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Relationship Between Logistics Performance, Trade Volume and Economic Growth

Lojistik Performans, Ticaret Hacmi ve Ekonomik Büyüme Arasındaki İlişki

ÖZ

Lojistik performansının rekabet gücü kazanarak maliyetleri düşürmesi, hizmet kalitesini iyileştirmesi, ticaret hacmini ve ekonomik büyümeyi artırması mümkündür. Şirket kârlılığı artırmak, rekabet avantajı elde etmek için yüksek kaliteli ve verimli lojistiğe öncelik vermeli, ulaştırma, iletişim ve depolamaya yatırım yapmalıdır. Bu çalışmanın amacı, lojistik performansı, ticaret hacmi ve ekonomik büyüme arasındaki ilişkiyi analiz etmektir. Çalışmada kullanılan değişkenlere ilişkin veriler Dünya Bankası ve OECD'nin resmi veri tabanlarından derlenmiş ve Entegre Entropi-TOPSIS MCDS yöntemi kullanılarak analiz edilmiştir. Buna göre, Hollanda'nın en yüksek lojistik performans, ticaret hacmi ve ekonomik büyüme performansına sahip ülke olduğu ve Japonya'nın ise en düşük performansa sahip ülke olduğu tespit edilmiştir.

Anahtar Kelimeler: Lojistik performans, Ticaret hacmi, Ekonomik büyüme, Entropi, TOPSIS

ABSTRACT

Logistics performance can significantly impact competitiveness, cost reduction, service quality improvement, trade volume expansion, and economic growth. To enhance profitability and secure a competitive edge, companies should focus on high-quality, efficient logistics and invest in transport, communication, and storage infrastructure. This study aims to explore the connection between logistics performance, trade volume, and economic growth. Data for this analysis were sourced from official World Bank and OECD databases and evaluated using the Integrated Entropy-TOPSIS MCDS method. The findings reveal that the Netherlands leads in logistics performance, trade volume, and economic growth, while Japan exhibits the lowest performance in these areas.

Keywords: Logistics performance, Trade volume, Economic growth, Entropy, TOPSIS

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1. Introduction

Economic growth is important for both developed and developing countries. As global borders started to diminish and science and technology underwent great development after the 1980s, countries became dependent on each other in terms of the production and trade of goods and services. These developments inevitably brought about certain difficulties, causing countries to be in a cutthroat competitive environment. It has become compulsory to accelerate technological development, increase trade volume, closely follow new developments and techniques, and increase R&D activities to boost global competitiveness. Developments in information and communication technologies, technological progress, and improvements in transportation modes provide cost advantages for local and foreign investors. Additionally, fostering the creation of high value-added goods and services can attract foreign investments to the country. Increasing global competition, widespread globalization, and the disappearance of borders have increased multilateral trade agreements, and therefore the need for more support for logistics activities has emerged (Tang and Abosedra, 2019; Andrejic and Kilibarda, (2014). Due to recent R&D activities and the use of the latest technology, goods, and products with high added value not only provide income for the treasury but also affect economic growth by strengthening foreign relations. Given the positive impact of foreign trade on economic growth, identifying the factors that enhance trade is also crucial for fostering economic development. Information and communication technologies have a determining role on economic growth. (Jorgenson, 2001, Oliner and Sichel, 2004, Pohjola (2001), Munnell (1992), Pohjola (2002)). Theoretically, information and communication technologies affect economic growth in 3 different ways. Accordingly, i) enabling the production of high value-added goods, ii) establishing high-capital business relations with ICT companies, iii) increasing the level of technological development with the multiplier effect on all sectors in the economy.

According to the Keynesian perspective on economics, the existence of underemployment in the economy leads to a current fluctuation independent of the scale of production, while it does not allow for a real increase in potential income or production scale through expansionary monetary or fiscal policies, exchange rates and/or foreign trade policies (Kibritçioğlu: 1998). Endogenous growth models differ from Neoclassical Growth Models in that growth is determined endogenously. They have demonstrated that the rise in per capita income since the Industrial Revolution cannot be solely explained without considering the differences in growth rates between countries driven by technological development. They have attempted to explain the variation in growth rates among countries by taking into account the choices of the public and private sectors. Consequently, the Internal Growth Rate complements other growth theories and continues its analysis by considering research and development at a sectoral or company level or productivity differences (Romer, 1994).

In Modern Foreign Trade Theories, there is a consensus on the positive effect of foreign trade on economic growth and this situation is addressed within the scope of the Export-led growth model. (Medina-Smith, 2001). Export-led growth is a prerequisite for economic development. Although they have different perspectives, the Neoclassical theory stimulates productivity growth by supporting resource utilization through scale economies with the help of export performance (Rami, 1987). Logistics performance is of vital importance in countries where the export-led growth model is implemented. Tang and Abosedra (2029) concluded in their study that there is a strong relationship between economic growth and the logistics sector in export-led economies. Advocates of export-led industrialization strategies highlighted the

disadvantages of the import-substitution industrialization strategy applied from World War II until the 1980s. The success of countries such as Singapore, South Korea, Taiwan and Hong Kong known as the Asian Tigers, achieved through open trade policies has been proven by the failure of India and Latin America which implemented closed-door policies during the same period (Awokuse, 2008). Tang and Abosedra (2019) found evidence that logistics performance supports export-led growth.

Economic development focuses on improving economic, social, and political conditions at the macro level. For less developed countries, the most significant concern is identifying the factors that affect economic growth to improve living standards and industrialization. The involvement of developing countries in global production networks by specializing in specific processes speeds up the economic growth process. Increasing exports and reducing poverty have also emerged as goals in sustainable development (Rodrigue and Notteboom, 2017; Amendolagine et al., 2019).

Recent studies on the determinants of trade suggest that in addition to many macroeconomic variables, such as R&D, technology, and exchange rates, factors that are the results of our time, such as transportation infrastructure, communication networks, and supply chain and logistics management, also have a positive effect on trade volume. In addition to these developments, the production of goods in different geographical regions has made logistics activities more critical. Logistics performance plays a crucial role in global trade not only because of production but also because of the growth and diversification of the market (KPMG, 2019).

The globalization of the production process has also increased the importance of the global supply chain. Port activities have particularly become a crucial component of logistics services. Global competition has driven intensive investments to develop and gain competitive advantages, access resources, and enter new markets. Logistics also encompasses the cost, time, and complexity of conducting international trade activities. For landlocked countries, physical infrastructure is a significant determinant of transportation costs and a component of logistics performance. Technological advancements involve the reconstruction of transportation routes, scales, and frequencies, leading to improved logistics performance. Advanced technologies enable the restructuring of transportation routes, scales, modes, or frequencies, resulting in enhanced logistics performance (Wang and Cullinane, 2006; Hausmann et al., 2013; Helling and Poister, 2000; Limao and Venables, 2001).

The current state of infrastructure is a reflection of the level of development, much like gross domestic product (GDP), gross national income, and general living standards (Developed Economy Definition, 2010). Logistics services serve as a resource for achieving economic growth and supporting exports. Efficient logistics services enhance the global competitiveness of countries (Arvis et al., 2007; Arvis et al., 2010). Logistics performance has an important role in delivering goods to the market. Logistics activities that are not carried out properly increase costs and cause a decrease in trade volume. The quality and efficiency of logistics activities in a country contribute to economic growth and development. As a significant physical input in the process of economic growth, logistics infrastructure not only increases capital accumulation but also leads to an increase in economic growth through technical improvements (Korinek and Sourdin, 2011; Diaz, 2021; Perkins, Fedderke, and Luiz, 2005; Hu et all. (2012), D'Aleo and Sergi, 2017). Consuently the logistics activities carried out, global transportation infrastructures are expanding and transportation is of vital importance in integrating national economies into world economies. The decrease in transportation costs facilitates and increases

global trade. Logistics is considered a tactical resource in gaining global competitive advantage and is also a driving force for economic growth (Arvis et al. 2019).
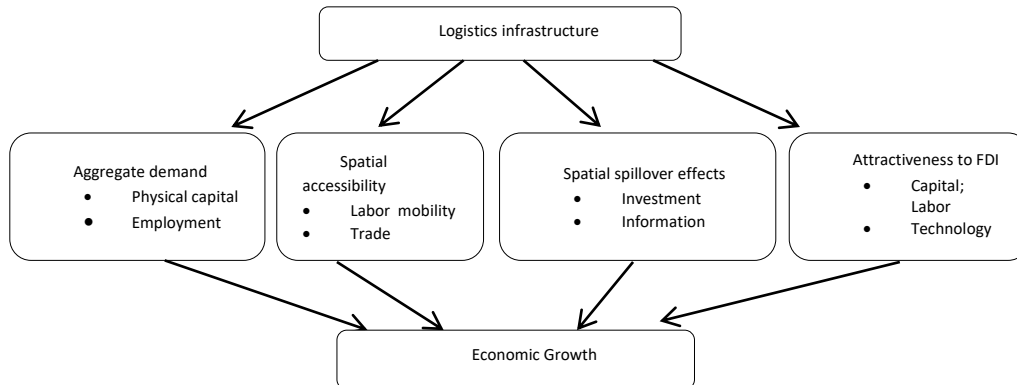

Figure 1. The advantage of logistics infrastructure for economic growth

Source: Kevin et al. (2017)

Figure 1, shows that infrastructure investment is an important determinant of economic growth. These investments create employment opportunities by increasing labor demand.

Moreover, the quality of logistics services is essential for enhancing regional and local accessibility. By utilizing logistics infrastructure, the duration of transportation and costs of freight transport can be reduced while enabling labor mobility in the transportation of passengers. This results in higher regional trade and, consequently, boosts economic growth. Another advantage of logistics activities is attracting foreign direct investment (FDI) to the region, creating new job opportunities, and offering employment prospects. In addition to job creation, FDI facilitates technology transfer, contributing to technological development. Countries with better logistics infrastructure have greater growth potential than countries with less developed infrastructure (Perkins, Fedderke, and Luiz, 2005; Shi, Bnag, and Li, 2016; Liu, Chen, and Zhou, 2007; Bwalya, 2006; Kisperka and Danuta, 1992). Countries with higher logistics performance tend to have a greater volume of trade (Martí, Puertas, and García, 2014). The quality, supply, and maintenance of transportation infrastructure are significant components of global competitiveness; therefore, logistics performance serves as a strategic function in enhancing global competitiveness (Korinek and Sourdin, 2011; Kunaka, Mustra, and Saez, 2013; Lakshmanan, 2007).

With the impact of globalization, production factors such as labor, capital, and technology move freely between countries. In this context, well-planned logistics infrastructure is vital for attaining sustainable economic growth. Therefore, transportation and logistics activities not only significant development strategies but also serve as unique sources of economic growth that cannot be compared to those of any other sector (Dutta, 2009; Havenga, 2010).

According to Arvis et al. (2014), the supply chain is a key component of global trade. Effective logistics activities are crucial for driving economic growth, fostering diversification, and reducing poverty. Logistics, as a series of coordinated activities, facilitates cross-border trade. Logistics activities carried out at the national level have become a fundamental component of the GDP of developed countries by facilitating the distribution of goods and services from the point of origin to the point of destination (Korinek and Sourdin, 2011). Countries with high logistics performance also experience an increase in trade volume. Additionally, improving

infrastructure, especially in developing countries, enhances logistics performance and boosts export volume (Martí, Puertas, and García, 2014; Wang and Choi, 2018).

This study seeks to assess the trade volume and economic growth in countries that had the highest logistics performance in 2018. The conceptual framework theoretically discusses the relationship between logistics performance, economic growth, and trade volume. This is followed by a literature review in which previous studies in this field were mentioned. After introducing the data set and method, the findings of the study are presented, followed by suggestions for future use.

2. Conceptual Framework

Wealth, growth, and development have been the main focuses of humanity throughout history. From the hunter-gatherer period to the information age, people have been on a quest to survive, maintain their lives, and gain influence. The increase in population and demand diversity has led to an increase in production. With the invention of sharp objects, people adopted a sedentary lifestyle, started agriculture, and developed trade over time. The development of humanity was accelerated first by agriculture and then by the industrial revolution. With industrial development, the emergence of a supply surplus has led to an increase in developed trade. Thus, people started to undertake different ways to increase wealth. The leading sectors in less developed, developing, and developed countries are agriculture, the industry sector, and service, respectively. The success of the service sector is an indicator of development. The quality of the service sector affects success in national and international markets. The service sector includes education, healthcare, defense, transportation, science and technology, and infrastructure. Logistics has become increasingly important as one of the most influential sectors due to globalization and the development of technology and transportation. Agricultural development has also aided the development of the industry. The development of the industry has improved the service sector and accelerated the transformation to the information age. For example, the manufacturing and agriculture sectors are no longer the leading sectors, while the service sector has become more prominent in many countries (Lee et al., 2007). Logistics technologies used in the agricultural sector greatly influence the scale of agricultural enterprises. In order to gain competitiveness in this sector, importance should be given to logistics activities. Logistics services such as shipment, tracking and monitoring positively affect agricultural growth (Dupaľ et all. (2019), Shıkur (2022)).

Megatrends such as globalization, privatization, digitalization and commoditization of processes, which have become more important especially in developing countries, have begun to emerge. These megatrends have changed the structure of the global economy. For example, the share of agriculture in national income was significantly greater a hundred years ago, but today, this share is only 2%. Agricultural development has created the necessary conditions for the industrial age, and the production level in the USA has increased threefold since the 1980s.

With the advance of globalization and accompanying information technologies, advanced manufacturing methods, and transportation improvements, developed countries are becoming increasingly interested in the service sector. Globalization has led to greater interdependence among countries, elevating the importance of the logistics sector as a key component of free trade. The Logistics Performance Index shows how countries with a higher score have a greater trade volume and a more developed economy. This result provides clues about a possible significant effect that these variables can have on each other.

Globalization, information technologies, advanced techniques in production systems, and developments in the means of transportation have caused developed countries to focus more on the service sector. Due to globalization, countries have become more dependent on each other, which has increased the importance of the logistics sector as a major part of free trade. Logistics, whose main field of activity is transportation, includes communication, dispatch, and warehousing activities between the parties, as well as transportation (Vallee and Dircksen, 2011). The fact that economic growth is high due to trade volume in countries with good logistics performance provides information about the theoretical relationship between the variables in question. Sectoral data appear to be absent from the relevant literature, but this may be more insightful for policymakers seeking to align resources with the national plan for export-oriented sectors (Le, 2022).

The leading sectors in the stages of economic growth are the agricultural sector in underdeveloped countries, the industrial sector in developing countries, and the service sector in developed countries. The performance of a country's service sector also reflects its level of economic growth. The quality of the service sector also affects the success of a country in both national and international markets. Fields such as education, health, defense, transportation, science, technology, and infrastructure constitute the service sector. As globalization, technology, and transportation services have advanced, the logistics sector—one of the most impactful service sectors—has gained increasing significance in recent years. The developments in agriculture also helped develop the industrial sector. The developments in the industrial sector have also developed the service sector and accelerated the transition to the information age. For example, the agriculture and manufacturing sectors are not the leading sectors in many countries; instead, the service sector has come to the forefront (Lee et al., 2007).

Many mega-trends, such as globalization, digitalization, liberalization/privatization, changing demographic structure, commoditization of processes, and growing economies, have begun to emerge in the global economy. These mega-trends have changed the economic structure of the world. For example, a century ago, the share of agriculture, which was the leading sector in national income, was quite high, but today, the share of agriculture in national income in the United States is only 2%. Agricultural development has set the conditions for the industrial age to develop over time, and production has tripled since 1980 in the United States (Lee and Lee, 2002; Drucker, 2002).

With the development of information, communication, and transportation technologies and the spread of globalization, the logistics sector has gained importance. There are many reasons why the logistics sector is so important (Demir, 2013). These reasons include (I) ensuring the flow of material between the production site and the storage area, (ii) increasing the need for material flow and storage as a result of the globalization of the supply process and production, (iii) difficulty in gaining a cost advantage due to increasing competition, (iv) the necessity of providing the right material at the right place and time to gain competitive advantage, (v) the necessity of obtaining the necessary inputs quickly in the increasing foreign-dependent market, and (vi) the desire to provide customer satisfaction.

Previously, however, the logistics sector only existed at the corporate level, and rapid changes have made it a sector that stands on its own. The logistics sector affects competitiveness by allowing similar goods produced by a large number of companies to be safely delivered to the buyer on time. Conversely, countries increase their attractiveness by maintaining and improving their current logistics routes. Today, both companies and countries are paying attention to their

investments in raw materials and markets, as well as existing logistics opportunities. The logistics sector has a great share of the development of e-commerce, which is another phenomenon brought about by globalization. Today, large companies engaged in e-commerce operate almost all over the world. Therefore, the effect of logistics performance should not be overlooked because the logistics sector is an important determinant of foreign trade. Governments should improve logistics activities in a country and make the necessary legal arrangements. It is particularly necessary to strengthen the logistics infrastructure in customs and to use technological means in transactions (Başar and Bozma, 2017).

Today, global trade occurs between countries that are open to the outside world and have good logistics infrastructure. The effective and efficient execution of logistics activities brings about cost and competitive advantage for countries. Countries with developed logistics infrastructure have a larger share of global trade. This is confirmed by the fact that the countries ranked high in the logistics performance list of the World Bank are generally developed economies and have a high share of global trade (KPMG, 2019). Globalization has made borders disappear, and product-service production and trade have become more common worldwide. The products are delivered to the buyer in less quantity but faster, increasing global trade. The production and consumption centers of the companies are located in different places, and companies can easily operate at different places thanks to their logistics services (Küçük, 2013).

International trade has played a key role in economic development, as it can increase national income and decrease poverty. As an indicator of development, international trade is connected to agriculture, transportation, energy, travel, and finance. Logistics and transportation not only facilitate international trade but are also effective in the development of an economy (OECD/WTO, 2013; UNCTAD, 2015). The effectiveness of logistics increases product mobility and allows fast and secure transportation. It also has cost-cutting effects. The efficiency of shipping, storing, and packaging also affects logistics performance. Effective and efficient logistics increase the competitive power of not only companies but also countries. A high-quality logistics system can facilitate global trade; however, the opposite will cause an obstacle (Marti et al., 2014). Logistics performance directly impacts international trade, as international trade relies on effective logistics and vice versa, highlighting the interdependence between logistics performance and global commerce (Ma et al. 2021; Lyu and Jing, 2015).
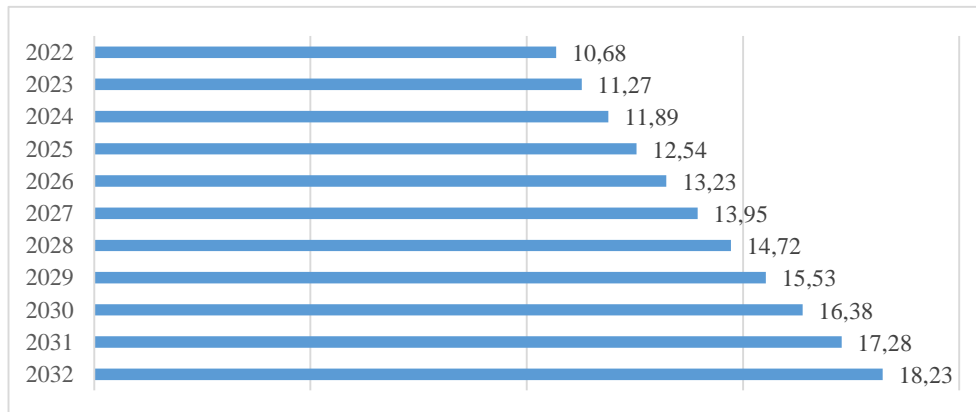

Figure 2. Logistic Market Size, 2023 to 2032 (USD Trillion)

Source: Globe Newswire.

"Logistic Market Size" is shown in Figure 2. In 2022, the logistics market size is calculated as 10.68 trillion dollars. According to the above figure, it is predicted that the market will continuously grow over the years. The reason for this increase is that the increase in the use of high-speed network connections and the spread of e-commerce are two important factors affecting the increase in logistics market size. An increase in the e-commerce sector has also led to the development of the logistics sector.

Undoubtedly, the logistics sector is among the industries most significantly impacted by the pandemic. Beck and Hensher (2020), Michail and Melas (2020), Arellana et all. (2020), Cole et all. (2020), Singh et all. (2020) focused on the effects of the pandemic on transportation modes, transportation costs and systems, and the environment. Since global trade depends on many different variables, great losses have occurred occasionally. Undoubtedly, it suffered its greatest loss during the COVID-19 pandemic. After the COVID-19 outbreak was declared a pandemic, the global trade volume decreased by approximately 21% in the second quarter of 2020. In addition to these decreases in exports and imports, international travel and transportation rates decreased by 81% and 29%, respectively, as countries closed their doors. In 2020, there was an 8% decrease in trade in goods and a 21% decrease in trade in services (Ivanov, 2021, WTO, 2020). China, often referred to as the world's factory, has been one of the countries most severely impacted by the Covid-19 outbreak. As a central hub in global production and trade networks, China has faced significant disruptions in the global supply chain as a result of the crisis. Wuhan, where the outbreak occurred, is a place where important raw materials and high-tech products such as automotive and steel are used. For this reason, the outbreak has caused significant losses in economies (Baldwin and di Mauro (2020), Araz et al. (2020), Kilpatrick and Barter (2020)). During the COVID-19 pandemic, countries closing their doors not only affected the logistics sector but also caused economic instability by causing a decrease in production, a decrease in trade volume, and an increase in unemployment.
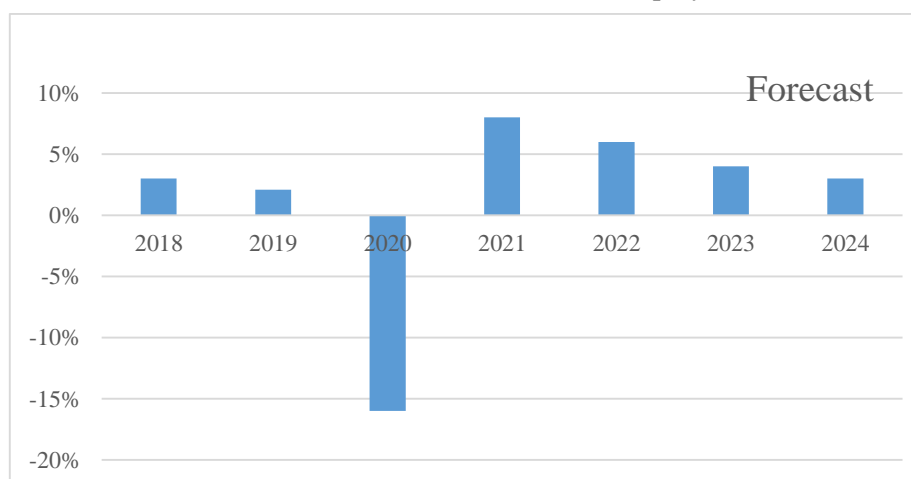

Figure 3. Global transport and logistics sector

Source: ING Research based on Oxford Economics

Figure 3 shows the general course of the international transportation and logistics sector between 2018 and 2014. According to the figure, the negative impact of the pandemic, which started in 2019 and affected the whole world in a short time, on the logistics sector stands out. In 2020, the sector, which showed a very sharp decline, started to recover as of 2021. The sector is expected to grow by approximately 3% in 2024.

The recovery in global trade that started in 2021 started to deteriorate again with the Russia-Ukraine War that broke out in March 2022. The effects of the Russia-Ukraine war quickly had a negative impact on the global supply chain, affecting countries in Eastern Europe and beyond. As Russia and Ukraine are major exporters of gas and metals, the rapid increase in fuel prices had a negative impact on the transportation sector. The negative impacts of the Russia-Ukraine War are similar to the negative impacts of COVID-19 on the global trade and transportation sector. The war has caused disruptions in global logistics activities, halted port operations, and increased freight rates (UNCTAD, 2022).

To eradicate infrastructural problems and adapt to rapidly changing environmental conditions, investment in logistics is crucial. Investing in logistics infrastructure reduces logistics costs and transit times, while also creating favorable conditions for business growth. Therefore, investing in logistics will help countries gain a competitive advantage and help them increase their production capacity together with financial developments (Navickas et al., 2011)

Today, with the effect of industrialization on developing countries, the logistics sector has begun to gain more importance. The sector affects important macroeconomic variables, such as ensuring economic growth and development, increasing the trade volume, and attracting foreign direct investments. It also provides competitive power to both countries and companies, as it provides services in almost every sector and increases productivity (Küçük, 2013).

The logistics sector offers cost-reducing, productivity-increasing, and added-value effects by encouraging economic growth, employment, production, and investment, especially for companies in developing countries. In terms of national economies, logistics activities have positive effects on foreign direct investments, trade volume, global competitiveness, and employment. Since the logistics sector has a very large scope in terms of operating in almost all sectors, it also offers countries a competitive advantage by increasing efficiency in all existing sectors (Marti et al., 2017; Küçük, 2013).

The Logistics Performance Index (LPI) offers insights into the effectiveness of countries in the logistics sector. According to Marti et. Al. (2014) improvements in any component of the LPI can boost economic growth by enhancing trade. The LPI is categorized into various dimensions, including customs performance, infrastructure quality, logistics service quality, ease of arranging shipments, and shipment tracking (Arvis, Saslavsky, Ojala, Shepherd, Busch, and Raj, 2014; Marti et al., 2014).
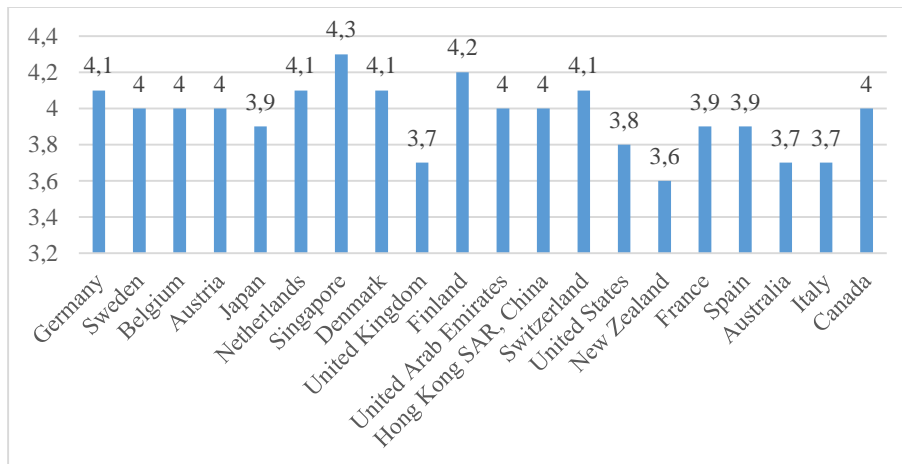

Figure 4. Dynamics of the logistics performance indices (LPIs) for some of the world in 2022

Source: We created the survey using World Bank data.

Figure 4 illustrates the dynamics of the LPI for various countries in 2022. LPIs offer a comprehensive evaluation of global logistics performance and analyze performance trends over time, enabling a better understanding of these trends (Ojala and Çelebi, 2015). While there is no theory directly linking logistics performance to trade volume, a study integrating Isard and Peck (1954), G. Haberler's opportunity cost doctrine (1933), and A. Weber's location theory (1909) explores how the distance between countries impacts geographical expertise and international trade (Jones, 1977).

According to Abbas et al. (2022), who investigated logistics for perishable products, supply chain management, environmental impacts on products, food quality, and green products, comprehending strategies to address foodborne diseases and reduce annual mortality rates caused by perishable food events is also valuable. Additionally, the study's findings reveal that improving product quality enhances trade volume among different stakeholders, from producers to retailers. Implementing an effective supply chain can boost producer profits and minimize quality losses at various stages of the food supply chain.

Gani (2017) investigated the link between logistics performance and trade volume, revealing a statistically significant relationship between logistics performance and both exports and imports. Similarly, Lutterman et al. (2017) utilized the Logistics Performance Index and identified a significant connection between logistics performance and trade volume. Wang Li-Jun (2005) highlighted the essential role of global logistics in advancing international trade through interaction analysis. The study showed that international trade and logistics are complementary and that there is a reciprocal relationship between the two. When the importance of logistics performance for sectors was evaluated by Lee (2022) with the Gravity Model, the positive impact of logistics performance was revealed.

In their study using sensitivity analysis, Zhang Bao-You (2009) found how developments in logistics positively affect trade volume. Thus, increasing investment in logistics will positively affect international trade by widening logistics networks. Additionally, Liping and Yang (2011) analyzed the relationship between international trade and transportation networks and found a dual causal relationship between the variables. They also stated that the development of transportation networks will increase the trade volume and that an increase in the trade volume will improve transportation networks Developments in the logistics sector have had positive consequences on economic growth (Chu, 2012; Lean et.al., 2014; Lun et.al., 2016; Li et.al., 2017). Coto-Milan et al. (2013) concluded that a 1% change in the LPI results in an increase in economic growth of 1.1% to 3.4%.

The following are the studies on the effect of logistics performance on economic growth (Karakas, 2014; Bozkurt, Efeoglu and Sevinc, 2017; Tunc and Kaya, 2016; Burmaoglu, 2012) the relationship between logistics performance and economic growth (Şimsek and Yigit, 2019); main determinants of logistics performance with panel data analysis (Wong and Tang, 2018); the effects of information and communication technologies on logistics performance (Kim and Lu, 2019); importance and determinants of logistics performance of selected countries (Erkan, 2014b) the effects of the logistics industry on international trade (Emirkadı and Balcı, 2018; Ofluoglu, Kalaycı, Artan and Bal, 2018); the relationship of logistics activities with national economies (Güngör, Dursun and Karaoglan, 2019); the effects of relationship marketing orientations of logistics companies on logistics performance (Akdogan and Durak, 2017); the mediator effect of logistics performance index on the relationship between foreign trade volume

(Uca, İnce, and Sumen, 2016); the effects of logistics services on growth in exports (Ateş and Işık, 2010); the impact of the logistics sector on competitiveness (Erkan, 2014a); relationship between export diversification and growth (Ceviker and Tas, 2011); analysis of logistics performance index (Pekmezci and Mutlu, 2018); the relationship between growth and logistics performance index of countries (Karaköy and Üre, 2019). Finally, according to Abbas et al. (2023), given the local and global implications of such seemingly small improvements in the environmental and social conditions of supply chain operations, the findings of the study, as described for highly perishable foods, emphasize that incentives to improve such transportation and distribution channels should be broadly supported by operations management.

The studies in the literature used the logistics performance of OECD countries with the SWARA-based EDAS method (Gök Kısa and Ayçin, 2019); the entropy-based EDAS method of performance analysis of logistics firms (Ulutaş, 2018); the logistics performance of selected Asian countries with the TOPSIS method (Oğuz, Alkan, and Yılmaz, 2019); the SD and WASPAS methods of the logistics performance index of the G-20 countries (Ulutaş and Karaköy, 2019); and the logistic performance index with data envelopment analysis (DEA) (Marti, Martín, and Puertas, 2017) as methods of evaluation. In this study, important economic variables such as economic growth and trade volume were evaluated by decision-making methods using the logistics performance variable, which is critically important for the production sector. An interdisciplinary study is needed because of its original value in terms of testing the variables of the study using different methods.

3. Data Set and Methodology

This study uses the multi-criteria decision-making (MCDM) method to assess logistics performance, trade volume, and economic growth in the top 20 countries with the highest logistics performance in 2018. Due to data collection limitations, three countries—United Arab Emirates, China, and Singapore—were excluded from the analysis. The data, obtained online as secondary sources, were based on annual indices. The interdisciplinary study explores the relationships between Logistics Performance Index (LPI), economic growth, and trade volume in countries with high logistics performance. Data on LPI, trade volume, and economic growth were compiled from official databases.

Based on expert opinions and the literature review results, the multi-criteria decision-making (MCDM) technique was chosen as the most suitable method for data analysis. MCDM methods were employed to rank countries based on logistics performance levels using variables such as logistics performance indices, economic growth rates, and trade volume indicators, and to assess performance levels related to economic growth and trade volume.

To evaluate logistics performance in accordance with economic growth and trade volume, entropy and TOPSIS were used together, and the countries were sorted based on their performance. The current evaluation criteria were determined using entropy, as entropy is a suitable method for determining the weight of each criterion. The logistics performances of the countries were evaluated with TOPSIS.

1. The entropy can be applied from part to whole. Additionally, the method is accepted as one of the few objective evaluation methods that can be applied at the point of aesthetic evaluation. Since information about building forms is also analyzed in this method, weighting calculation techniques that involve more than one criterion are considered objective methods. The weights of the criterion in the entropy method are calculated with the current data in the decision matrix, and as there is no need for another evaluation, the method is easily applied.

2. The TOPSIS method was selected for its ability to determine the closest distance to the positive ideal solution and the farthest distance from the negative ideal solution. The positive ideal solution represents the optimal combination of criteria, whereas the negative ideal solution signifies the least favorable combination. Table 1 presents the steps involved in the Entropy method (Karami and Johansson, 2014) and the TOPSIS method (Ayçin and Aşan, 2018).

Table 1. Application Stages of Entropy and TOPSIS

Stages	Entropy	TOPSIS
1. Stage	Creation of the Decision Matrix (D) $$D = \begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{bmatrix} X_{11} & X_{12} & ... & X_{1n} \\ X_{21} & X_{22} & ... & X_{2n} \\ \vdots & \vdots & ... & \vdots \\ X_{m1} & X_{m2} & ... & X_{mn} \end{bmatrix}$$	Creation of the Decision Matrix (A) $$A_{ij} \begin{bmatrix} a_{11} & a_{12} & ... & a_{1n} \\ a_{21} & a_{22} & ... & a_{2n} \\ \vdots & \vdots & ... & \vdots \\ a_{m1} & a_{m2} & ... & a_{mn} \end{bmatrix}$$
2. Stage	Normalization of the Decision Matrix $$pij = \frac{X_{ij}}{\sum_{i=1}^{m} X_{ij}} \ \forall \ i, j$$	Creation of the Normalized Decision Matrix (R) $$r_{ij=} \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}} \quad (i=1,2,...,m \text{ and } j=1,2,...,n)$$
3. Stage	Finding the Entropy Values Related to the Criteria $$eij = -k. \sum_{j=1}^{n} pij.ln(pij)$$ $i=1,2,...,m$ and $j=1,2,...,n$ $k=(ln(m)^{-1}) \ eij=0 \leq ej \leq 1$	Creation of a Weighted Standard Decision Matrix (V) $$V_{ij} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & ... & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & ... & w_n r_{2n} \\ \vdots & \vdots & ... & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & ... & w_n r_{mn} \end{bmatrix}$$
4. Stage	Finding the Degree of Differentiation $dj=1-ej$ $\quad j=1,2,...,n$	Creation of Ideal (A^+) and Negative Ideal (A^-) Solutions $$A^+ = \left\{ \left(\max_i v_{ij} \mid j \in J \right), \left(\min_i v_{ij} \mid j \in J' \right) \right\}$$ $$A^- = \left\{ \left(\min_i v_{ij} \mid j \in J \right), \left(\max_i v_{ij} \mid j \in J' \right) \right\}$$
5. Stage	Calculation of Entropy Criterion Weights $$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$	Calculation of Separation Measures $$S_i^* = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^*)^2} \quad S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}$$
6. Stage	Making Corrections If There are Negative Data	Calculation of Relative Closeness to the Ideal Solution $$C_i^* = \frac{S_i^-}{S_i^- + S_i^*}$$

MCDM methods are preferred because they contribute to decision-making in terms of the degree to which the variables affect each other, the evaluation of their relationships, and the sorting of their priorities.

4. Results

A weighted standard decision matrix was generated using the entropy weighting model, allowing for the ranking of criteria based on the actual data values. The criteria weights were determined using the entropy method, and the subsequent step involved evaluating country performances with the TOPSIS method. Table 2 displays the criteria weights determined at the 5th stage of the entropy method.

Table 2. Criteria Weights Calculated through the Entropy Method.

	(GDP)	(LPI)	(TR)
Weight	0,254393	0,265309	0,231348

Following the TOPSIS method, the weights were calculated. In the 1st stage, a decision matrix (A) was created and then normalized in the 2nd stage. In Stage 3, a weighted standard decision matrix was generated by multiplying each criterion's weights, derived from the entropy method, with the values from the normalized decision matrix, as shown in Table 3:

Table 3. Weighted normalized decision matrix (V)

Weighted Normalized Decision Matrix (V)			
	(GDP)	(LPI)	(TR)
Germany	0,028	0,061	0,031
Sweden	0,041	0,060	0,027
Belgium	0,050	0,060	0,085
Austria	0,077	0,060	0,037
Japan	0,016	0,058	0,015
Netherlands	0,069	0,061	0,074
Singapore	0,056	0,064	0,083
Denmark	0,059	0,061	0,025
United Kingdom	0,063	0,055	0,017
Finland	0,032	0,063	0,026
United Arab Emirates	0,115	0,060	0,074
Hong Kong SAR, China	0,054	0,060	0,139
Switzerland	0,032	0,061	0,037
United States	0,032	0,057	0,008
New Zealand	0,033	0,054	0,016
France	0,040	0,058	0,020
Spain	0,084	0,058	0,026
Australia	0,056	0,055	0,017
Italy	0,057	0,055	0,026
Canada	0,053	0,060	0,022

In the fourth stage of the method, the ideal positive (A+) and ideal negative (A-) solution sets are established. The ideal positive solution set is determined by selecting the highest value from each column in the weighted normalized decision matrix, while the ideal negative solution set is formed by choosing the lowest value from each column. The resulting ideal positive and negative values are presented in Table 4.

Table 4. Determination of the Ideal (A+) and Negative Ideal (A-) Solutions

Determination of the Ideal (A+) and Negative Ideal (A-) Solution			
A+	0,114650	0,064435	0,139211
A-	0,015913	0,053946	0,008378

The next stage calculates the deviations of each decision point from the positive ideal solution and negative ideal solution points. The positive ideal discrimination (S+) and negative ideal discrimination (S-) values of each decision point are given in Table 5 (5. Stage)

Table 5. Calculation of Alternatives' Distances

Calculation of Distances of the Alternatives		
	S+	**S-**
Germany	0,139	0,027
Sweden	0,135	0,032
Belgium	0,084	0,084
Austria	0,109	0,068
Japan	0,159	0,008
Netherlands	0,080	0,085
Singapore	0,081	0,086
Denmark	0,127	0,047
United Kingdom	0,133	0,048
Finland	0,140	0,025
United Arab Emirates	0,066	0,119
Hong Kong SAR, China	0,061	0,136
Switzerland	0,132	0,033
United States	0,155	0,016
New Zealand	0,148	0,019
France	0,141	0,027
Spain	0,118	0,071
Australia	0,136	0,041
Italy	0,127	0,045
Canada	0,133	0,039

Table 6 displays the relative closeness of each decision point to the ideal solution (C) in the final stage of the method. Countries are ranked based on their C+ values, which indicate their proximity to the ideal solution, from highest to lowest. The country with the highest C+ value is closest to the ideal solution and should be prioritized first, while the country with the lowest C+ value is considered the least preferred.

Table 6. Calculation of the relative closeness to the ideal solution

	Calculation of Relative Closeness to the Ideal Solution		
No	**Countries**	**C+**	**Row**
1	Germany	0,1609	15
2	Sweden	0,1901	14
3	Belgium	0,5011	5
4	Austria	0,3839	6
5	Japan	0,0492	20
6	**Netherlands**	**0,5154**	**3**
7	Singapore	0,5152	4
8	Denmark	0,2708	8
9	United Kingdom	0,2675	9
10	Finland	0,1531	17
11	**United Arab Emirates**	**0,6433**	**2**
12	**Hong Kong SAR, China**	**0,6908**	**1**
13	Switzerland	0,2025	13
14	United States	0,0949	19
15	New Zealand	0,1134	18
16	France	0,1604	16
17	Spain	0,3752	7
18	Australia	0,2316	11
19	Italy	0,2600	10
20	Canada	0,2285	12

Based on the data in Table 6, countries are ranked according to logistics performance, economic growth, and trade volume criteria. The country with the highest C+ value achieved the best performance, while the country with the lowest C+ value had the poorest performance. Consequently, the top-performing countries in terms of logistics performance, economic growth, and trade volume are the Netherlands, Luxembourg, the USA, Australia, Switzerland, Sweden, Denmark, Spain, Austria, Canada, Finland, France, Germany, Belgium, the UK, Norway, and Japan.

The Netherlands produces agricultural products using innovative agricultural technologies. It is the second-largest exporter of agricultural products in the world. Wageningen University in the Netherlands is a university with significant achievements in sustainable growth and agriculture. Universities are conducting studies on production, technology, marketing, distribution networks, and R&D. There are many important R&D projects, and there is an increase in productivity. The Netherlands also has a highly qualified workforce capacity. The R&D centers of 12 of the world's 40 largest food and beverage industries are located in the Netherlands. The Netherlands is not only an exporter of agricultural products but also agricultural machinery. The consultancy activities carried out on agricultural processes are also considered service exports. Behind all the successes lies the fact that the Netherlands is one of the most important maritime trading countries in history. Having an important port city such as Rotterdam also positively affects the trade volume and logistics performance of the country (Donat, 2015).

5. Conclusions

The literature review indicated that research on the impact of logistics performance on trade volume is limited, with existing studies differing in methodology and variables. This study utilized the Entropy-TOPSIS multi-criteria decision-making methods to evaluate logistics performance, trade volume, and economic development among the top 20 countries with the highest logistics performance scores. The unique aspects of this study include its choice of countries, distinct methodologies, and the policy implications proposed.

The Netherlands ranked first among the countries based on the criteria of economic growth, logistics performance, and trade volume. If the evaluation was performed with the data from 2018 without the weights of these criteria, then the trade volume of the Netherlands in the decision matrix would be 100,1, and the contribution to economic growth would be 3,5. The logistics performance rate of 4,07 also contributed to the Netherlands being the highest country in terms of general performance. The results show how all criteria have an important role in determining the values that are generated after the data are weighted. The entropy-weighted TOPSIS method revealed that Japan was the country with the lowest performance. Despite its trade volume ratio of 97,2, based on nonweighted data, Japan contributes to economic growth by 0,8. A logistics performance rate of 3,99 also puts Japan at the end of the list.

In summary, countries should also be good at logistics activities to increase their trade volume, which has an important share in ensuring economic growth. These results parallel those of previous studies (Marti, Martín, and Puertas, 2017; Erkan, 2014b; Uca, İnce, and Sumen, 2016). The competitive and cost advantages achieved through logistics activities will boost trade volume over the long term and foster a favorable environment for economic growth. To achieve a good level of logistics performance, countries should increase their R&D activities and improve the quality of science, technology, and transportation services.

Globalization and increased competition have made logistics an important component of global trade. For developing countries, enhancing logistics performance and leveraging globalization benefits are crucial for participating in global trade. Efficient logistics activities lower production costs and improve access to goods and services. To enable countries to access goods and services affordably, promptly, and reliably, it is essential to improve the quality of trade-related infrastructure through better logistics services. As mentioned before, logistics performance is effective at increasing trade volume, attracting FDI, enhancing product diversity, and ultimately achieving economic growth. An increase in trade volume in a country not only contributes to economic growth and development but also provides an opportunity to participate in global trade and gain a larger share of the global trade pie. To accomplish this, it is essential to improve logistics performance, increase related investments, and update policies accordingly. The high logistics performance observed in developed countries supports these assertions. In this context, the studies of Martí, Puertas, and García (2014); Korinek and Sourdin (2011); Kunaka, Mustra, and Saez (2013); and Lakshmanan (2007) have shown parallel findings.

The role of logistics in all sectors of agriculture, industry, and service in developed countries should not be underestimated. For this reason, developing countries in particular should attach importance to logistics activities to gain cost advantages and additional gains from trade volume. The logistics sector is considered a vital element of developed economies, and many studies have investigated its influence on a country's welfare (Özdağoğlu et al., 2022; D'Aleo, 2015; Altıntaş, 2022). The service quality in logistics parallels the richness of the economy (Arvis, et al., 2014). It is very difficult for national economies to achieve economic growth

without logistics performance. In this respect, it can be emphasized that countries should pay attention to their own capabilities and logistics performance indicators when evaluating their economies and that they should not ignore these details in their decisions.

Investment in logistics is crucial for increasing trade volume. Logistics is a sector in which intense competition is going through rapid change, and it requires innovation. In particular, the sector needs to keep up with changes in information and communication technologies. Companies should also adapt to Logistics 4.0, which is the name given to the transformation of logistics.

Countries that can produce quality products at lower costs and those that offer a low-cost transportation channel for products have a competitive advantage because high logistics costs hinder international trade. For this reason, countries should revise their policies and change to those that offer a competitive advantage in logistics in addition to launching initiatives to improve logistics systems (Aigigner, 1998; Jhawar et al., 2017).

Yeung (2006), Hausmann et al. (2013), Martí et al. (2014), Gani (2017), La and Song (2017), Tang and Abosedra (2019), Host et al. (2019), Yeo et al. (2020), Halaszovich and Kinra (2020), Liang and Liu (2020), Yeo and Deng (2020), Luttermann et al. (2020), and Song and Lee (2022) have concluded that logistics performance positively affects economic growth by increasing trade. The findings of this study support the observation that improved logistics performance boosts trade volume and, in turn, drives economic growth. Previous research has mainly focused on export values, due to the greater impact of logistics performance on exports relative to imports. Studies by Puertas, Martí, and García (2014), Gani (2017), Host, Skender, and Zaninovic (2019) have also reached similar conclusions. Numerous studies have explored the connection between logistics infrastructure and regional economic growth (Cheng and Peng, 2006; Yuan and Kuang, 2010; Chu, 2012; Huang and Peng, 2014; Lean et al., 2014; Hayaloğlu, 2015).

It is believed that future qualitative research on the subject can also contribute significantly to the literature. Additionally, analyzing the factors that influence the calculation of logistics performance index scores and investigating the impact levels of these factors on the obtained results would be another valuable contribution to the field. . Future research could explore food quality issues across various supply chain routes, in addition to supply chain management systems and environmental impact measurement policies (Abbas et al., 2022). In this context, examining the relationship between logistics performance and trade volume with a different sample could also be considered.

In the light of this study considering the different scenarios that will develop or the possibilities that may be encountered in the future, dangerous economic crises and global epidemics will contribute to the reaction of enterprises to these processes in favour of their companies. It is thought that the planning of studies to increase logistics performance in order to improve the ability of companies to meet difficult periods will be the basis for decision makers to maximise their contribution to economic growth. In addition, it is thought to be a guiding for different planned studies and inspiring at the point of determining the subject

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Conflict of Interest

The authors declare that they have no competing interest.