASEAN GVC countries, especially in relation to the effect of the LPI on trade volume. This study establishes that the gravity model has a significant effect on the analysis of trade volume between ROK and ASEAN GVC countries. Also, the LPI plays an important role in the change in trade volume between countries. Therefore, this study is meaningful in that the LPI can be used as a theoretical basis for the development of the logistics industry in terms of policy. Practically speaking, the LPI can be used in the GVC reconfiguration strategy of global companies. Global enterprises, including major Korean ones such as Samsung, Hyundai, LG, Lotte, and POSCO, are actively reconfiguring their GVCs. Global companies can use the findings of this study to help select regions for GVC reconfiguration.

In addition to the above result, the research may offer insights to the government of Indonesia about necessary parts of the logistics field to increase trade between ROK and Indonesia. It is because gravity models and logistics performance indicators have been studied a lot in the past, no research has been conducted for the purpose of increasing trade between ROK and Indonesia.

The Indonesian government is supporting a number of programs to enhance the nation's logistics system. The national mid- to long-term development plan (RPJMN 2020–2024) includes the construction of logistics infrastructure, as well as a digital platform (The government of Indonesia, 2020). The plan has been operational since September 2020 to improve logistical capabilities by declaration of 'Presidential Instruction No. 5' (The Government of Indonesia, 2020). The Indonesian government is also upgrading the port infrastructure close to the industrial complex and developing the Tanjung Priok port facility close to Jakarta, the country's capital (The government of Indonesia, 2020). Considering above policy trends, the Indonesian government can also use the results as a basis for policy to gain an edge in the competition for GVC reconfiguration among ASEAN GVC countries. One of the promising GVC targets for ROKn businesses is Indonesia. However, ROKn businesses have considered the possibility of reconfiguring their supply chains to include not only Indonesia but also other ASEAN countries like Vietnam and Malaysia that may serve as production hubs. In order for Indonesia to gain an edge in the competition for GVC reconfiguration with other nations, various efforts will be required, such as studying logistics variables. By examining the logistics variables that affect trade between ASEAN GVC countries and ROK, it is possible to identify the logistics areas that Indonesia needs to focus on.

2. Theoretical basis

2.1. Logistic performance index (LPI)

The LPI is a measurement tool developed by the World Bank to facilitate the identification of challenges and opportunities in trade and logistics performance and what can be done to improve performance. An LPI is developed using the weighted average after administering a survey on the status of logistics to trade and logistics experts in each country and aggregating the results. By calculating the average based on the numbers provided by trade and logistics specialists, logistics performance indicators are developed. Positive or successful cases receive a maximum of 5 points, and negative or insufficient cases receive a minimum of 1 point. Principal component analysis (PCA) is used to combine the scores for the six sub-items of the LPI into a single score (Hoekman, 2010). Traded products are classified as general products. Products that require special management, such as pharmaceuticals and hazardous goods, are not included in the survey data. LPI survey targets include freight forwarders, express carriers, and logistics providers.

The LPI consists of six specific items and a total score. Detailed indicators are divided by the World Bank into two categories: input and output. Output indicators include the ease of shipment, the ability to track goods, and timeliness of delivery, whereas input factors include customs clearance, logistical infrastructure, and services capacity (Lim & Jun, 2019). The six LPIs can be divided into two types according to their characteristics. The first involves policy regulation, which represents the key inputs to the supply chain (customs, infrastructure, and services). Then comes the output of supply chain performance (the response to LPI metrics for time, cost and reliability, timeliness, and international delivery). Specific details include the ease of customs clearance (customs), the environment for logistics infrastructure (infrastructure), the capability and quality of logistics services, the simplicity of shipping at a competitive price (shipment), the ability to track cargo in transit (tracking and tracing), and timeliness, which refers to on-time delivery (Jaramillo, Carlos Felipe, et al., 2018). Six logistics performance indicators were released by the World Bank for 2007, 2010, 2012, 2014, 2016, and 2018. The World Bank has not released any new logistical performance indicators as of June 30th, 2022, although the market research firm Euromonitor processed World Bank data and published logistical performance indicators from 2019 to 2021. As a result, the analysis in this study was based on the most recent statistical data released by Euromonitor in 2021.

Table 1
LPI evaluation items

Category	Definition
Customs clearance (CUST)	The efficiency of customs and border management clearance
Logistics infrastructure (INFR)	The quality of trade-and transport-related infrastructure
Logistics services (LOGS)	The competence and quality of logistics services
Shipment of goods (ITRN)	The ease of arranging competitively priced international shipments
Timeliness (TIME)	The frequency with which shipments reach consignees within the scheduled or expected delivery time
Item tracking (TRAC)	The ability to track and trace consignments
Overall (OVRL)	Comprehensive evaluation

2.2. The gravity model

The gravity model is an analytical tool that uses Newton's law of gravity to describe the flow of trade between two countries by considering elements like the size of each nation's economy and their distance from one another. The physics theory, which states that the force of attraction between two bodies is proportional to the product of their mass and inversely proportional to the square of the distance between them, was applied to the international model (Anderson, 1979). The basic premise of the gravity model is that the trade volume (exports + imports) between two countries is proportional to the product of their GDP, and inversely proportional to the distance between them (Wang & Choi, 2018). This can be expressed simply in the following basic equations and examples (Evenett & Keller, 2022). According to Frankel and Rose (2002), the volume of bilateral trade decreases by 1% for every 1% increase in distance (Frankel & Rose, 2002). Limao and Venables (2001), who analyzed transportation costs using the port of Baltimore in the US, found that a 10% increase in transportation costs results in a 20% loss in trade volume (Limao & Venables, 2001).

The main principle of the gravity model is that the volume of trade between two countries increases in proportion to market economic variables such as GDP per capita and population, while the amount of trade between them declines as they continue to trade (Ahn, 2021). The distance between two countries also reflects differences in their legal systems, currencies, and cultural and religious systems (Anderson & Van Wincoop, 2004). The gravity model was initially criticized for having no theoretical underpinnings, but since the late 1970s, there has been active research, and the theoretical foundation has been strengthened by success in deriving gravity models like the Ricardo model, the Heckscher-Ohlin model, and the monopolistic competition model.

The gravity model's explanatory capacity is constrained, nevertheless, if all potential trade barriers in international trade are transformed into geographic distances and examined. In order to better understand the logistics environment, costs, systems, and infrastructure involved in global commodities trading, this study examines the LPI released by the World Bank. Panel data combining cross-sectional and time series data are mainly used for gravity model analysis. Analysis through panel data provides more information and variability compared to cross-sectional and time-series data, thereby obtaining a more efficient estimator. It also has the advantage of being able to consider unobserved heterogeneity in the model.

3. Research Method

3.1. Conceptual Framework

The LPI is a measure in the gravity model that is frequently used in studies that analyze the volume of trade between countries. Marti et al. employed a gravity model to explore the impact on commodities exports, utilizing the LPI as an

observation variable. They found that the LPI variable significantly affected growth in exports, and that the LPI variable's coefficient value was higher than that of the geographic distance variable, indicating that logistics performance had a greater impact on commodities trade than the latter (Martí et al., 2014).

Compared to previous research, this study looked at the effect of the LPI on trade volume between ROK and ASEAN GVC countries based on the gravity model as in previous research. The research limited several variables affecting the volume of international trade such as global economic growth, free trade agreements between countries, currency exchange rates, and international oil prices (Korea International Trade Association, 2008) in order to concentrate analysis of the effect of LPI's on the trade volume. The gravity model, a representative research model that assesses trade volume between countries, was utilized to analyze trade volume. With this model, the representative variables affecting international trade, including distance, gross domestic product (GDP) per capita, and population, were extracted as variables. Further, by extracting the LPI developed by the World Bank as a variable, the effect on international trade was examined. After that, the effect of each LPI on trade between countries was compared with Indonesia's logistics index, and the logistics areas that Indonesia should focus on were identified. In sum, the variables used in this study were derived from the gravity model (distance, GDP per capita, population) and the LPI. Other variables affecting international trade volume were excepted from this study.

As a result, six indicators comprising the LPI were selected as independent variables, including GDP per capita, distance from ROK, and population, which are significant components of the gravity model. Through this, an LPI that has a significant impact on trade volume was derived, and by comparing it to the Indonesian logistics situation, areas of the logistics sector that require development in order to boost trade with ROK were analyzed from the Indonesian perspective.

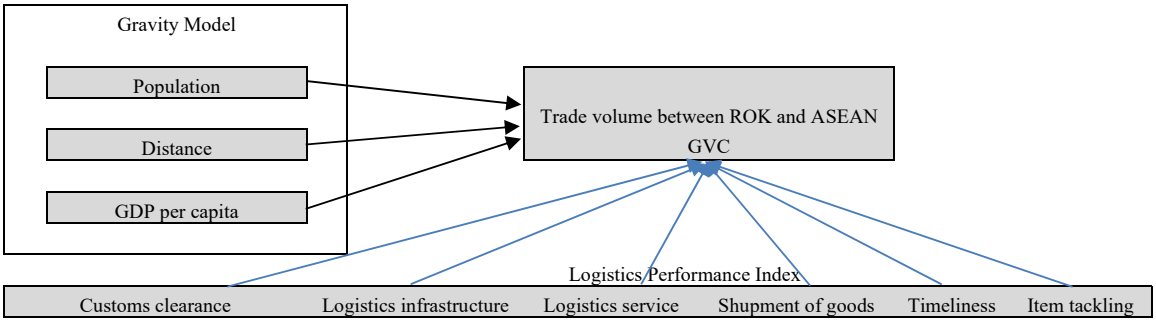

Fig. 1. Conceptual Research Model

3.2. Hypotheses

Several studies have attempted to analyze the effect of the LPI on international trade volume using the gravity model. The outcomes of previous studies were referred to for establishing the hypotheses of the study. A previous study (Lim & Jun, 2019) which analyzed the effect of the LPI on international trade volume between ROK and its major trading partner was mainly referred to in the study. Based on the gravity model, LPI was added in addition to trade volume, GDP, distance, and proximity to the coast in that study. Through this, the study established the effect of the LPI, as well as whether the gravity model works effectively in analyzing trade volume. In conclusion, those results were helpful to extract the assumption of the relationship between LPI and trade volume between countries. The relationship between the influence of model factors and LPI was also referred to in a study that investigated the impact of the 2021 LPI and the Korea-ASEAN FTA on trade volume between ROK and ten ASEAN nations (Ahn, 2021). This study examined the effect of the LPI and FTA on trade volume based on the gravity model. Along with the basic variables of the gravity model (e.g., population, GDP, distance, etc.), the LPI and the fact of whether an FTA was signed or not were set as additional variables.

Looking at these past cases, it is possible to assume that the growth of trade volume between ROK and ASEAN GVC countries would accelerate in case the influence of model factors (except for distance factors) and LPI increase. It means that changes in GDP and population will have a positive effect on trade volume between ROK and ASEAN GVC countries. This is because population is a variable representing the size of the market, and as the market size between ROK and an ASEAN GVC nation expands, the trade volume between the two countries will increase. Thus, the rise in GDP and population (POP) between ROK and a given ASEAN GVC country is expected to increase the demand for goods traded between ROK and that country, so a positive sign is expected. A negative sign is anticipated as the trade volume is significantly impacted by the increased distance between ROK and ASEAN GVC countries, as well as by the high costs of transportation and logistics. Physical separation is a factor that the gravity model considers to be a representative trade barrier. If the LPI is positive, it boosts the trade volume between two countries. The LPI means the capability of logistical areas (customs clearance, logistic infrastructure, logistics service, shipment of goods, timeliness, item tracking) of each country.

With those insights from previous research, the hypotheses of the study were set as follows.

H_1: *The influence of model factors and customs clearance impact trade volume between ROK and ASEAN GVC countries*.
H_2: *The influence of model factors and logistic infrastructure impact trade volume between ROK and ASEAN GVC countries.*
H_3: *The influence of model factors and logistics services impact trade volume between ROK and ASEAN GVC countries.*
H_4: *The influence of model factors and the shipment of goods impact trade volume between ROK and ASEAN GVC countries.*
H_5: *The influence of model factors and timeliness impact trade volume between ROK and ASEAN GVC countries.*
H_6: *The influence of model factors and item tracking impact trade volume between ROK and ASEAN GVC countries.*
H_7: *The influence of model factors and overall LPI impact trade volume between ROK and ASEAN GVC countries.*

This study did not collect new data, but rather analyzed previously published (secondary) data to derive novel outcomes. Therefore, it was possible to proceed with data collection regardless of the location and time of the study. Most of the statistical data (LPI, GDP per capita, population size) were extracted from the World Bank database opened to the public in 2022. The LPI was extracted from a market research institute. Euromonitor in 2022 as well. The data of trade volume between ROK and a given ASEAN GVC country were from IHS Markit, which is a research institute in 2022. Distance data were from google search in 2022. All studies utilized quantitatively measured data.

Research variables such as GDP per capita, population, distance, and the LPI are all quantified data. The LPI was through the World Bank survey administered to logistics experts in each country. However, since the results of the qualitative survey were transformed into quantitative figures (INDEX), they can also be regarded as quantitative data. Data analysis was performed using a software called EViews. The hypotheses, developed in advance, were verified along with the outcomes. Based on the results of testing the hypothesis, conclusions were drawn. The trade volume between ROK and eight ASEAN GVC countries was extracted from IHS Markit (IHS MARKIT, 2022). Per capita GDP, distance from ROK, and population were extracted based on the gravity model from the World Bank and IHS Markit. Further, the LPI of each country was extracted from Euromonitor and the World Bank. In sum, there are 15 pieces of data for each variable. ROK is a fixed partner, and there are eight ASEAN GVC countries, 11 measurement variables and 15 years, and 1,320 pieces of data. The eight ASEAN GVC countries used in the study are competing with Indonesia for GVC reconfiguration in the ASEAN region, as previously described (KO HEECHAE, 2019). All data in this research were downloaded from the appropriate website and reprocessed for this study. The definition of each variable is as follows.

Table 2
The definitions of the variables

Variables	Description
Trade volume (Trade)	Total trade volume between ROK and each ASEAN GVC country
GDP scale (PGDP)	The multiple scales of GDP per captia between ROK and each ASEAN GVC country
Population size (POP)	The multiple scales of population between ROK and each ASEAN GVC country
Logistic performance index (LPI)	Specific logistic performance index (including overall score)
Distance (DIS)	Airline distance between ROK and each ASEAN GVC country's capital

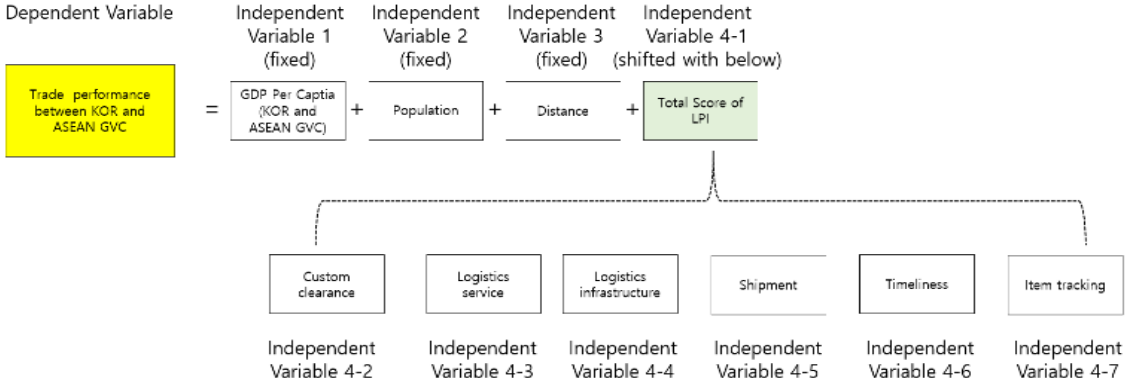

Fig. 2. The model of multiple regression analysis

The data used are panel data that include a time series, which shows the flow of time, and cross-sectional data that lists several analysis targets in parallel. 'Trade volume (Trade)' means the total trade volume between ROK and each ASEAN GVC country. 'GDP scale (GGDP)' implies multiple scales of GDP per capita between ROK and each ASEAN GVC country. 'Population size (POP)' stands for the multiple scales of population between ROK and each ASEAN GVC country. 'Logistic Performance Index (LPI)' means that the specific LPI includes the overall score of each ASEAN GVC country. There are 6 specific LPIs and an overall score. Lastly, 'Distance (Dis)' is the airline distance between ROK and each ASEAN GVC country's capital. All descriptions except for LPI are based on the gravity model. The dependent variable is 'Trade' which indicates the change in trade volume between ROK and an ASEAN GVC country. The independent variables are 'PGDP', 'POP' 'DIS' and 'LPI' as described above. The dependent variable was set as the amount of trade between ROK and a given ASEAN GVC country. As independent variables, PGDP, POP, and DIS were fixed based on the gravity model. Then, the LPI, the main variable of this study, was added as an independent variable. There are six LPIs for each field. Including the total LPI, research was conducted seven times.

The analysis targets clarify how each of the six indicators and the total indicator of LPI affect existing trade volume. First, the effect of the total score of logistics performance on the volume of trade was examined. Next, individual indicators (such as customs clearance and logistics infrastructure) were substituted into the existing model to analyze the impact. The coefficient values of all variables were converted to natural logarithms before data analysis because the unit is different for each variable and large. In addition, this is meant to examine the effect of a 1% change in the independent variable on the dependent variable as the elasticity coefficient. After all variables were transformed using natural logarithms, multiple regression analysis was performed using EViews. In sum, each of the seven LPIs were combined with fixed independent variables to determine the effect on trade volume. Thus, seven regression analyses were performed. This study analyzed panel data from 2007 to 2021. When analyzing the panel data, several tests were performed to select a model more suitable for the study's purpose among the common effects model and the fixed effects model and the random effects model. Three models—the common effects model (the OLS regression model), the fixed effects model, and the random effects model—were used for panel data analysis (Wooldridge, 2015). When performing regression analysis using EViews, the most appropriate model was selected and employed according to the criteria below.

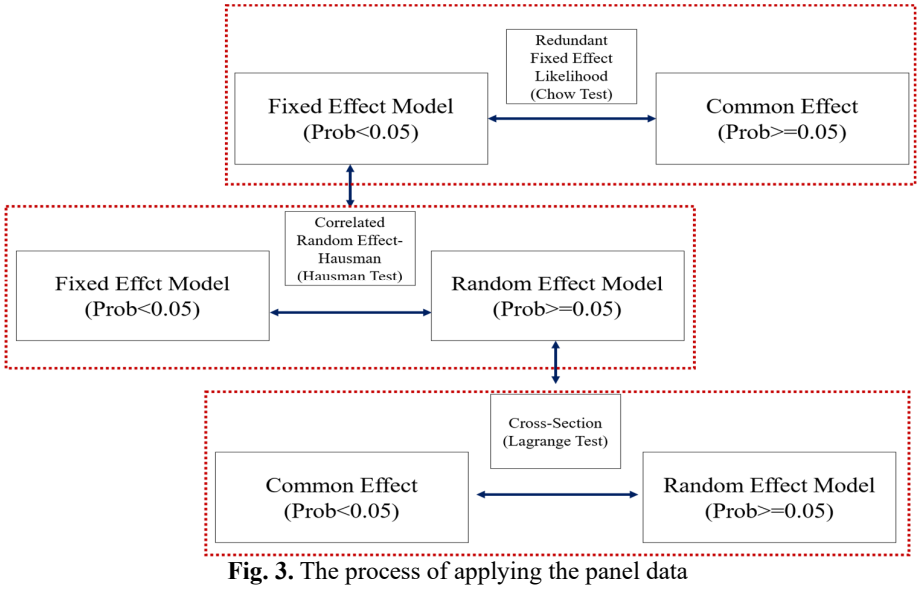

Fig. 3. The process of applying the panel data

The common effects model was used in the panel data regression analysis because the fixed effects model cannot be applied as the distance (Dis) variable has the same value. Some previous studies have substituted distance variables with other variables or applied the random effects model in order to overcome criticism against the power of explanation of the common effects model (Lim & Jun, 2019). In this study, the Lagrange test was performed to select an appropriate model between the common effects model and the random effects model, and the common effects model was found to be more suitable for analysis.

In this study, multiple regression analysis with panel data was carried out. From 2007 to 2021, trade volume between ASEAN GVC countries and ROK was designated as a dependent variable. In addition, the number of populations between each country and ROK, GDP per capita, distance, and the LPI were designated as independent variables. In the gravity model using panel data, the coefficient values of the variables were adjusted through natural logarithms. This refers to the effect of a 1% change in the independent variable on the dependent variable as the elasticity coefficient. The data used are as follows.

Table 3
Description of the data (variables)

Variable(s)	Description
Tradei jt	Trade volume of goods between ROK (i) and the ASEAN GVC partner (j) (at time t)
(PGDPi × PGDPj)t	GDP per capita between ROK (i) and the ASEAN GVC partner (j) (at time t)
(POPi × POPj)t	Population between ROK (i) and the ASEAN GVC partner (j) (at time t)
DISij	Distance between ROK (i) and the ASEAN GVC partner (j)
LPIjt	The ASEAN GVC partner's LPI at time t
εijt	Error term

The LPI was obtained from the World Bank and Euromonitor. The World Bank was also able to provide data on the size of GDP between two given countries. Data on the distance between ROK and ASEAN GVC countries were found through a website called Korea2me.com through a Google search. Trade volume between ROK and Indonesia was used as a dependent variable, and IHS Markit was referred to for this purpose. The data on distance were extracted from Korea2Me.com (Korea2Me, 2022). The distance was measured between Seoul, ROK's capital, and the capital of each ASEAN GVC country. The World Bank administered its survey and released the LPI six times in 2007, 2010, 2012, 2014, 2016, and 2018. Euromonitor announced the LPI from 2007 to 2021 based on these figures. Therefore, this study used the data released by Euromonitor. The trade volume between ROK and eight ASEAN GVC countries was extracted from IHS Markit. Per capita GDP, distance from ROK, and population were extracted based on the gravity model from the World Bank and IHS Markit. Further, the LPI of each country was extracted from Euromonitor and the World Bank. In sum, there are 15 pieces of data for each variable. ROK is a fixed partner, and there are eight ASEAN GVC countries, 11 measurement variables and 15 years, and 1,320 pieces of data.

4. Research Results and Discussion

Logistics performance indicators were used as observation variables. Scores for customs, infrastructure, shipping, logistics services, cargo tracking, and timeliness were individually analyzed with separate research models. In addition, the total score, which is the average of each item, was used as a variable for analysis. Since the coefficient value of each variable in the gravity model takes the natural logarithm, it becomes the elasticity coefficient. This study utilized panel data, as described above. EViews, a professional statistical program, was used to examine the panel data. The multiple regression analysis equation using the panel data is as follows. Since the coefficient value of each variable in the gravity model takes the natural logarithm, it becomes the elasticity coefficient.

$$Ln(Trade_{ijt}) = \beta_0 + \beta_1 Ln(PGDP_i \times PGDP_j)_t + \beta_2 Ln(POP_i \times POP_j)_t + \beta_3 Ln(DIS_{ij}) + \beta_4 Ln(LPI_{jt}) + \varepsilon_{ijt}$$

Fig. 4. The multiple regression analysis equation

Based on the gravity model, other independent variables were fixed and each of the six logistics performance indicators and one overall score were substituted into the equation to examine the effect of the corresponding LPI on trade volume.

4.1. Do gravity model factors and customs clearance (LPI) impact trade volume between ROK and ASEAN GVC countries?

Since the distance value did not change, the fixed effects model could not be used. Hence, the Lagrange test was performed to compare the common effects model and the random effects model. If the probability value of both is bigger than 0.1, then the data are suitable for analysis using the random effects model. However, the data are smaller than 0.1, so they are suitable for analysis using the common effects model. The results are as follows.

Table 4
The research results (LPI_Customs)

Variable	Coefficient	Probability	Std. Error	T-statistic	R-squared	F-statistic	Prob (F-statistic)	Durbin-Watson Statistic
C	-26.81	0.00	3.58	-7.49	0.88	218.62	0.00	0.19
PGDP	0.47	0.00	0.11	4.27				
POP	1.10	0.00	0.59	18.69				
DIS	-0.38	0.35	0.40	-0.94				
LPI_CUST	4.75	0.00	0.66	7.22				

It is needed to clarify the definition of 'Coefficient' and 'Prob' for analyzing the result. If a 'coefficient' of independent variables changes by 1%, the trade volume between ROK and ASEAN GVC nations, which is dependent variable, will be changed by the percent of specific value of the coefficient of each independent variable in case the 'Prob' is smaller than 0.05 in the 95% significant level. R-squared is a statistical measure that represents the proportion of the variance for a

dependent variable that's explained by an independent variable or variables in a regression model. Generally, a higher r-squared value indicates more variability. The analysis of the result was conducted with the definition above. First, the effects of the variables extracted from the gravity model on trade volume were examined. Except for the distance variable, all variables showed results that met the basic assumptions of the gravity model. Looking at the findings, we can see that an increase in GDP per capita and population has a positive effect on trade volume. For example, if the population increases by 1%, the trade volume between ROK and each ASEAN GVC countries will boost by 1.10%. As the distance increased, it appeared to have a negative effect on trade volume, but it did not have statistical significance due to a high probability value. Next, an analysis was performed of the LPI's effect on trade volume. The coefficient value of the customs clearance score showed a positive value of 4.75 at the 5% significance level. This means that as the customs clearance score increases by 1%, the trade volume of goods increases by 4.75%. These results imply that an increase in the customs clearance score affects the increase in trade in goods.

4.2. Do gravity model factors and logistics infrastructure (LPI) impact trade volume between ROK and ASEAN GVC countries?

As a result of the Lagrange test to compare the common effects model and the random effects model, the common effects model is more convincing than the random effects model. If the probability value of both is bigger than 0.1, the data are suitable for analysis using the random effects model. However, the data are smaller than 0.1, so they are suitable for analysis using the common effects model. The results are as follows.

Table 5
The research results (LPI_Infrastructure)

Variable	Coefficient	Probability	Std. Error	T-statistic	R-squared	F-statistic	Prob (F-statistic)	Durbin-Watson Statistic
C	-18.33	0.00	3.93	-4.67				
PGDP	0.29	0.02	0.12	2.42				
POP	1.03	0.00	0.06	17.41	0.89	230.88	0.00	0.18
DIS	-0.72	0.07	0.39	-1.86				
LPI_CUST	4.63	0.00	0.60	7.77				

First, the effects of the variables extracted from the gravity model on trade volume were examined. Except for the distance variable, all variables showed results that met the basic assumptions of the gravity model. Looking at the outcomes, we can see that an increase in per capita GDP and population has a positive effect on trade volume. As the distance increased, it appeared to have a negative effect on trade volume, but the probability value was high, so it did not have statistical significance. However, it could be significant at the 90% level. Next, an analysis was performed of the effect of the LPI on trade volume. Looking at the results using the logistics infrastructure score as a variable among the LPIs, most variables revealed significant results at the 5% significance level, similar to the customs clearance score. As for the outcomes of the logistics infrastructure score, the values of the GDP and POP variables were positive in the same way as the results of the customs clearance variable. Also, geographic distance appeared negative. The coefficient value of logistics infrastructure, an observational variable, was 4.63, which was positive at the 5% significance level. This means that as the logistics infrastructure score increases by 1%, the trade volume of goods increases by 4.63%.

4.3. Do gravity model factors and logistics services (LPI) impact trade volume between ROK and ASEAN GVC countries?

As a result of the Lagrange test to compare the common effects model and the random effects model, the common effects model is more convincing than the random effects model. If the probability value of both is bigger than 0.1, the data are suitable for analysis using the random effects model. However, the data are smaller than 0.1, so they are suitable for analysis using the common effects model. The results are as follows.

Table 6
The research results (LPI_LOGS)

Variable	Coefficient	Probability	Std. Error	T-statistic	R-squared	F-statistic	Prob (F-statistic)	Durbin-Watson Statistic
C	-21.70	0.00	3.70	-5.87				
PGDP	0.27	0.03	0.12	2.16				
POP	1.01	0.00	0.06	16.76	0.89	233.23	0.00	0.19
DIS	-0.28	0.47	0.39	-0.73				
LPI_CUST	5.45	0.00	0.69	7.88				

First, the effects of the variables extracted from the gravity model on trade volume were examined. Except for distance, all variables showed results that met the basic assumptions of the gravity model. Looking at the findings, we can see that an increase in per capita GDP and population has a positive effect on trade volume. As distance increased, it appeared to have a negative effect on trade volume, but the probability value was high, so it did not have statistical significance. Next, an analysis was performed of the effect of the LPI on trade volume. The coefficient value of logistics services, an observation variable, showed a positive value of 5.45 at the 5% significance level. This means that as the logistics services score increases by 1%, the trade volume of goods increases by 5.45%.

4.4. Do gravity model factors and the shipment of goods (LPI) impact trade volume between ROK and ASEAN GVC countries?

As a result of the Lagrange test to compare the common effects model and the random effects model, the common effects model is more convincing than the random effects model. If the probability value of both is bigger than 0.1, the data are suitable for analysis using the random effects model. However, the data are smaller than 0.1, so they are suitable for analysis using the common effects model. The results are as follows.

Table 7
The research results (LPI_ITRN)

Variable	Coefficient	Probability	Std. Error	T-statistic	R-squared	F-statistic	Prob (F-statistic)	Durbin-Watson Statistic
C	-29.03	0.00	3.55	-8.18				
PGDP	0.40	0.00	0.12	3.28				
POP	1.06	0.00	0.06	17.27	0.89	212.67	0.00	0.15
DIS	0.21	0.61	0.41	0.51				
LPI_CUST	4.56	0.00	0.66	6.94				

First, the effects of the variables extracted from the gravity model on trade volume were examined. Except for distance, all variables showed results that met the basic assumptions of the gravity model. Looking at the outcomes, we can see that an increase in per capita GDP and population has a positive effect on trade volume. As distance increased, it appeared to have a negative effect on trade volume, but the probability value was high, so it did not have statistical significance. Next, an analysis was performed of the effect of the LPI on trade volume. The coefficient value of the shipment of goods, an observational variable, was 4.56, which was positive at the 5% significance level. This means that for every 1% increase in the shipment of goods score, the trade volume of goods increases by 4.56%. The shipment of goods score gauges the ease of scheduling competitively priced shipments. If the shipment of goods is high, export and import shippers can easily use sea transportation at an economical price; if it is low, this means that shippers are experiencing difficulties in shipping goods for sea transportation. If the global logistics crisis continues, such as the war between Russia and Ukraine after the recent COVID-19 pandemic, workers in the logistics industry will underestimate the performance of the shipment of goods.

4.5. Do gravity model factors and timeliness (LPI) impact trade volume between ROK and ASEAN GVC countries?

As a result of the Lagrange test to compare the common effects model and the random effects model, the common effects model is more convincing than the random effects model. If the probability value of both is bigger than 0.1, the data are suitable for analysis using the random effects model. However, the data are smaller than 0.1, so they are suitable for analysis using the common effects model. The results are as follows.

Table 8
The research results (LPI_TIME)

Variable	Coefficient	Probability	Std. Error	T-statistic	R-squared	F-statistic	Prob (F-statistic)	Durbin-Watson Statistic
C	-25.32	0.00	3.84	-6.59				
PGDP	0.70	0.00	0.10	7.22				
POP	1.02	0.00	0.07	15.59	0.89	199.93	0.00	0.19
DIS	-0.82	0.05	0.42	-1.97				
LPI_CUST	4.57	0.00	0.73	6.29				

Looking at the results using the timeliness index as a variable among the LPIs, all variables showed significant values within the 5% level. All variables except distance displayed the same positive outcome as the assumption. The distance variable

showed negative results. The coefficient value of timeliness, an observation variable, revealed a positive value of 4.57 at the 5% significance level. This means that as the timeliness score increases by 1%, the trade volume of goods increases by 4.57%. The timeliness score measures the frequency with which cargo arrives at the consignee at the scheduled time and within the scheduled period. Like the logistics services score discussed above, the timeliness score can be viewed as an evaluation index of the capability and performance of a logistics company that performs the actual logistics process. Hence, such logistics timeliness has a positive effect on the increase in imports and exports.

4.6. Do gravity model factors and item tracking (LPI) impact trade volume between ROK and ASEAN GVC countries?

As a result of the Lagrange test to compare the common effects model and the random effects model, the common effects model is more convincing than the random effects model. If the probability value of both is bigger than 0.1, the data are suitable for analysis using the random effects model. However, the data are smaller than 0.1, so they are suitable for analysis using the common effects model. The results are as follows.

Table 1
The research results (LPI_TRAC)

Variable	Coefficient	Probability	Std. Error	T-statistic	R-squared	F-statistic	Prob (F-statistic)	Durbin-Watson Statistic
C	-26.55	0.00	3.99	-6.65				
PGDP	0.62	0.00	0.12	5.34				
POP	1.02	0.00	0.07	14.79	0.89	182.57	0.00	0.13
DIS	-0.26	0.55	0.43	-0.59				
LPI_CUST	3.19	0.00	0.61	5.27				

First, the effects of the variables extracted from the gravity model on trade volume were examined. Except for distance, all variables showed results that met the basic assumptions of the gravity model. Looking at the outcomes, we can see that an increase in per capita GDP and population has a positive effect on trade volume. As distance increased, it appeared to have a negative effect on trade volume, but the probability value was high, so it did not have statistical significance. Next, an analysis was performed of the LPI's effect on trade volume. The coefficient value of item tracking, an observational variable, revealed a positive value of 3.19 at the 5% significance level. This means that the trade volume of goods increases by 3.19% as the item tracking score increases by 1%. The item tracking score measures the tracking capability of consigned cargo, and the current logistics environment can track and check items in transit in real time. This enables companies to accurately check the present location of goods and provides significant advantages in terms of the supply cycle and inventory management. Goods tracking capacity refers to a logistics company's service capacity along with its ability to deliver on time, and is classified as an output index along with the shipment of goods score. Hence, having such a tracking capability has a positive effect on the increase in the trade volume of goods.

4.7. Do gravity model factors and overall LPI impact trade volume between ROK and ASEAN GVC countries?

As a result of the Lagrange test to compare the common effects model and the random effects model, the common effects model is more convincing than the random effects model. If the probability value of both is bigger than 0.1, the data are suitable for analysis using the random effects model. However, the data are smaller than 0.1, so they are suitable for analysis using the common effects model. The results are as follows.

Table 10
The research results (LPI_TOTAL)

Variable	Coefficient	Probability	Std. Error	T-statistic	R-squared	F-statistic	Prob (F-statistic)	Durbin-Watson Statistic
C	-21.59	0.00	3.57	-6.05				
PGDP	0.28	0.02	0.12	2.40				
POP	0.99	0.00	0.06	16.68	0.89	248.11	0.00	0.19
DIS	-0.32	0.40	0.38	-0.84				
LPI_CUST	6.06	0.00	0.71	8.49				

First, the effects of the variables extracted from the gravity model on trade volume were examined. Except for distance, all variables showed results that met the basic assumptions of the gravity model. Looking at the outcomes, we can see that an increase in per capita GDP and population has a positive effect on trade volume. As distance increased, it appeared to have a negative effect on trade volume, but the probability value was high, so it did not have statistical significance. Next, an

analysis was performed of the LPI's effect on trade volume. The coefficient value of the total score, an observation variable, was 6.06, which was positive at the 5% significance level, recording the maximum value in this analysis. This means that for every 1% increase in the total score of the LPI, the trade volume

5. Conclusion and Recommendations

Variables such as distance, per capita GDP, and population extracted using the gravity model emerged as the results assumed in the model. Increases in per capita GDP and population have a positive impact on trade volume between ROK and ASEAN GVC. Distance, which the existing gravity model indicates has a negative influence on trade volume between ROK and ASEAN GVC, also had a negative effect on trade volume in this study. However, distance did not fully demonstrate statistical significance in some of the seven regression analyses. The improvement in logistics performance, which is the objective of this research, has been proven to increase trade volume. The results, utilizing the six sub-items and the overall score of the LPI as observation variables, are consistent with the hypotheses for both sub-items and total score. Each of the logistical performance measures included in the regression had a positive impact on trade, and their reliability exceeded 95%. For every 1% increase in the LPI, the volume of trade between ROK and ASEAN GVC increased by 3–5%. If the entire score of the LPI increased by 1% point, it was predicted that the trade volume between ROK and ASEAN GVC countries would increase by 6.06%. The three top indicators that have the greatest impact on trade volume are: (1) the logistic service index; (2) the customs clearance index; and (3) the logistics infrastructure index. If the logistics services index were to increase by 1%, the trade volume between ROK and ASEAN GVC countries would be expected to rise by 5.45%. Next, if the customs clearance index were to increase by 1%, the trade volume between ROK and ASEAN GVC countries would be expected to rise by 4.75%. If the logistics infrastructure index were to increase by 1%, the trade volume between ROK and ASEAN GVC countries would be expected to rise by 4.63%. As a result of the analysis, the following results were derived.

5.1. Gravity model factors (except for distance) and customs clearance (LPI) significantly impact trade volume between ROK and ASEAN GVC countries. Customs clearance is the second index, which affects trade volume between ROK and ASEAN GVC countries among the six LPIs.
5.2. All gravity model factors and logistics infrastructure (LPI) significantly impact trade volume between ROK and ASEAN GVC countries. Logistics infrastructure is the third index, which has an effect on trade volume between ROK and ASEAN GVC countries among the six LPIs.
5.3. Gravity model factors (except for distance) and logistics services (LPI) significantly impact trade volume between ROK and ASEAN GVC countries. Logistics services is the first index that has an effect on trade volume between ROK and ASEAN GVC countries among the six LPIs.
5.4. Gravity model factors (except for distance) and shipment (LPI) significantly impact trade volume between ROK and ASEAN GVC countries.
5.5 All gravity model factors and timeliness (LPI) significantly impact trade volume between ROK and ASEAN GVC countries.
5.6. Gravity model factors (except for distance) and item tracking (LPI) significantly impact trade volume between ROK and ASEAN GVC countries.
5.7. Gravity model factors (except for distance) and the item's overall score of the LPI significantly impact trade volume between ROK and ASEAN GVC countries.

On the other hand, this study has some limitations. First, only limited variables were used in the analysis of trade volume. The original purpose of focusing on the LPI's effect on trade volume has been achieved. However, in addition to the LPI, there are innumerable variables that can affect trade volume, although they are not covered in this study. The second limitation is that the paper is unable to reflect on the latest logistics status changes since 2021. The most recent LPI published by the World Bank is from 2018. Euromonitor announced LPI statistics based on World Bank data from 2021 (Euromonitor, 2022). The latest logistics trends, which are rapidly changing in diverse situations (such as global supply chain reorganization and regional war after 2021), were not considered. Lastly, there was a limitation on the selection of the model because the value of distance, one of the variables used in the gravity model, was fixed. For this reason, the common effects model (the OLS regression model), which is the basic analysis model of panel data, was used. The common effects model can efficiently analyze data, but autocorrelation and heteroscedasticity problems may occur in the data error terms.

Nevertheless, the LPI was found to have a significant effect on trade volume, so it is expected that this can be used in various ways to strengthen logistics capabilities. In addition, it is expected that future studies will overcome the above mentioned limitations. The top three LPIs that have the greatest impact on trade volume are: (1) the logistics services index; (2) the customs clearance index; and (3) the logistics infrastructure index. Indonesia is in the middle of the ASEAN GVC countries in the areas of logistics services, customs clearance, and logistics infrastructure, which are three variables that have a major impact on trade. GVC reorganization is a situation that requires improvement to gain an edge in the competition and increase trade volume. This study found that policy efforts are needed for Indonesia to gain an edge in the ASEAN GVC competition. In particular, intensive support for policies is needed in the areas of logistics services, customs clearance, and logistics infrastructure.

The logistics services score is a representative output index of the LPI and is related to the capabilities of private logistics companies engaged in the logistics industry, rather than the capabilities of the government. Recently, in the logistics industry, the demand for new types of logistics services such as smart, fulfillment, and cold chain logistics has risen due to the development of ICT. The logistics services score is expected to improve if the government supports enhancement of logistics companies' capacity. The customs clearance score refers to the efficiency of customs. If customs procedures are efficient in doing business, the customs clearance score will be high. Indonesia's customs clearance score is 2.59, which is behind that of its competitors such as Thailand and Vietnam. Continuous improvement efforts from the Indonesian government are needed. The logistics infrastructure score measures the quality of infrastructure related to trade and transportation. The standard deviation of the logistics infrastructure index among ASEAN GVC countries is 0.66, which is the largest standard deviation compared to other indicators at the 5% significance level according to this research. This means that although the establishment of logistics infrastructure is necessary to increase trade volume, there is a large difference in the level of infrastructure between countries. In sum, Indonesia needs to improve its logistics performance compared to other ASEAN GVC countries.

The logistics services index, which has the greatest impact on trade volume, refers to the capabilities and levels of logistics-related service companies. In order to improve the logistics services index, it is necessary to strengthen companies' capacity (they are service subjects) rather than that of the government. Strengthening logistics services capabilities is necessary for all logistics companies. Because of globalization, it is necessary to satisfy the logistics demand of producers and consumers regardless of the market's geographic location. Recently, with the development of ICT in the logistics industry, demand for new logistics services such as smart, fulfillment, and cold chain logistics is increasing. The logistics services index can be improved through capacity development that reflects such demand. In addition, unpredictable uncertainties may arise in the management activities of logistics services companies, such as the temporary container shortage caused by COVID-19 and the Russia-Ukraine war. In this case, the government can indirectly support the capacity building of logistics companies through various policy activities.

The customs clearance index refers to the efficiency of customs clearance in import and export clearance. If the efficiency is high in carrying out business with the government customs office for customs procedures, the customs clearance score will be high; if the efficiency is low, the customs clearance score will be low. An electronic customs clearance system and the implementation of FTAs can enhance the customs clearance index, which should be improved by the government rather than by private companies.

The logistics infrastructure index is an item linked to trade and transportation-related infrastructure quality. Logistics infrastructure includes infrastructure development such as roads, ports, and airports, as well as ICT infrastructure to respond to logistics caused by rapidly increasing e-commerce. Rather than private companies, the government should take the lead in developing logistics infrastructure and sometimes promote development in collaboration with private companies. Fortunately, Indonesia's logistics sector has high growth potential thanks to the rapidly growing e-commerce industry based on its huge population.

It would be expected that this study can provide insights for improving Indonesia's logistics performance and gaining an edge over other countries in GVC competition.

References

Ahn, T. (2021). A Study on the Effect of Logistics Performance on the Trade of Goods in the Korea-ASEAN FTA. *Journal of Korea Port Economic Association, 37*(4), 145-160.

Anderson, J. E. (1979). A theoretical foundation for the gravity equation. *The American economic review*, *69*(1), 106-116.

Anderson, J. E., & Van Wincoop, E. (2004). Trade costs. *Journal of Economic literature, 42*(3), 691-751.

Arvis, J.-F., Ojala, L., Wiederer, C., Shepherd, B., Raj, A., Dairabayeva, K., & Kiiski, T. (2018). Connecting to Compete 2018 : Trade Logistics in the Global Economy. World Bank.

De Backer, K. & Flaig, D. (2017). The Future of Global Value Chains: Business as Usual or A New Normal?. OECD Science, Technology and Innovation Policy Papers, No. 41.

Euromonitor. (2022). Retrieved from https://www.portal.euromonitor.com/statisticsevolution/index

Evenett, S. J., & Keller, W. (2022). On theories explaining the success of the gravity equation. *Journal of political economy, 110*(2), 281-316.

Frankel, J., & Rose, A. (2002). An Estimate of the Effect of Common Currencies on Trade and Income. *The Quarterly Journal of Economics, 117*(2), 437–466.

Hoekman, B. A. (2010). Connecting to compete 2010: trade logistics in the global economy-the logistics performance index and its indicators. Washington DC: World Bank.

IHS MARKIT. (2022). Retrieved from https://connect.ihsmarkit.com/gta/standard-reports

Jaramillo, C. F., Freund, C., Reis, J. G., Arvis, J. F., Wiederer, C. K., Ojala, L. M., ... & Kiiski, T. M. M. (2018). Connecting to compete 2018: trade logistics in the global economy-the logistics performance index and its indicators.

KO HEECHAE. (2019). Strategies for Utilizing Value Chains in Major Southern Countries(신남방 주요국 가치사슬 활용전략). *Korea Trade-Investment Promotion Agency*, 19-100, 4-46.

Korea International Trade Association. (2008). The Impact of International Variables on International Trade(국제변수의 변화가 무역에 미치는 영향). Institute for International Trade of Korea International Trade Association, 5-37.

Korea2Me. (2022). Retrieved from Korea2Me: https://www.korea2me.com/cc/KR-ID

Lim, E. J. & Jun, S. H. (2019). The effects of Logistics Performance Index on International Trade of Korea. *Journal of Korea Port Economic Association, 35*(1), 77-96.

Limao, N., & Venables, A. J. (2001). Infrastructure, geographical disadvantage, transport costs, and trade. *The world bank economic review, 15*(3), 451-479.

Martí, L., Puertas, R. & García, L. (2014). The importance of the Logistics Performance Index in international trade. *Applied economics, 46*(24), 2982-2992.

The government of Indonesia. (2020). Peraturan Presiden(Perpres) tentang Rencaba Pembangunan Janka Menengah Nasional. Retrieved from https://peraturan.bpk.go.id/Home/Details/131386/perpres-no-18-tahun-2020

The government of Indonesia. (2020). Peraturan Presiden(Perpres) tentang Rencaba Pembangunan Janka Menengah Nasional. Retrieved from https://peraturan.bpk.go.id/Home/Details/131386/perpres-no-18-tahun-2020

The Government of Indonesia. (2020). Presidential Instruction No. 5 2020. Retrieved from https://jdih.setkab.go.id/PUUdoc/176124/Inpres_Nomor_5_Tahun_2020.pdf

Wang, M. L., & Choi, C. H. (2018). How logistics performance promote the international trade volume? A comparative analysis of developing and developed countries. *International Journal of Logistics Economics and Globalisation, 7*(1), 49-70.

Wooldridge, J. M. (2015). Introductory econometrics: A modern approach. Cengage learning.

WORLD BANK. (2022). Retrieved from WORLD BANK: https://data.worldbank.org/indicator?tab=all

© 2023 by the authors; licensee Growing Science, Canada. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license (http://creativecommons.org/licenses/by/4.0/).