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A Comprehensive Model for Calculating the LPI Index of Key Transport Corridors in Serbia

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Abstract: The Logistics Performance Index (LPI) represents a tool developed by the World Bank that is used to measure the efficiency and effectiveness of a country's logistics sector, and comprises of six components. This indicator is used to compare the logistics performance of different countries, identify challenges in global supply chains, and help policymakers improve their logistics infrastructure and service quality. Given the importance of this indicator, every country aims to achieve a higher LPI score and, consequently, a more favorable ranking. The objective of this paper is to propose a new methodology for calculating the LPI score for transport routes. To validate the proposed methodology, the study analyzes seven cases involving import and export flows from Serbia. Based on the results, the analysis identifies which transport routes achieve the highest scores and which require specific preventive and corrective actions to improve their performance.

Keywords: LPI; Customs; Import; Export; Logistics

1 Introduction

Logistics is a fundamental pillar of the global economy. The efficiency of logistics services directly influences the competitiveness and economic growth of any country. In today's business landscape, globalization and international trade have become key drivers of economic activity, with logistics playing a central role in ensuring the seamless movement of goods, information, and capital. The Logistics Performance Index (LPI) stands out as a crucial metric, providing an objective framework for evaluating and comparing the logistics performance of countries around the world. This index comprises six core components: the efficiency of customs and border management clearance, the quality of trade and transport-related infrastructure, ease of arranging competitively priced international shipments, competence and quality of logistics services, the ability to track and trace shipments, and timeliness of delivery. Each dimension offers specific insights into the logistics processes and highlights the challenges countries face in enhancing their logistics capabilities.

This paper presents an analysis of the LPI structure, with a particular focus on Serbia and its dominant import and export routes. Due to its strategic geographical position in Southeast Europe, Serbia has significant potential to achieve optimal logistics efficiency. However, to fully unlock this potential, improvements in logistics performance are essential, along with the removal of barriers that hinder the smooth flow of goods. These enhancements would allow Serbia to become more competitive in the global market. The paper also examines Serbia's main import and export routes based on an analysis of trade flows in 2023. Understanding these key routes is vital for identifying the logistical challenges faced by the countries involved and recognizing opportunities for improvement.

A key contribution of this research is the calculation of the LPI for Serbia's dominant import and export routes, using a novel methodology that considers the evaluation of each component of the route as well as its relative importance. Each component is assigned a weight, representing its significance, using a subjective method. This approach enables a more precise assessment of logistics performance along these key routes. The LPI for these routes also facilitates comparisons with other countries and helps identify specific areas that require improvement, allowing Serbia to strengthen its competitive position in international trade. The expected findings of the study provide a basis for proposing corrective measures that could improve logistics efficiency and procedures, both in Serbia and in other countries, ultimately enhancing their long-term competitiveness and positioning on the global logistics market.

The paper is organized as follows: after the introduction, the second section presents a detailed description of the LPI and a review of the relevant literature. The third section develops a methodology for calculating the LPI for Serbia's dominant import and export routes, along with examples of calculations. The final section offers concluding remarks and directions for future research.

2 LPI Analysis and Literature Review

The logistics sector plays a significant role in trade, reducing transportation costs, and stimulating economic growth. Logistics can be defined as a part of the supply chain that plans, implements, and controls the efficient flow of goods, services, and information from the point of origin to the point of consumption. Logistics encompasses a wide range of factors, activities, and functions, which pose a significant challenge in terms of achieving market competitiveness and maintaining the level of efficiency that meets customer demands [1]. Logistics services can be crucial for the continuous growth of trade. High-quality logistics, combined with the liberalization of the economic environment, contributes to increasing trade volume. It can have a positive impact on economies of scale, as well as on the volume of distribution and influence economic growth [2]. On the other hand, poor logistics services, inadequate infrastructure, and underdeveloped operational processes can be significant barriers to global trade interaction. The main objective of market participants is to ensure the efficient transport of goods to end consumers in the most economical and cost-effective way possible. In achieving this goal, the efficiency of the logistics system plays a crucial role, especially in the context of international interaction. An efficient logistics sector facilitates international trade and enables economic entities to efficiently conduct the import and export of goods and services.

The continuous growth of international trade and the desire of many countries to accelerate their integration into the global trade system depend on maintaining the openness of the global trade system, as well as improving the volume and efficiency of supporting structures such as logistics services. Once the importance of logistics was recognized, the need to measure the efficiency of its services also became apparent. Logistics activities are described by a wide range of different indicators, and the challenge arises when selecting the most relevant indicators that best describe logistics activity [3].

There are many different scales that can be used to measure logistics efficiency. At the micro level, it is possible to analyze the performance of an individual company or even a specific department within a company, while at the macro level, the performance of a country or an entire continent can be assessed. Over time, several methods for measuring logistics efficiency have been proposed, ranging from the use of quantitative metrics, such as trade flows and productivity, to qualitative metrics, such as customer satisfaction.

To measure the efficiency of countries in the field of logistics, the World Bank created the LPI in 2007. The LPI is an interactive benchmarking tool designed to help countries identify the challenges and opportunities they face in providing logistics services, as well as to determine the measures they can take to improve performance [4].

Efficiency is a key indicator in business analysis and is one of the most fundamental and frequently used parameters for evaluating performance. Optimizing logistics activities can significantly reduce transportation and service delivery costs to end users. Additionally, improving the efficiency of logistics services contributes to better access to international markets and increases trade volume. High-quality and efficient logistics operations not only optimize costs but also enable a country to achieve a competitive advantage over other countries, both regionally and globally [3].

The LPI has been studied in the literature. For instance, Marti et al. [5] explored the importance of the LPI in international trade. The authors used a gravity model to determine the impact of each LPI component on trade in emerging economies. On the other hand, Beysenbaev and Dus [6] gave proposals for improving the LPI in their paper. Marti et al. [7] proposed an approach based on DEA (Data Envelopment Analysis) to compute a novel index that represents overall logistics performance. Rezaei et al. [8] used the Best Worst Method (BWM) for measuring the relative importance of LPI indicators. The results showed that infrastructure is the most important component of LPI. Similarly, Ulutas and Karakoy [9] proposed an MCDM model based on Stepwise Weight Assessment Ratio Analysis (SWARA), Criteria Importance Through Intercriteria Correlation (CRITIC) and proximity indexed value (PIV) methods for analyzing the LPI of EU countries. The aim of the study [10] was to assess the level of the impact of logistics performance on trade volume in the Central and Eastern European countries (CEECs) and Western Balkans. To do so, the authors analyzed the impact of LPI on international trade in 2007 and 2018, using the gravity model. An MCDM model incorporating a Method based on the Removal Effects of Criteria (MEREC) and Measurement of alternatives and ranking according to Compromise solution (MARCOS) methods was proposed by Miškić et al. [11] for determining weights of LPI components as well as ranking 27 EU countries. A similar subject was addressed by Ju et al. [12] where the authors proposed a novel approach based on CRITIC, MEREC, Entropy and Fuzzy ROV (Range of Value). Stojanović and Ivetić [13] investigated the possibilities of using Incoterms clauses in assessing a country's logistics performance. Also, Stojanović and Ivetić [14] studied the relationship between the LPIs of trade countries and sharing obligations related to logistics services in delivery among parties in international sales contracts. Alnipak et al. [15] studied the propellants of the LPI. Based on the results it was concluded that GDP

per capita, the percentage of commercial service imports, and the liner shipping connectivity index have significant effects on the LPI at the country level. Determining the relationship between LPI and the Global Competitiveness Index using the ANOVA method was addressed by Sergi et al. [16] in their paper.

2.1 International LPI

The international LPI is calculated by the World Bank as a tool to measure the quality of the logistics environment in countries where logistics operators operate. This indicator is based on data collected through surveys of logistics operators worldwide, allowing them to provide feedback on the logistics conditions in countries with which they have business and trade relations. The LPI serves as an international benchmarking tool, focusing on assessing the ease of trade and transport in specific countries, helping to identify key obstacles and opportunities for improving the logistics sector. In addition to providing a comprehensive evaluation of logistics efficiency on a global level, the LPI also enables the analysis of performance trends, offering insights into changes over time [8].

This singular indicator can be used to compare countries, regions, and income-level country groups, as well as for detailed analyses at the level of individual nations. Since field operators have the most accurate understanding of key aspects of logistics, the LPI relies on a structured online survey conducted among logistics professionals from companies involved in international transport, including multinational logistics firms and major carriers. These experts are best positioned to assess the performance of countries, as they directly influence the selection of shipping routes and gateways, which, in turn, impacts companies' decisions regarding production, supplier selection, and target markets. Their involvement is crucial for ensuring the quality and credibility of the LPI [8]. Experts evaluate six different components of the LPI on a scale of 1 to 5: customs, infrastructure, service quality, timeliness, shipment tracking, and international shipments, or the ease of arranging shipments. The participation of experts is necessary due to the lack of globally available quantitative data, such as cost and time information, that would allow for the assessment of efficiency [8]. Table 1 presents the six components, with explanations provided to experts in the questionnaire used for creating the LPI report.

Table 1. LPI components

Component	Definition
Customs	Efficiency of customs and border control
Infrastructure	Quality of trade and transport infrastructure
Services quality	Competence and quality of logistics services
Timeliness	Frequency with which shipments reach recipients within expected delivery times
Tracking and tracing	Ability to track and trace-shipments
Intemational shipments	Ease of arranging shipments at competitive prices

In the LPI survey, respondents rate eight foreign countries, with the countries assigned randomly based on the most important import and export markets of the respondents' country of origin. The average scores for different components form the overall LPI score, which is then used to rank countries [8].

The authors of the 2016 LPI report highlight two key limitations concerning the methodologies used for constructing the LPI. The first limitation is that large international freight forwarders may not provide a representative view of the broader logistics environment in poorer countries. These countries often rely on more traditional, smaller operators, meaning that the opinions of large international experts regarding these countries may differ from the actual situation. The second limitation arises from the fact that different freight forwarders may have different experiences with the same country. For example, large international operators may have specific experiences with government officials, such as customs officers, which differ from the experiences of regional and smaller operators. Additionally, the perception of service quality depends on the respondents' experiences with various service providers in that country. The third limitation concerns landlocked countries and small island states. Regarding these countries, the LPI may reflect access issues beyond their borders due to dependence on the infrastructure or customs services of neighboring countries. Thus, a low score for landlocked countries may not accurately reflect their trade efficiency [17].

The fact that the LPI is constructed by averaging the scores of six equally weighted components assumes that all components are equally important. However, in practice, not all components are equally significant. The relevant literature does not provide sufficient information about the relative importance of the different components and other factors that affect logistics efficiency. Research into the relative importance of these factors can offer valuable insights into what actually determines how well a country performs. This insight could help countries more effectively direct their efforts and projects to improve their logistics efficiency in the best way [17].

The LPI uses six key indicators, presented in Table 1, to rank countries based on their overall logistics efficiency. Over the past decade, the LPI has become an important tool among researchers for formulating strategies in logistics

and freight transportation [8]. Focusing on a country's logistics efficiency is the first step toward improving trade flows and the economies of nations [3]. The LPI score for each country is calculated by using normalized scores for each component, which are then multiplied by the respective component weights, after which all results are summed. The component weights, which serve as factors, actually explain data variations and may not reflect the true significance of individual components [17].

To account for potential sampling error and the limited accuracy of the LPI, LPI scores are calculated with an approximate 80% confidence interval, based on the standard error of the LPI scores from all respondents. These confidence intervals should be carefully analyzed to determine whether a change in the score or the difference between two scores is statistically significant. Countries with fewer respondents, such as Sweden, Norway, Bahrain, New Zealand, and Ethiopia, have wider intervals between the upper and lower bounds of their scores and ranks, as their estimates are less reliable. The average confidence interval translates, on average, to 20 ranking places, using the upper and lower bounds of the rank [1].

The international LPI is an indicator that represents the performance of the logistics sector by combining key data from the six basic components of logistics efficiency into a single indicator. The survey uses interpolation to estimate values not provided by respondents for these six main components. Missing responses are compensated by taking the average of all responses to individual survey questions collected from a given country.

The LPI has found wide application in numerous studies that provide insight into logistics situations in different countries. Within research, the link between logistics efficiency and policies in trade and transport is highlighted. Additionally, many other studies use LPI scores or scores for individual components for various research purposes. Analyzing various World Bank indices related to trade restrictions and facilitation and applying them to developing countries has led to the conclusion that the LPI score is used as an indicator of logistics efficiency, which can be influenced by certain policy measures. To improve trade, it is more useful to implement policy measures that affect LPI scores rather than applying other measures, such as tariff barriers and well-known non-tariff measures.

The LPI allows for comparisons between 160 countries and is used to identify challenges and opportunities related to transport infrastructure, logistics competence, and the availability of efficient supply chains within a country. In this context, the LPI serves as a valuable benchmark for assessing a country's trade logistics performance and as a reference point when selecting locations for various types of operations. This is one of the main reasons countries tend to focus on their ranking position rather than on actual improvements in the underlying values of the LPI indicators [1].

Research into the moderating effect of the Global Competitiveness Index (GCI) and its relationship with the LPI concluded that higher GCI scores can be achieved by improving key LPI components such as timeliness, shipment tracking, and international shipments. The GCI is a comprehensive metric that evaluates the global competitiveness of nations. Developed and published by the World Economic Forum (WEF), it analyzes a country's ability to foster sustainable economic growth and prosperity. The GCI infrastructure indicators examined in the study linking the LPI and GCI include the quality of roads, rail infrastructure, port infrastructure, air transport infrastructure, the breadth of value chains, and corporate investments in research and development. The study found that only two out of the six indicators - port infrastructure quality and road infrastructure quality - had a significant correlation with the overall LPI score [1].

Further studies examining the importance of each LPI component in the context of trade and economic performance found that all LPI components positively correlate with the volume of international trade, suggesting that each factor contributes to trade facilitation [17]. The LPI can be divided into input and output elements. Input elements encompass policy-regulated areas such as infrastructure, customs procedures, and service quality, which are essential for an efficient supply chain. On the other side, output elements reflect supply chain performance outcomes in areas such as lead times, reliability, on-time deliveries, international shipments, and shipment tracking.

By considering both input and output elements and their interdependencies, the LPI provides a comprehensive view of a country's logistics performance and helps pinpoint the key factors affecting the efficiency of its logistics processes.

Several countries have included specific goals related to their LPI score or ranking in their strategic development plans. To enhance their attractiveness, these countries are undertaking large-scale projects across various sectors to improve their position on the LPI. However, the proximity of countries' scores at any given performance level may be more significant than the ranking itself. Countries with similar performance levels can have notably different ranks, particularly in the middle and lower-income ranges. Rankings and relative changes between two editions of the LPI should be interpreted with caution. The latest LPI report also provides a listing of countries with a weighted average of their LPI scores and ranks across all four editions from 2007 to 2014. This listing helps to smooth out inevitable year-to-year variations in survey-based data, offering a more balanced overall picture. Understanding trends in logistics performance requires looking beyond LPI scores and rankings to identify interactions between logistics performance and political actions, competitive forces, and the broader economic and political environment [1].

In a study conducted by Taiwan's Institute of Transportation (IOT) and the Ministry of Transportation and

Communications, it was emphasized that service quality, customs efficiency, and infrastructure are defined as "leading indicators," which are key contributors to the competitiveness of a country's international logistics services. The IOT argued that the performance of these three indicators profoundly impacts their mutual functioning. The government should prioritize investing in improving the performance of these three indicators, and as a result, the performance of other indicators, including timeliness, international shipments, and shipment tracking, will also improve [18].

The LPI not only provides a comprehensive assessment of logistics performance worldwide but also tracks performance trends, allowing for an understanding of changes over time. It also includes a set of domestic performance indicators that are not factored into the overall country score. Additionally, it is supplemented with quantitative data on specific aspects of international supply chains in countries where respondents operate, including import/export times, supply chain costs, customs processing, and the percentage of shipments subject to physical inspections [18].

2.1.1 Customs component

The customs component within the LPI measures the efficiency and effectiveness of customs procedures, considering factors such as speed, simplicity, and predictability. Customs are recognized as a critical factor in facilitating trade. Numerous studies highlight the importance of customs as a key factor in logistics, particularly in developing countries where even small changes in customs procedures can significantly improve the overall efficiency of the logistics system [17].

Trade plays a key role in economic growth, and international trade has driven changes in customs services. International trade involves the movement of goods across borders, subject to various customs procedures. The role of customs encompasses the protection of financial interests, the enhancement of international trade, the protection of society, and more. Customs procedures are the most important factor in international trade, and a country's competitiveness is a result of the efficiency and effectiveness of its customs services [19].

The main challenge in measuring efficiency in the public sector is identifying relevant input and output data [19]. Every organization strives to carry out its activities efficiently, regardless of ownership. In the public sector, the issue lies in the lack of direct correlation between revenue and expenditure. Additionally, political factors often cause public organizations to focus more on achieving goals than on optimizing resources.

The core element of the LPI is customs efficiency. In this sense, there are various aspects to evaluating customs services' efficiency [1]:

• Efficiency of customs services in the international LPI (efficiency of the clearance process, i.e., the speed, simplicity, and predictability of formalities performed by border control agencies, including customs);

• Efficiency of customs services in the domestic LPI (quality and competence of customs agencies' services, clearance and delivery of import and export flows, transparency of customs procedures, provision of adequate and timely information on regulatory changes, number of agencies involved in import and export, number of forms for import and export, etc.).

The LPI places particular emphasis on the efficiency of customs administration. This index thus includes the private sector's perception of the efficiency of customs procedures, as well as the range of services provided by customs authorities and related agencies. The effectiveness and efficiency of the customs clearance process (time, documentation, costs, etc.) by customs services and associated border control agencies are also key elements of the LPI [1].

2.1.2 Infrastructure component

Infrastructure is a crucial factor in trade, playing a central role in determining construction and maintenance costs while generating significant benefits for the economy. Numerous studies indicate a direct link between transportation infrastructure and economic growth and trade volume, with logistics services acting as key intermediaries in this process. These effects are evident in both developing and developed economies [17].

Transportation represents the most expensive component of logistics in trade, and appropriate infrastructure is essential for facilitating the delivery of transport services. Exporting at competitive prices or importing at reasonable costs is challenging if the transportation and logistics sector is inefficient or even dysfunctional. High costs, poor service, and a lack of reliability in transport and logistics can effectively isolate a country from global markets [2].

The rise of global value chains is becoming increasingly significant, as participation in such chains in production relies fundamentally on transportation and logistics. The efficiency of logistics and transportation systems affects the costs of international trade just as much as geographical distance does [2]. Transportation infrastructure has a significant impact on productivity and cost structures. For example, better connectivity between ports and hinterlands can reduce the costs associated with building distribution networks or transporting products. An efficient logistics system is the foundation of a prosperous economy that attracts foreign investment [1].

2.1.3 Timeliness component

Timeliness, which refers to the ability of shipments to arrive at a designated location as scheduled, plays a crucial role in enhancing trade activities. Improved timeliness and predictability of deliveries significantly contribute to the

growth of trade volume. Economically, each day in transit can be considered equivalent to a customs duty ranging from 0.6% to 2.1% of the value of the goods [4]. Consequently, reducing transport time has become one of the key objectives of transportation policy. The effectiveness of these policies is often assessed through cost-benefit analyses, with particular attention given to their impact on this performance measure [4].

Disruptions in supply chains during 2021-2022 underscored the importance of reliability, as reflected in the LPI survey under the category of "timeliness of delivery." During this crisis, businesses and consumers worldwide faced situations where goods did not arrive on time due to disruptions in shipping movements and delays in shipments at critical hubs and entry-exit points longer than usual. In scenarios of low inventory, unexpectedly long delivery times can lead to serious problems. Addressing such disruptions requires coordination of various policies, but a focus on supply chain management highlights the importance of time spent at maritime or air hubs and entry-exit points. Investing in productivity, improving information flow, and enhancing logistics services can significantly contribute to better outcomes [4].

2.1.4 Shipment tracking and tracing component

Shipment tracking is becoming an increasingly important area for future investments, as it enables all participants in the supply chain to have improved visibility of the location of their products at any given time. This aspect of logistics is gaining significance due to the growing need for precise and accurate information regarding the status of shipments. Within the realm of transport management in logistics, information and communication technologies (ICT) play a crucial role. Transport policies are becoming increasingly important to support innovations in information and communication technologies. Advances in shipment tracking enhance the efficiency and transparency of logistics processes, which are essential for modern trade [17].

A tracking and tracing system provides detailed and comprehensive information about the location of shipments, encompassing all relevant data that allows for monitoring during transport. The system includes all data significant for long-distance international trade, covering container trade and air freight transport, while excluding the transportation of bulk goods. Although the data is global in scope, it is less representative of interregional trade due to a lack of coverage for road and rail transport. While there are precise tracking systems for trucks and freight trains at the national or regional level, without a global repository, these modes of transport cannot be analyzed in the same way as others. Nevertheless, information on the performance of transport corridors can be obtained from tracking data of containers moving to and from inland destinations, which includes trade from landlocked developing countries [4].

2.1.5 International shipments component

It is estimated that a 1% reduction in transport costs can lead to a 1.4% increase in trade, while a 1% reduction in overall costs can result in a 0.4% increase in trade [17]. The ease of organizing international transport is closely linked to regulations concerning the safety and security of transportation.

Reducing transport costs and overall expenses, along with improving regulations related to safety and efficiency, are crucial for enhancing international shipments and ultimately increasing trade volumes. The growing complexity of international business has allowed logistics to play a vital role in determining the performance of countries in international trade. A focus on improving logistics performance would significantly enhance international trade. Among countries with similar income levels, those with better logistics performance have been shown to achieve an additional 1% GDP growth and a 2% increase in trade [17].

Therefore, improving logistics performance, such as developing transport infrastructure, logistics services, port efficiency, and logistics centers, as well as continuously enhancing information systems, is essential for improving countries' trade performance. A positive correlation between logistics performance and trade has also been established, highlighting that the quality of logistics components positively influences export flows.

The consequences of globalization have led to an increase in international transportation of goods, as well as international logistics. Trade between countries has significantly advanced over the past decades. Before the era of globalization, nations primarily competed with neighboring countries within their regions, but globalization has expanded the competitive landscape to a global level, encompassing nearly all countries in the world. This shift has heightened the importance of logistics in international trade, making it one of the key elements in the development of individual nations. Consequently, there has emerged a need for a system to measure logistical efficiency.

2.1.6 Service quality component

Logistical services connect sectors within the local economy and link the domestic economy to the international market. The interconnection of various interdependent production sectors (such as agriculture, manufacturing, tourism, etc.) within the domestic economy is enhanced through efficient transportation and logistics systems. One of the primary motivations for producers is the reliable transport of goods to consumers in a cost-effective manner, minimizing delays.

Logistical performance positively influences the volume of international trade; therefore, logistics is recognized as a key factor in facilitating trade and removing barriers to stimulate economic development. As the level of international trade continues to rise globally, the contribution of the logistics sector to national economies increases

alongside the liberalization and openness of these economies, leading to broader trade integration and the exploitation of global market advantages.

Improvements in logistical performance can yield positive effects on exports and facilitate trade activities. Progress in trade can primarily be achieved by enhancing the efficiency of goods transport and accelerating the processing of accompanying documentation. Trade facilitation involves measures aimed at reducing costs, including improving customs procedures, refining the regulatory and institutional framework, simplifying processes, and implementing digital technologies. It can be defined through four key dimensions: port efficiency, customs procedures, regulatory environment, and the application of e-commerce [4].

Effective management and utilization of information technology solutions in both the private and public sectors are essential for high-quality logistics. In this context, the importance of digitalization is increasing, supported by rapid advancements in software, hardware, and innovative solutions. One notable area of development is enhancing supply chain visibility. Managing access to big data creates new business opportunities and analytical applications, further driving technological innovation. Efficient utilization of big data access is becoming an increasingly crucial policy issue at both the domestic and trade facilitation levels. However, the digitalization of supply chain processes may pose challenges for low- and middle-income countries, where limited access to technology and the reliability of essential infrastructure (particularly electricity) may hinder their ability to engage effectively. Capacity building, ensuring access to appropriate technologies, and supporting infrastructure should remain integral to policy agendas [4].

Although the contribution of logistics to national output may not be as competitive as that of other sectors, the role of logistics in supporting economic activities is indispensable. The well-established link between transport, logistics, and national development facilitates international trade, which, under optimal conditions, yields numerous additional beneficial economic and social outcomes. The logistics sector and high-quality logistical services are critical in facilitating international trade, enabling firms to efficiently conduct the import and export of goods and services and manage accompanying transactions.

The sustained growth of global trade and the desire of many countries to accelerate their integration into the global trading system depend not only on maintaining an open global economic environment but also on enhancing the quality and efficiency of supporting structures, such as logistics services. Poor logistical services - characterized by limited coordination among countries regarding border procedures, inefficiencies in customs processes at ports, inadequate transport infrastructure, expensive and scarce transport options, delays in shipment tracking, and terminal processing and customs clearance inefficiencies - can significantly disrupt international trade.

The strengths of trade liberalization will continue to encourage countries worldwide to achieve greater participation and seize the advantages offered by a globalizing economy, which presents expanding market opportunities. The level of development of both domestic and international logistical services can be a crucial factor in enabling countries to trade with fewer restrictions and at lower costs. While enhancing overall logistical services may be an important step toward shaping long-term trade facilitation, the question of whether the level of logistical services facilitates increased trade remains an important empirical inquiry deserving further research, especially considering the scarcity of empirical studies from this perspective [4].

Existing literature indicates a lack of detailed empirical studies regarding the effects of logistics on trade performance. One potential reason for this gap is the absence of consistent and timely numerical measures that comprehensively capture logistical performance across a wide range of countries and sector-specific characteristics. Although trade researchers have provided some qualitative assessments of the development of logistical services at the national level, empirical research on the impact of logistics on trade could offer valuable insights for trade policymakers as well as logistics operators [4].

Innovations in logistical services provide significant advantages for supply chains, including increased efficiency and enhanced customer satisfaction. Furthermore, high-quality logistical services have an indirect positive impact on economic indicators. Transportation policy can significantly influence the quality of logistical services, whether through regulatory measures in the transportation sector or through direct support for services, such as traffic management [17].

2.2 Domestic LPI

The efficiency of logistics in a country is crucial not only for the country itself but also for other nations. Depending on the perspective, there are two groups of indicators: domestic and international. Domestic indicators provide information that describes logistics activities from the viewpoint of local (domestic) entities, while international indicators come from foreign logistics and trade entities [3].

The Domestic LPI is a component of the LPI that focuses on assessing the logistics capacities and performance within the country itself, in contrast to the International LPI, which evaluates a country's ability to engage in global trade. While the International LPI ranks countries based on six key dimensions of global logistics, the Domestic LPI emphasizes the operational and infrastructural aspects of logistics within the country. The key characteristics of the Domestic LPI include quantitative and qualitative assessments, internal infrastructure, service efficiency, border

procedures and timings, and supply chain reliability [20].

The Domestic LPI reflects the state of the logistics sector at the individual country level, identifies potential weaknesses in the supply chain, and highlights opportunities for addressing these weaknesses, indicating segments of the supply chain that could be improved [10].

In calculating the Domestic LPI, there is no singular overall index; instead, values are recorded for individual elements evaluated according to a defined methodology. The assessment elements for the Domestic LPI include [8]:

a) Taxes and fees within the country:
- Agency fees
- Storage and transshipment fees
- Railway usage fees
- Road usage fees
- Airport usage fees
- Seaport usage fees

b) Quality of infrastructure and trade in the country:
- Quality of telecommunications and intelligent systems
- Quality of storage and transshipment facilities
- Quality of railways
- Quality of roads
- Quality of airports
- Quality of seaports

c) Competence of personnel and quality of services in the country:
- Service quality from the customer's perspective
- Quality of services from trade and transport associations
- Quality of services from customs brokers
- Quality of services from health agencies
- Quality of services and competence of inspection services
- Quality of services from customs agencies
- Quality of services from freight forwarders
- Quality of storage and distribution services
- Quality of maritime transport services
- Quality of air transport services
- Quality of railway transport services
- Quality of road transport services

d) Process efficiency within the country:
- Efficiency of expedited customs processes for highly compliant traders
- Efficiency in providing timely and accurate information on regulatory changes
- Transparency of customs procedures
- Efficiency of export delivery processes
- Efficiency of import delivery processes

e) Delays and causes of delays:
- Delays due to informal payments
- Delays due to criminal activities
- Delays due to shipment transloading
- Delays due to shipment inspections
- Delays due to mandatory storage

f) Assessment of changes in the logistics environment:
- Reduction of informal payments
- Changes in regulations related to logistics
- Improvement of private logistics services
- Changes in telecommunications infrastructure
- Changes in transportation infrastructure
- Changes in official customs procedures
- Changes in customs clearance processes

3 Development of a Model for Assessing the Logistics Efficiency of Key Trade Routes in Serbia

In this section, it is necessary to identify the dominant import and export routes from Serbia and analyze the LPI for the countries located on these dominant routes. After determining Serbia's dominant export and import routes, the LPI should be calculated for the identified routes, taking into account the LPI of all countries along the defined route. The LPI will be calculated by analyzing each LPI component separately. A weight coefficient will be assigned to each component, reflecting its significance. All components will be multiplied by their respective weight coefficients, summed, and then the arithmetic mean will be determined for all countries along the defined route.

Regarding Serbia's position compared to the last report published in 2018, Serbia has dropped from 65th to 73rd place. According to analysts at the World Bank, Serbia's overall score is 2.8, similar to the report from 2018 (2.84). The lower ranking indicates that Serbia has remained in the same position, but other countries are making better progress. Customs has a score of 2.2 (down from 2.6 in 2018), infrastructure is rated at 2.4 (down from 2.60 in 2018). In the category of international shipments, the score is 2.9 (down from 2.97 in 2018), the score for the quality of logistics services is 2.70 (the same as in 2018), in the tracking section the score is 3.4 (up from 2.79 in 2018), and in the timeliness of delivery, there has been a decline from a score of 3.33 in 2018 to the current score of 2.9.

3.1 Analysis of Dominant Export Flows by Export Volume

In 2023, Serbia exported a total of 14,124,656.80 tons of goods [21]. Analyzing the export volume, the highest quantity of goods was exported to Bosnia and Herzegovina, amounting to 1,814,586.20 tons, which represents 12.8% of the total exported goods for that year. Following Bosnia and Herzegovina, the largest quantity of goods was exported to Romania, with 1,636,697.50 tons recorded. Italy ranked third, receiving 1,170,106.70 tons of goods. Bulgaria held the fourth position with 956,913.30 tons exported, while North Macedonia came in fifth with 824,707.90 tons [21].

Other notable countries that ranked highly in exports from Serbia in 2023 include Montenegro, Croatia, China, Hungary, and Germany, as presented in Table 2. This table displays the dominant countries in Serbia's export flows for 2023, along with the quantities recorded for the defined export routes. Each country is ranked according to the volume of goods exported.

Table 2. Dominant countries in Serbia's export flows in 2023 [21]

Rank	Country	Goods Quantity (t)
1	Bosnia and Herzegovina	1814586.20
2	Romania	1636697.50
3	Italy	1170106.70
4	Bulgaria	95691.30
5	North Macedonia	824707.90
6	Montenegro	795043.50
7	Croatia	794215.10
8	China	712156.50
9	Hungary	706360.40
10	Germany	703292.60

In the following section of the paper, a detailed analysis will be conducted on the top five dominant export flows of Serbia in 2023, and it is essential to determine the LPI for the defined routes. In 2023, Serbia directed its dominant export flows primarily towards neighboring countries, namely Bosnia and Herzegovina, Romania, Bulgaria, and North Macedonia. An exception is Italy, where the export commodity flow must transit through the territories of multiple countries.

3.1.1 Export to Bosnia and Herzegovina

When it comes to exports to Bosnia and Herzegovina, 1,814,586.20 tons of goods were exported. Bosnia and Herzegovina is a neighboring country to Serbia. In order to obtain the LPI score, i.e., the logistics performance rating of this export route, it is necessary to take into consideration the LPI scores of both countries, Serbia and Bosnia and Herzegovina. Table 3 presents the LPI results for Bosnia and Herzegovina and Serbia in 2023, according to the World Bank report.

Serbia's LPI score is 2.8. This score includes an analysis of partial components such as customs, infrastructure, international shipments, logistics service quality, timeliness, and shipment tracking. Bosnia and Herzegovina's LPI score is 3.0, and the same parameters were analyzed for this calculation. The LPI score for the export route from Serbia to Bosnia and Herzegovina will be determined by assigning a weighting coefficient to each component, representing the importance of that criterion for both countries. The route score will be the sum of all multiplied

individual components, followed by the arithmetic mean of the resulting sum, i.e., by applying Eq. (1). Table 4 presents the weight values of the coefficients determined using a subjective method.

Table 3. LPI results of Serbia and Bosnia and Herzegovina [4]

Results	Country	
	Serbia	**Bosnia and Herzegovina**
Customs	2.2	2.7
Infrastructure	2.4	2.6
International-shipments	2.9	3.1
Service quality	2.7	2.9
Timeliness	3.4	3.2
Shipment tracking and tracing	2.9	3.2
LPI-score	2.8	3.0

Table 4. Weight coefficients of LPI components

Component	Weight
Customs	0.25
Infrastructure	0.25
International-shipments	0.10
Service quality	0.15
Timeliness	0.15
Shipment tracking and tracing	0.10
Sum	1

Customs procedures have a significant impact on the speed and efficiency of international trade. Efficient customs procedures enable faster border crossing for goods, reducing both costs and waiting times. As a result, this component has been assigned a high importance score of 0.25, reflecting its key role in the overall logistics chain. The quality of transport and logistics infrastructure is fundamental to the efficient operation of logistics systems. Good infrastructure reduces transit time, costs, and risks associated with damage or loss of goods, giving it an advantage over other components. Its score is also 0.25. The ability to organize international shipments, including transport capacity and connections to global markets, is an important aspect of logistics. However, this component holds less importance compared to customs procedures and infrastructure, resulting in a weight of 0.10. Although important, the ability to organize international shipments relies on core elements such as customs and infrastructure. The expertise and capabilities of logistics providers significantly affect customer satisfaction and the efficiency of the supply chain. However, since customs and infrastructure directly influence logistics efficiency, the component of logistics service quality is rated slightly lower -0.15. Timely delivery of goods is essential for maintaining supply chain efficiency and customer satisfaction. Delivery delays can lead to substantial losses. Given that timeliness is critical to maintaining market competitiveness, its importance is equal to that of the logistics service quality component, with a weight of 0.15. The ability to track shipments in real time enables better control over logistics processes and reduces the risk of loss or theft. While shipment tracking is important, its relative significance compared to other components is somewhat lower, with a score of 0.1. The LPI of the defined route will be calculated using Eq. (1).

$$\mathrm{LPI}(d1, d2) = \sum_{J=1}^{m} \sum_{i=1}^{6} \frac{Wi * LKij}{m}, \tag{1}$$

where:

Wi: weight coefficient,

LKij: LPI component,

m: the number of countries located along the import/export route,

(d1,d2): the trade flow route determined by the exporting and importing countries.

Using Eq. (1) and the input data from Tables 3 and 4, the following results are obtained for defining the LPI score of the export route from Serbia to Bosnia and Herzegovina, denoted as LPI (*S, BIH*).

LPI (*S, BIH*) = 2.2*0.25 + 2.4*0.25 + 2.9*0.1 + 2.7*0.15 + 3.4*0.15 + 2.9*0.1 + 2.7*0.25 + 2.6*0.25 + 3.1*0.1 + 2.9*0.15 + 3.2*0.15 + 3.2*0.1

LPI (*S, BIH*) = 0.55 + 0.6 + 0.29 + 0.41 + 0.51 + 0.29 + 0.675 + 0.65 + 0.31 + 0.435 + 0.48 + 0.32 = 5.52

LPI (*S, BIH*) = 5.52 / 2 = 2.76

The LPI score for the export route from Serbia to Bosnia and Herzegovina is 2.76.

3.1.2 Export to Romania

The same calculation approach will be applied to each subsequent assessment. Table 5 contains the input data, specifically the LPI scores for Serbia and Romania, presented by individual components. Romania is a neighboring country to Serbia, so only the LPI components of these two countries will be considered. The weighting coefficients from Table 4 will also serve as input data for the calculation of the export route Serbia – Romania.

Table 5. LPI results of Serbia and Romania [4]

Results	Country	
	Serbia	**Romania**
Customs	2.2	2.7
Infrastructure	2.4	2.9
International shipments	2.9	3.4
Service quality	2.7	3.3
Timeliness	3.4	3.6
Shipment tracking and tracing	2.9	3.5
LPI score	2.8	3.2

LPI (*S, R*) = 2.2*0.25 + 2.4*0.25 + 2.9*0.1 + 2.7*0.15 + 3.4*0.15 + 2.9*0.1 + 2.7*0.25 + 2.9*0.25 + 3.4*0.1 + 3.3*0.15 + 3.6*0.15 + 3.5*0.1

LPI (*S, R*) = 0.55 + 0.6 + 0.29 + 0.41 + 0.51 + 0.29 + 0.675 + 0.725 + 0.34 + 0.495 + 0.54 + 0.35

LPI (*S, R*) = 5.77 / 2 = 2.89

The LPI score for the export route from Serbia to Romania is 2.89.

3.1.3 Export to Italy

The export flow to Italy involves providing logistics services across the territories of Serbia, Croatia, Slovenia, and Italy. The LPI score will be calculated in the same manner, using Eq. (1). The input data can be found in Table 6.

Table 6. LPI results for Serbia, Croatia, Slovenia and Italy [4]

Results	Country			
	Serbia	**Croatia**	**Slovenia**	**Italy**
Customs	2.2	3.0	3.4	3.4
Infrastructure	2.4	3.0	3.6	3.8
International shipments	2.9	3.6	3.4	3.4
Service quality	2.7	3.4	3.3	3.8
Timeliness	3.4	3.2	3.3	3.9
Shipment tracking and tracing	2.9	3.4	3.0	3.9
LPI score	2.8	3.3	3.3	3.7

LPI (*S, I*) = 2.2*0.25 + 2.4*0.25 + 2.9*0.1 + 2.7*0.15 + 3.4*0.15 + 2.9*0.1 + 3.0*0.25 + 3.0*0.25 + 3.6*0.1 + 3.4*0.15 + 3.2*0.15 + 3.4*0.1 + 3.4*0.25 + 3.6*0.25 + 3.4*0.1 + 3.3*0.15 + 3.3*0.15 + 3.0*0.1 + 3.4*0.25 + 3.8*0.25 + 3.4*0.1 + 3.8*0.15 + 3.9*0.15 + 3.9*0.1

LPI (*S, I*) = 0.55 + 0.6 + 0.29 + 0.41 + 0.51 + 0.29 + 3.19 + 3.38 + 3.38 + 3.685

LPI (*S, I*) = 16.28 / 4 = 4.06

The LPI score for the export flow from Serbia to Italy is 4.06.

3.1.4 Export to Bulgaria

In Table 7, the input data, specifically the LPI results for Serbia and Bulgaria, are presented by individual components. Bulgaria is a neighboring country to Serbia, so in calculating this export flow, it is necessary to consider only the two countries.

LPI (*S, B*) = 2.2*0.25 + 2.4*0.25 + 2.9*0.1 + 2.7*0.15 + 3.4*0.15 + 2.9*0.1 + 3.1*0.25 + 3.1*0.25 + 3.0*0.1 + 3.3*0.15 + 3.5*0.15 + 3.3*0.1

LPI (*S, B*) = 0.55 + 0.6 + 0.29 + 0.41 + 0.51 + 0.29 + 0.775 + 0.775 + 0.3 + 0.495 + 0.525

LPI (*S, B*) = 5.515 / 2 = 2.76

The LPI result for the export flow from Serbia to Bulgaria is 2.76.

Table 7. LPI results for Serbia and Bulgaria [4]

Results	Country	
	Serbia	**Bulgaria**
Customs	2.2	3.1
Infrastructure	2.4	3.1
International shipments	2.9	3.0
Service quality	2.7	3.3
Timeliness	3.4	3.5
Shipment tracking and tracing	2.9	3.3
LPI score	2.8	3.2

Table 8. LPI results for Serbia and North Macedonia [4]

Results	Country	
	Serbia	**North Macedonia**
Customs	2.2	3.1
Infrastructure	2.4	3.0
International shipments	2.9	2.8
Service quality	2.7	3.2
Timeliness	3.4	3.5
Shipment tracking and tracing	2.9	3.2
LPI score	2.8	3.1

3.1.5 Export to North Macedonia

The last export flow to be analyzed is the export flow from Serbia to North Macedonia. Table 8 contains the input data for calculating the LPI for the export route from Serbia to North Macedonia.

LPI (*S, NM*) = 2.2*0.25 + 2.4*0.25 + 2.9*0.1 + 2.7*0.15 + 3.4*0.15 + 2.9*0.1 + 3.1*0.25 + 3.0*0.25 + 2.8*0.1 + 3.2*0.15 + 3.5*0.15 + 3.2*0.1

LPI (*S, NM*) = 0.55 + 0.6 + 0.29 + 0.41 + 0.51 + 0.29 + 0.775 + 0.75 + 0.28 + 0.48 + 0.525 + 0.32

LPI (*S, NM*) = 5.775 / 2 = 2.89

The LPI result for the export flow from Serbia to North Macedonia is 2.89.

Table 9 shows the LPI ratings for the prominent export routes of Serbia. The highest rating is for the route Serbia – Italy, which ranks third in terms of the quantity of goods exported. In second place are the routes Serbia – Romania and Serbia – North Macedonia, both with a rating of 2.89. Slightly lower ratings are assigned to the export routes to Bosnia and Herzegovina and Bulgaria.

Table 9. LPI scores of dominant export routes

Route	LPI Score
Serbia - Bosnia and Herzegovina	2.76
Serbia - Romania	2.89
Serbia - Italy	4.07
Serbia - Bulgaria	2.76
Serbia - North Macedonia	2.89

In the LPI calculations for the routes listed in Table 9, it is noteworthy that the route with the highest volume of exported goods (Serbia-Bosnia and Herzegovina) has the lowest LPI score of 2.76. For this route, specific corrective measures and initiatives should be implemented to improve the LPI score. One of the critical components is the efficiency of customs clearance. It is essential to focus on streamlining customs procedures and adopting modern data processing technologies wherever possible. In terms of infrastructure, upgrading and modernizing road networks, especially at border crossings, could significantly improve logistical efficiency. Consideration should also be given to constructing additional border crossings or expanding the capacity of existing ones to reduce delays. Enhancing the quality of logistics services is another priority. Increasing the number of warehouses and improving current logistics infrastructure could lead to shorter transit times and better shipment organization.

The Serbia-Bulgaria route has a similar LPI score. This slightly lower score highlights the need for investment in roads and border crossings between the two countries. It is particularly crucial to improve the road networks

connecting key economic hubs. As with the Bosnia and Herzegovina route, efforts should focus on expediting customs procedures and incorporating advanced technologies to enhance the flow of goods.

Romania is Serbia's second-largest export market after Bosnia and Herzegovina. The LPI score for this route can also be improved. Potential corrective measures include modernizing border crossings and aligning logistics systems, policies, and procedures between the two countries to ensure the seamless movement of goods, information, and services across borders. Additionally, upgrading the railway infrastructure and increasing freight train capacity between Serbia and Romania could contribute to faster, more efficient goods transport, further improving logistical performance.

The Serbia-North Macedonia route has the same LPI score. For this route, strengthening infrastructure links, particularly through the expansion of road and rail networks, is crucial. Improving the quality of logistics services, including staff training and the implementation of advanced tracking technologies, is another area where progress can be made. These measures would enhance both the timeliness and tracking of shipments.

The highest LPI score, 4.07, is for the Serbia-Italy route. To further enhance this route, it is recommended to develop intermodal transport, which could improve efficiency and reduce costs. Strengthening maritime connections and upgrading port facilities would increase transport capacity between Serbia and Italy. Moreover, improving supply chain visibility through the adoption of advanced digital solutions for shipment tracking and logistics management could boost delivery accuracy and reliability on this route.

3.2 Analysis of Dominant Import Flows Based on Imported Goods Quantities

In 2023, Serbia imported a total of 24,842,998.6 tons of goods, with the largest volume coming from Russia, amounting to 2,994,602.8 tons [21]. A slightly smaller quantity was imported from Bosnia and Herzegovina, totaling 2,198,552.8 tons. Bulgaria ranks third, with 1,798,818.2 tons of imported goods. Indonesia follows with 1,587,897.5 tons. Iraq holds the fifth position, from which Serbia imported 1,450,778.5 tons of goods [21]. The next countries, ranked up to the tenth position, are Romania, Turkey, China, Croatia, and Hungary, making them significant sources of imported goods to Serbia in 2023. The statistical data are presented in Table 10.

Table 10. Dominant countries in Serbia's import flows in 2023 [21]

Rank	Country	Imported Goods Quantity (t)
1	Russia	2,994,602.8
2	Bosnia and Herzegovina	2,198,552.8
3	Bulgaria	1,798,818.2
4	Indonesia	1,587,897.5
5	Iraq	1,450,778.5
6	Romania	1,069,435.8
7	Turkey	928,232
8	China	885,389.7
9	Croatia	862,336.6
10	Hungary	859,616.5

In the following section, two import flows are analyzed in detail, the first from Russia and the second from Indonesia, and the LPI for these routes is determined. Serbia's dominant import flows in 2023 were directed from Russia, Bosnia and Herzegovina, Bulgaria, Indonesia, and Iraq.

3.2.1 Import from Russia

For the analysis of the import route from Russia to Serbia, a route involving six countries - Serbia, Hungary, Slovakia, Poland, Belarus, and Russia - will be considered. This route was selected due to its strong infrastructural connections between these nations, as well as relatively low transit costs. The calculation will be based on the application of Eq. (1), using the weight coefficients outlined in Table 4. Table 11 provides the LPI results for the aforementioned countries, detailing each individual LPI component.

LPI (R, S) = 2.2*0.25 + 2.4*0.25 + 2.9*0.1 + 2.7*0.15 + 3.4*0.15 + 2.9*0.1 + 2.7*0.25 + 3.1*0.25 + 3.4*0.1 + 3.1*0.15 + 3.6*0.15 + 3.4*0.1 + 3.2*0.25 + 3.3*0.25 + 3.0*0.1 + 3.4*0.15 + 3.5*0.15 + 3.3*0.1 + 3.4*0.25 + 3.5*0.25 + 3.3*0.1 + 3.6*0.15 + 3.9*0.15 + 3.8*0.1 + 2.6*0.25 + 2.7*0.25 + 2.6*0.1 + 2.6*0.15 + 2.6*0.1 + 3.1*0.15 + 2.4*0.25 + 2.7*0.25 + 2.3*0.1 + 2.6*0.15 + 2.9*0.15 + 2.5*0.1

LPI (R, S) = 2.645 + 3.135 + 3.29 + 3.56 + 2.7 + 2.58

LPI (R, S) = 17.91/ 6 = 2.98

The LPI result for the import flow from Russia to Serbia is 2.98.

Table 11. LPI results for Serbia, Hungary, Slovakia, Poland, Belarus and Russia [4]

Results	Country					
	Serbia	**Hungary**	**Slovakia**	**Poland**	**Belarus**	**Russia**
Customs	2.2	2.7	3.2	3.4	2.6	2.4
Infrastructure	2.4	3.1	3.3	3.5	2.7	2.7
International shipments	2.9	3.4	3.0	3.3	2.6	2.3
Service quality	2.7	3.1	3.4	3.6	2.6	2.6
Timeliness	3.4	3.6	3.5	3.9	3.1	2.9
Shipment tracking and tracing	2.9	3.4	3.3	3.8	2.6	2.5
LPI score	2.8	3.2	3.3	3.6	2.7	2.6

3.2.2 Import from Indonesia

For the analysis of the import flow from Indonesia to Serbia, a route involving five countries will be examined. This route incorporates both maritime and road transport. The maritime segment begins in Indonesia and leads to the Port of Singapore. From Singapore, the vessel traverses the Indian Ocean, passing through the Gulf of Aden and the Red Sea, and then through the Suez Canal, a crucial passage between Asia and Europe. The route continues across the Mediterranean Sea, arriving at the Port of Rijeka in Croatia. At this point, the maritime transport portion concludes, and the road transport segment begins, continuing through Croatia to Serbia. The countries considered for the LPI results are Serbia, Croatia, Egypt (for the passage through the Suez Canal), Singapore, and Indonesia. Table 12 presents the input data. The input also utilizes the weight coefficients from Table 4.

Table 12. LPI results for Serbia, Croatia, Egypt, Singapore and Indonesia [4]

Results	Country				
	Serbia	**Croatia**	**Egypt**	**Singapore**	**Indonesia**
Customs	2.2	3.0	2.8	4.2	2.8
Infrastructure	2.4	3.0	3.0	4.6	2.9
International shipments	2.9	3.6	3.2	4.0	3.0
Service quality	2.7	3.4	2.9	4.4	2.9
Timeliness	3.4	3.2	3.6	4.3	3.3
Shipment tracking and tracing	2.9	3.4	2.9	4.4	3.0
LPI score	2.8	3.3	3.1	4.3	3.0

LPI (*I, S*) = 2.2*0.25 + 2.4*0.25 + 2.9*0.1 + 2.7*0.15 + 3.4*0.15 + 2.9*0.1 + 3.0*0.25 + 3.0*0.25 + 3.6*0.1 + 3.4*0.15 + 3.2*0.15 + 3.4*0.1+2.8*0.25 + 3.0*0.25 + 3.2*0.1 + 2.9*0.15 + 3.6*0.15 + 2.9*0.1 + 4.2*0.25 + 4.6*0.25 + 4.0*0.1 + 4.4*0.15 + 4.3*0.15 + 4.4*0.1 + 2.8*0.25 + 2.9*0.25 + 3.0*0.1 + 2.9*0.15 + 3.3*0.1 + 3.0*0.15

LPI (*I, S*) = 2.645+3.19+3.035+4.345+2.955

LPI (*I, S*) = 16.17 / 5 = 3.24

The LPI result for the import flow from Indonesia to Serbia is 3.24.

4 Conclusions

The LPI serves as a critical tool for assessing and comparing the logistics capabilities of countries worldwide. Through the analysis of the LPI, it becomes possible to identify key strengths and potential areas for improvement within logistics systems. This enables policymakers to direct resources and initiatives aimed at enhancing logistics efficiency and increasing competitiveness in the international market. This paper provides a comprehensive examination of the LPI structure, with a particular emphasis on Serbia and its predominant export and import routes.

The research findings reveal significant variations in the performance of logistics routes concerning Serbia's export and import flows. In terms of export routes, the countries that Serbia primarily exports to, based on the analysis of export flows in 2023, are Bosnia and Herzegovina, Romania, Italy, Bulgaria, and North Macedonia. These routes achieved LPI scores ranging from 2.76 to 4.07. Notably, the Serbia-Italy route stands out with the highest LPI score of 4.07, indicating relatively high logistics efficiency and considerable potential for further development in this area. In contrast, other export routes, such as Serbia-Bosnia and Herzegovina, Serbia-Romania, Serbia-Bulgaria, and Serbia-North Macedonia, have LPI scores ranging from 2.76 to 2.89, highlighting certain weaknesses in their logistics operations.

Regarding import routes, Serbia's primary imports in 2023 originated from Russia, Bosnia and Herzegovina, Bulgaria, Indonesia, and Iraq. The LPI scores for the analyzed routes are as follows: 2.98 for Russia, and 3.24 for

Indonesia. These scores reflect variability in the performance of logistics flows, with the Serbia-Indonesia route achieving the highest score of 3.24, indicative of better management and efficiency in this segment.

The analysis reveals numerous challenges and opportunities for enhancing logistics capacities. The findings underscore the need for improvements in logistics processes to respond more effectively to the demands of international trade and to bolster competitiveness on a global scale. Such changes could facilitate not only a more effective integration of Serbia into the international network but also a greater overall efficiency of the logistics sector.

By calculating the LPI for specific export and import routes using subjectively assigned weights to the criteria, insights into the performance of the logistics sector are provided, not only for Serbia but also for other countries involved in the defined import and export routes. Key factors influencing low LPI scores have been identified, along with opportunities for enhancing the logistics chain.

Recommended corrective measures include upgrading infrastructure, optimizing logistics operations, and implementing advanced technologies for shipment tracking. The implementation of these measures could significantly enhance the efficiency of logistics operations and elevate LPI scores, positioning Serbia as a more competitive player in the global market.

The limitations of this study stem from the subjective determination of the weights assigned to the LPI components. Future research should incorporate objective methods for establishing the weights of these components. Additional directions for future research could involve combining the proposed methodology with other Multi-Criteria Decision-Making (MCDM) approaches to optimize route selection during import and export, as well as applying the proposed methodology to other routes. Although this study has focused on selected routes, the results and methodology employed provide a foundation for broader application and further exploration, both in terms of other routes and in comparative analyses with other countries. This paper contributes to a deeper understanding of the logistics challenges faced by Serbia and offers valuable insights for future improvements within this critical sector.

Author Contributions

Conceptualization, N.G., M.A. and V.P.; methodology, N.G., M.A. and V.P.; writing—original draft preparation, N.G., M.A. and V.P.; writing—review and editing, N.G., M.A. and V.P. All authors have read and agreed to the published version of the manuscript.

Data Availability

The data supporting our research results are included within the article or supplementary material.

Conflicts of Interest

The authors declare no conflicts of interest.

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