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RESEARCH OF INDIVIDUAL LOGISTICS PERFORMANCE INDEX INDICATORS IN EUROPEAN UNION COUNTRIES

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Abstract:
Research background: The Logistics Performance Index (LPI) is a key indicator for assessing the efficiency and competitiveness of logistics systems in different countries around the world. The LPI is produced by the World Bank and is based on a survey of international transport operators and organisations. The index provides a comprehensive view of the logistics capabilities of countries and organizations, allowing comparison and identification of areas with high potential for improvement.
Purpose of the article: The purpose of this article is to provide a comprehensive view of the Logistics Performance Index (LPI) and its use in comparing logistics systems of different countries. The article aims to provide information that may be useful to the wider public as well as to organisations and policy makers interested in logistics performance and competitiveness at national and international levels.
Methods: The article will compare LPI between European Union countries using multivariate methods. These methods allow for a more comprehensive analysis of logistics systems and their efficiency, considering several aspects such as customs processes, quality of infrastructure, ability to track and deliver shipments, and others. The aim is to provide a more detailed and objective comparison.
Findings & Value added: The use of multivariate methods to assess the Logistics Performance Index (LPI) has enabled a more comprehensive comparison of logistics systems between different countries. These methods take multiple aspects into account, providing a more useful and objective assessment.

Keywords: Logistics Performance Index; method; comparison; ranking; indicator

JEL Classification: L8; F2; O4; O5

1. Introduction

Trade between countries has developed significantly in recent decades. Before globalization, countries mostly competed with other countries in their region, but globalization has expanded the scope to almost all countries in the world, which has increased the importance of logistics in international trade and made it one of the key factors of a country's development (Marti et

al., 2014; Razzaque, 1997), which in turn has created the need for a logistics performance measurement system. There are many different methods that can be used to measure logistics performance. At the micro level, it is possible to analyse the performance of a single company or even individual departments of a company, while at the macro level it is possible to measure the performance of a country or an entire continent. Over time, several methods have been proposed that vary from the use of hard indicators such as business flows and productivity to soft indicators such as customer satisfaction (Chow et al., 1994).

The importance of logistics to a country's economy created a need for detailed measurement, and so in 2007, World Bank researchers created the Logistics Performance Index (LPI). The LPI is an interactive benchmarking tool that countries can use to identify potential challenges and opportunities they face in trade logistics. Updated versions of the LPI were published in 2010, 2012, 2014, 2016, 2018 and most recently in 2022 (Arvis et al., 2018). All these versions included a ranking of all countries for which information was available, and the most recent version included 160 countries. Experts from around the world were asked to rate each country on six components. Each expert rated each country using a score from 1 (poor performance) to 5 (excellent performance) in each of the components (Rezaei at al., 2018).

In trade logistics, logistics performance is a critical factor that affects a country's ability to support both domestic and international trade (Anderson and Villa, 2015). This performance focuses on the efficiency and effectiveness in carrying out logistics operations, which include freight transportation, warehousing, payment systems, customs clearance, and more. It implies a set of well-coordinated activities (Fugate et al., 2010). High logistics performance implies faster, safer, and more cost-effective movement of goods within a country, which also indicates favourable conditions for international trade (Havenga, 2011; Havenga et al., 2017).

Logistics and transport are becoming increasingly important in global trade. The Logistics Performance Index (LPI) assesses the variation between countries in customs procedures, logistics costs and infrastructure for land and sea transport (Marti et al., 2014). Logistics and transport increasingly play a key role in international trade relations. The Logistics Performance Index (LPI) measures the efficiency of business supply chains or on-site logistics performance. In their paper, Marti et al. (2017) propose a data envelopment analysis (DEA) approach to compare the logistics performance of countries.

The LPI is used in many studies to provide insight into logistics conditions in different countries. For example, in Finland (Solakivi et al., 2015), Malaysia (Jumadi and Zailani, 2010), and Turkey (Ekici et al., 2016), the LPI has been shown to be accepted as a reliable indicator of a country's logistics performance and linked to trade and transport policies. Other studies have used the LPI score or its components for various research purposes. Hoekman and Nicita (2011) examined various World Bank indices on trade restrictions and facilitation and applied them to developing countries. The LPI score is often used as an indicator of logistics performance, which can be influenced by various policy measures. Researchers have found that it is more effective to implement policy measures that affect LPI scores to increase trade than to implement other measures such as tariff barriers or non-tariff measures. Cemberci et al. (2015) examined the moderating effect of the Global Competitiveness Index (GCI) on the LPI and concluded that higher GCI scores can be achieved by improving LPI components such as timeliness, tracking, and international shipments. Kim and Min (2011) combined the LPI score with the Environmental Performance Index (EPI) to create a green logistics index, which represented a completely different perspective than the LPI or EPI alone.

Erkan (2014) examined the relationship between GCI and LPI. The infrastructure components of GCI analysed included road quality, rail infrastructure, port infrastructure, air transport infrastructure, breadth of value chain, and business R&D expenditure. Through

regression analysis with data from 113 countries, an attempt was made to see if there was a significant relationship between the overall LPI score and the individual indicators. He found that only two of these indicators (quality of port infrastructure and quality of road infrastructure) have a significant relationship with the overall LPI score.

There is a large body of research on logistics performance in trade logistics, most of which either deals with the costs and benefits of trade facilitation (Banomyong et al., 2008; Hausman et al., 2005; Hoekman and Nicita, 2011; Rodrigues et al., 2005), or rather deals with the evaluation of inherent problems (Chow et al., 2005; Gupta and Goh, 2012; Wang et al., 2014). Yet, there is a dearth of studies that examine logistics performance in trade logistics from a country-wide perspective (Ekici et al., 2016). This may be due to the difficulty of obtaining country-level data that cover different activities in trade logistics.

2. Methodology

In today's world of global trade and international transport, the LPI is a key tool for comparing the efficiency and competitiveness of logistics systems between different countries. LPI benchmarking allows us to get closer to understanding the differences and similarities in the logistics performance of countries, thus providing important information for policy makers, organizations, and other stakeholders. This process can promote more effective international cooperation and contribute to a better understanding of the factors affecting logistics performance and competitiveness at the global level.

The first edition of the LPI in 2007 rated countries based on six main components: efficiency of customs procedures, quality of transport infrastructure, ease of organizing shipments, quality of logistics services, tracking and tracing of shipments, and frequency of on-time delivery of shipments. In 2010, the methodology of data collection and analysis was improved for a more accurate assessment. Between 2012 and 2014, the assessment and methodology were adapted for greater data consistency and reliability. In 2016, a broader methodology with more data sources and more respondents was introduced, resulting in a more accurate assessment. Updates in 2018 included assessment of specific logistical challenges and deeper analysis of index components. In 2022, the methodology was updated again to reflect changes in global logistics trends and new challenges such as the COVID-19 pandemic. Despite these changes, the main components of the LPI have remained consistent, allowing for comparisons of results across years. The efficiency of customs procedures and the quality of infrastructure remain at the core of the assessment, ensuring consistency and continuity of results (The World Bank, n. d.).

The Logistics Performance Index (LPI) was first published in 2007, covering 150 countries. Germany was the highest scoring country. In 2010, the second edition of the LPI included 155 countries, with Germany leading the way, followed by Singapore and Sweden. Significant progress has been made in many developing countries thanks to investments in logistics and infrastructure. Singapore and Hong Kong again dominated in 2012, while Germany maintained its high ranking. The fourth edition in 2014 included 160 countries, with Germany remaining in first place. The fifth edition in 2016 also included 160 countries, with Germany, Luxembourg and Sweden topping the rankings. The sixth edition in 2018 again confirmed Germany's position, followed by Sweden and Belgium. The latest edition of the LPI in 2023 includes 139 countries, with developed European countries holding on to the top spot, while developing countries continued to improve their logistics performance (The World Bank, n. d.).

Several methods can be used in practice for cross-country assessment and comparison. Specifically, these are univariate and multivariate methods.

Univariate methods are the simplest way of cross-country comparison, where states are ranked from best (in the case of the LPI with the highest indicator values) to worst (in the case of the LPI with the lowest indicator values). This method can only provide information on a state's position relative to other countries within a single indicator, which is its disadvantage (Slota, 2007).

Multidimensional methods are used to obtain a more comprehensive assessment of the state's position. In these methods, a ranking of the analysed states (in our case the EU27) is produced simultaneously according to several indicators. In this case, the principles of multi-criteria decision-making are applied using matrix structures. In practice, methods such as the ranking method, the normalized variable method, the distance to dummy object method and the variability method are most used (Slota, 2007).

In this paper, the ranking method and the distance to fictitious object method will be used to compare the EU27 countries.

2.1. Ranking method

The ranking method is a mathematical method that can be designed for cross-country comparisons. The ranking method assesses the position of a given country relative to the other countries in the LPI based on an ordinal scale given by the number of countries analysed n. Based on an analysis of the individual LPI indicators and their selected representative values, the individual countries compared within each indicator are assigned a ranking from the highest value (ranking 1) to the lowest value (ranking 27). In the case of identical values, the same ranking number is assigned (Jencova and Litavcova, 2011).

Then, after ranking the countries from the highest value to the lowest value, the sum of the assigned ranks for each country is calculated. The resulting rankings are then determined by simple arithmetic averages for each country, according to the formula:

$$\bar{x}_j = \frac{1}{m} \cdot \sum_{i=1}^{m} x_{ij}, \tag{1}$$

where $\bar{x}_j$ is the arithmetic average of the values of the indicators of the j-th country

m is the number of indicators

x_{ij} is the value of the i-th indicator for the j-th country

Then, based on the calculated simple arithmetic averages ($\bar{x}_j$) for each j-th country, a ranking p_j is assigned from the highest value (ranking 1) to the lowest value (ranking 27).

The advantage of the ranking method is its simplicity and speed. The disadvantage of the ranking method is that it does not quantify and account for the difference between states, i.e. it does not determine how much better or worse a given state (e.g. n-5) is than another state (e.g. n-6) with respect to the LPI (Jencova, 2011).

2.2. Method of distance to a fictitious object

The method of distance to a dummy object works with normalized variables. The so-called normalization is used to calculate the normalized variables. Normalization is a statistical procedure in which the original values of each selected variable are transformed into a normalized theoretical form that is quantified by a dimensionless number. In this way,

variability within the same indicators between the countries being compared is removed (Jencova and Litavcova, 2011).

In this method, a fictitious object is understood as a fictitious, ideal, model, or exemplary state, which achieves the best values of individual indicators in each issue (the highest values of given indicators in the case of their maximization). The indicator is in normalized form, that is, normalized variables are created for the given indicators. Subsequently, the Euclidean distances for each state from the ideal values of the dummy object are computed. The resulting ranking of the states is determined based on the distance from the dummy object, that is, the state that is the farthest from the dummy object is the worst and, conversely, the state that is the farthest from the dummy object is the best (Jencova and Litavcova, 2011).

The procedure for the method of distance from a fictitious object is as follows:

Step 1: Simple arithmetic averages are calculated for each selected indicator according to the formula:

$$\bar{x}_j = \frac{1}{n} \cdot \sum_{i=1}^{n} x_{ij}, \tag{2}$$

where $\bar{x}_j$ is the arithmetic average of the j-th indicator for $j = 1, 2, \dots, m$ (m is the number of indicators)

n is the number of compared countries

x_{ij} is the value of the i-th country of the j-th indicator for $i = 1, 2, \dots, n$, and for $j = 1, 2, \dots, m$

Step 2: The standard deviations for each indicator are calculated according to the following formula:

$$s_j = \sqrt{\frac{1}{n} \cdot \sum_{i=1}^{n} (x_{ij} - \bar{x}_j)^2}, \tag{3}$$

where s_j is the standard deviation of the j-th indicator for $j = 1, 2, \dots, m$

Step 3: As these are maximizing indicators, the arithmetic means of the indicator (x_{ij}) is subtracted from the values of the i-th country of the j-th indicator ($\bar{x}_j$) and their difference is divided by the standard deviation. The values of the different variables are then replaced by the values of the standardized variables according to the following formula:

$$u_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j}, \tag{4}$$

where u_{ij} is the standardised variable of the i-th country of the j-th indicator for $i = 1, 2, \dots, n$, and for $j = 1, 2, \dots, m$ (Jencova and Litavcova, 2011)

Step 4: The best value for the indicator is determined. According to the normalized values from step 3, the maximum value of the normalized variable is selected to serve as the ideal (fictitious) object for the indicator.

Step 5: For each state, the Euclidean distances to the fictitious object are calculated according to the following formula:

$$d_{j,0} = \sqrt{\frac{1}{m} \cdot \sum_{j=1}^{m} (u_{j,max} - u_{ij})^2}, \quad (5)$$

where $d_{j,0}$ is the Euclidean distance for the i-th country for $i = 1, 2, \dots, n$

$u_{j,max}$ is the ideal (maximum) value of the normalized variable for the j-th variable for $j = 1, 2, \dots, m$

Step 6: The resulting order of states is determined by the distance of the state from the fictitious object. Individual states are ranked by distance from the highest value (rank 1) to the smallest value (rank 27) (Jencova and Litavcova, 2011).

The distance to fictitious object method is one of the most accurate methods of multidimensional comparison because it quantifies the total distance of each state from a certain point. The state that is the least distant from the fictitious object is the best and, conversely, the state that is the farthest from the fictitious point is the worst (Jencova and Litavcova, 2011).

2.3. Logistics Performance Index (LPI)

The Logistics Performance Index (LPI) is used to assess the level of logistics performance both nationally and internationally. In the logistics sector, the LPI has been developed to assess performance at national level using certain predefined criteria, allowing comparisons of the performance of logistics chains between different countries. The World Bank previously conducted surveys and assessments every two years, but due to the Covid-19 pandemic, the interval between the last assessments has been extended to 4 years (between 2018 and 2022).

The LPI evaluation covers six key areas representing critical facets of the contemporary logistics landscape, graded on a scale of 1 to 5. Of these six areas, up to four are associated with the quality of logistics services. These indicators (aspects) of the LPI include:

- I1 – Ability to track and trace consignments,
- I2 – Competence and quality of logistics services,
- I3 - Ease of arranging competitively priced shipments,
- I4 - Efficiency of customs clearance process,
- I5 - Frequency with which shipments reach consignee within scheduled or expected time,
- I6 - Quality of trade and transport-related infrastructure.

The International LPI provides a qualitative assessment of a country in six areas by its trading partners, namely logistics professionals from other countries. For each of these six areas, a standardized score is determined, multiplied by the indicator weights (Table 1), and then summed. These weights represent the importance given to each logistics area. Since the weights for all six areas are similar, the international LPI represents a simple average of these indicators.

In Table 2 below, we can see the representative values of the individual indicators for the EU27 countries in 2022. Thus, for all calculations, the 2022 values will be used.

Table 1: Aspects of the international LPI and their importance weights. Source: Authors according to The World Bank

	Aspect	Weighting of importance of aspects by 2018 (-)	Weight of importance of aspects from 2018 (-)
aspect 1 of LPI	Ability to track and trace consignments	0.41	0.4133
aspect 2 of LPI	Competence and quality of logistics services	0.40	0.4168
aspect 3 of LPI	Ease of arranging competitively priced shipments	0.42	0.3931
aspect 4 of LPI	Efficiency of customs clearance process	0.41	0.4105
aspect 5 of LPI	Frequency with which shipments reach consignee within scheduled or expected time	0.40	0.4021
aspect 6 of LPI	Quality of trade and transport-related infrastructure	0.41	0.4133

Source: The World Bank (n. d.)

Table 2: Representative values of individual indicators for the EU27

Country / Indicator	I1	I2	I3	I4	I5	I6
AUT	4	4	3.8	3.7	4.3	3.9
BEL	4	4.2	3.8	3.9	4.2	4.1
BGR	3.2	3.3	3	3.1	3.5	3.1
CYP	3.2	3.2	3.1	2.9	3.5	2.8
CZE	3.3	3.6	3.4	3	3.7	3
DEU	4.1	4.2	3.7	3.9	4.1	4.3
DNK	4.1	4.1	3.6	4.1	4.1	4.1
ESP	3.9	3.9	3.7	3.6	4.2	3.8
EST	3.6	3.7	3.4	3.2	4.1	3.5
FIN	4.2	4.2	4.1	4	4.3	4.2
FRA	3.9	3.8	3.7	3.7	4.1	3.8
GRC	3.7	3.8	3.8	3.2	3.9	3.7
HRV	3.3	3.4	3.6	3	3.2	3
HUN	3.2	3.1	3.4	2.7	3.6	3.1
IRL	3.6	3.6	3.6	3.4	3.7	3.5
ITA	3.7	3.8	3.4	3.4	3.9	3.8
LTU	3.4	3.6	3.4	3.2	3.6	3.5
LUX	3.6	3.9	3.6	3.6	3.5	3.6
LVA	3.5	3.7	3.2	3.3	4	3.3
MLT	3.3	3.4	3	3.4	3.2	3.7
NLD	4.1	4.2	3.7	3.9	4	4.2
POL	3.6	3.6	3.3	3.4	3.9	3.5
PRT	3.4	3.6	3.1	3.2	3.6	3.6
ROU	3.2	3.3	3.4	2.7	3.6	2.9
SVK	3.3	3.4	3	3.2	3.5	3.3
SVN	3.3	3.3	3.4	3.4	3.3	3.6
SWE	4	4.2	3.4	4	4.2	4.2

Source: The World Bank (n. d.)

3. Results

In the following subsections, two multivariate methods of cross-country comparison will be presented. The first method is the ranking method. The second method is the method of distance to a fictitious object.

3.1. Application of the ranking method

In the ranking method, a ranking from the highest value (ranking 1) to the lowest value (ranking 27) is assigned based on the representative values (Table 2). In the case of a matching of values, the same ranking is determined (Table 3).

The procedure for using the ranking method to compare EU27 countries is as follows:

Step 1: For each country, the sum of their ranks is calculated, and a simple arithmetic average is computed according to formula (1), which is presented in chapter 2.1. An example of the calculation for the Slovak Republic is as follows:

$$\bar{x}_{SR} = \frac{1}{6} \cdot 9 + 8 + 9 + 8 + 8 + 9 = 8.5000 \quad (6)$$

Step 2: The resulting ranking is assigned to each country based on a calculated simple arithmetic average from the lowest (ranking 1) to the highest (ranking 27). In the case of equal values, the same ranking shall be assigned.

Table 3 provides a comparison of the LPIs of the EU27 countries.

Table 3: Ranking of countries based on the ranking method

Country / Indicator	I1	I2	I3	I4	I5	I6	$\sum$	$\bar{x}_j$	Ranking
AUT	3	3	2	4	1	4	17	2.8333	**5**
BEL	3	1	2	3	2	3	14	2.3333	**3**
BGR	10	9	9	9	8	10	55	9.1667	**19**
CYP	10	10	8	11	8	13	60	10.0000	**20**
CZE	9	7	5	10	6	11	48	8.0000	**16**
DEU	2	1	3	3	3	1	13	2.1667	**2**
DNK	2	2	4	1	3	3	15	2.5000	**4**
ESP	4	4	3	5	2	5	23	3.8333	**6**
EST	6	6	5	8	3	8	36	6.0000	**10**
FIN	1	1	1	2	1	2	8	1.3333	**1**
FRA	4	5	3	4	3	5	24	4.0000	**7**
GRC	5	5	2	8	5	6	31	5.1667	**8**
HRV	9	8	4	10	10	11	52	8.6667	**18**
HUN	10	11	5	12	7	10	55	9.1667	**19**
IRL	6	7	4	6	6	8	37	6.1667	**11**
ITA	5	5	5	6	5	5	31	5.1667	**8**
LTU	8	7	5	8	7	8	43	7.1667	**14**
LUX	6	4	4	5	8	7	34	5.6667	**9**
LVA	7	6	7	7	4	9	40	6.6667	**13**
MLT	9	8	9	6	10	6	48	8.0000	**16**
NLD	2	1	3	3	4	2	15	2.5000	**4**
POL	6	7	6	6	5	8	38	6.3333	**12**
PRT	8	7	8	8	7	7	45	7.5000	**15**
ROU	10	9	5	12	7	12	55	9.1667	**19**
SVK	9	8	9	8	8	9	51	8.5000	**17**
SVN	9	9	5	6	9	7	45	7.5000	**15**
SWE	3	1	5	2	2	2	15	2.5000	**4**

Source: author

Using the ranking method, the countries with the highest LPI values are Finland (rank 1), Germany (rank 2) and Belgium (rank 3). Rank 4 is shared by three countries: Denmark, the Netherlands and Sweden. Austria is the 5th country in the ranking. The last places in the ranking method are taken by Croatia (ranking 18), Bulgaria, Hungary, and Romania (shared ranking 19), and Cyprus (ranking 20).

3.2. Application of the method of distance to a fictitious object

The procedure for applying the distance of fictitious object method to the comparison of EU27 countries is as follows:

Step 1: For each indicator (I1 - I6), simple arithmetic averages are calculated according to formula (2) given in chapter 2.2. An example of the calculation for indicator 1 is as follows:

$$\bar{x}_j = \frac{1}{27} \cdot (4 + 4 + 3.2 + \ldots + 3.3 + 3.3 + 4 = 3.6185 \quad (7)$$

Step 2: The standard deviations for each indicator are calculated according to the formula (3) given in chapter 2.2. An example of the calculation of the standard deviation for indicator 1 is as follows:

$$s_j = \frac{1}{27} \cdot [(4 - 3.6185)^2 + \ldots + (4 - 3.6185)^2 = 1.7207 \quad (8)$$

Table 4 shows the values of the simple arithmetic means and standard deviations for indicators 1-6.

Table 4: Calculated simple arithmetic averages and standard deviations for each LPI

Indicator	**I1**	**I2**	**I3**	**I4**	**I5**	**I6**
Simple arithmetic average (x_j)	3.6185	3.7074	3.4667	3.4111	3.8074	3.5963
Standard deviation (S_j)	1.7207	1.7374	1.4422	2.0166	1.7200	2.2067

Source: author

Step 3: The standardized variables for each indicator are calculated according to formula (4) in Section 2.2. An example of the calculation of the standardized variable for indicator 1 is as follows:

$$u_{ij} = \frac{4 - 3.6185}{1.7207} = 0.2217 \quad (9)$$

Step 4: The best value shall be determined for each indicator. In the case of the normalized values calculated according to step 3, the maximum value of the normalized variable shall be selected to serve as the ideal value for the indicator.

Table 5 shows the calculated normalized variables along with the specified maximum value of the normalized variable that serves as the ideal model ($u_{j,\,max}$).

Step 5: Euclidean distances are calculated for the individual EU27 countries according to relation (5) given in chapter 2.2. An example of the calculation for the Slovak Republic is as follows:

$$d_{SR.0} = \sqrt{\frac{1}{6} \cdot \sum_{j=1}^{m} [(0.3379 - (-0.1851)^2 + \cdots + (0.3189 - (-0.1343)^2]} = 1.2699 \quad (10)$$

Step 6: The resulting ranking of states is determined by the distance of the state from the fictitious object (Table 6). The individual EU27 states are ranked by distance from the highest value (rank 1) to the smallest value (rank 27).

Based on the application of the distance to fictitious object method. the country with the highest LPI value was Finland (rank 1), Germany (ranking 2), Belgium (ranking 3), the Netherlands (ranking 4) and Denmark (ranking 5) were next. The Visegrad Four (V4) countries were ranked as follows - Poland in first place (rank 15), the Czech Republic in second place (rank 20), the Slovak Republic in third place (rank 23) and Hungary in last place (rank 25). The lowest LPIs are Bulgaria (rank 26) and Cyprus (rank 27).

Table 5: Calculated country-standardized variables for selected indicators

Country / Indicator	**I1**	**I2**	**I3**	**I4**	**I5**	**I6**
u_{ij}	u_{i1}	u_{i2}	u_{i3}	u_{i4}	u_{i5}	u_{i6}
$u_{j.\,max}$	**0.3379**	**0.2835**	**0.4391**	**0.3416**	**0.2864**	**0.3189**
AUT	0.2217	0.1684	0.2311	0.1433	0.2864	0.1376
BEL	0.2217	0.2835	0.2311	0.2424	0.2282	0.2283
BGR	-0.2432	-0.2345	-0.3236	-0.1543	-0.1787	-0.2249
CYP	-0.2432	-0.2921	-0.2542	-0.2535	-0.1787	-0.3609
CZE	-0.1851	-0.0618	-0.0462	-0.2039	-0.0624	-0.2702
DEU	0.2798	0.2835	0.1618	0.2424	0.1701	0.3189
DNK	0.2798	0.2260	0.0925	0.3416	0.1701	0.2283
ESP	0.1636	0.1109	0.1618	0.0937	0.2282	0.0923
EST	-0.0108	-0.0043	-0.0462	-0.1047	0.1701	-0.0436
FIN	0.3379	0.2835	0.4391	0.2920	0.2864	0.2736
FRA	0.1636	0.0533	0.1618	0.1433	0.1701	0.0923
GRC	0.0474	0.0533	0.2311	-0.1047	0.0538	0.0470
HRV	-0.1851	-0.1769	0.0925	-0.2039	-0.3531	-0.2702
HUN	-0.2432	-0.3496	-0.0462	-0.3526	-0.1206	-0.2249
IRL	-0.0108	-0.0618	0.0925	-0.0055	-0.0624	-0.0436
.ITA	0.0474	0.0533	-0.0462	-0.0055	0.0538	0.0923
LTU	-0.1270	-0.0618	-0.0462	-0.1047	-0.1206	-0.0436
LUX	-0.0108	0.1109	0.0925	0.0937	-0.1787	0.0017
LVA	-0.0689	-0.0043	-0.1849	-0.0551	0.1120	-0.1343
MLT	-0.1851	-0.1769	-0.3236	-0.0055	-0.3531	0.0470
NLD	0.2798	0.2835	0.1618	0.2424	0.1120	0.2736
POL	-0.0108	-0.0618	-0.1156	-0.0055	0.0538	-0.0436
PRT	-0.1270	-0.0618	-0.2542	-0.1047	-0.1206	0.0017
ROU	-0.2432	-0.2345	-0.0462	-0.3526	-0.1206	-0.3155
SVK	-0.1851	-0.1769	-0.3236	-0.1047	-0.1787	-0.1343
SVN	-0.1851	-0.2345	-0.0462	-0.0055	-0.2950	0.0017
SWE	0.2217	0.2835	-0.0462	0.2920	0.2282	0.2736

Source: author

4. Discussion

The first important point to note is that the LPI (Logistics Performance Index) is a structured framework for assessing the logistics capabilities of countries. Using multidimensional methods such as the ranking method and the distance to fictitious object method opens the possibility of obtaining more comprehensive and detailed insights into the logistics performance of countries.

The ranking method allowed us to rank countries according to their logistics performance and identify those that are making significant achievements as well as those that need improvement. This approach provided clear comparisons between countries and allowed us to identify areas where further action is needed to improve logistics systems.

Conversely, the distance to fictitious object method provided us with a detailed view of the relative distances between countries on logistics indicators. This approach allowed us to identify which countries have similar logistics characteristics and which differ.

The use of the rank order method and the distance to fictitious object method allowed us to gain a deeper understanding of the logistics capabilities of the EU27 countries and provided us with a useful means to assess their logistics systems. However, it is important to note that the LPI is only one of many indicators and is not sufficient on its own to fully understand the complexity of the logistics systems in each country. Therefore, other factors and context need to be considered when interpreting the results of the LPI assessment.

Table 7 presents the ranking of countries according to the different methods, which makes it possible to identify potential disparities between them. For example, Austria has an overall LPI score of 4, which places it in 3rd place, while it is in 5th place according to the ranking

Table 6: Ranking of states based on the distance to fictitious object method

Country / Indicator	**I1**	**I2**	**I3**	**I4**	**I5**	**I6**	∑	$d_{j.0}$	**Ranking**
u_{ij}	u_{i1}	u_{i2}	u_{i3}	u_{i4}	u_{i5}	u_{i6}			
$u_{j.\,max}$	**0.3379**	**0.2835**	**0.4391**	**0.3416**	**0.2864**	**0.3189**			
AUT	0.2217	0.1684	0.2311	0.1433	0.2864	0.1376	1.1885	0.3343	**7**
BEL	0.2217	0.2835	0.2311	0.2424	0.2282	0.2283	1.4353	0.2336	**3**
BGR	-0.2432	-0.2345	-0.3236	-0.1543	-0.1787	-0.2249	-1.3592	1.3744	**26**
CYP	-0.2432	-0.2921	-0.2542	-0.2535	-0.1787	-0.3609	-1.5825	1.4656	**27**
CZE	-0.1851	-0.0618	-0.0462	-0.2039	-0.0624	-0.2702	-0.8297	1.1582	**20**
DEU	0.2798	0.2835	0.1618	0.2424	0.1701	0.3189	1.4566	0.2249	**2**
DNK	0.2798	0.2260	0.0925	0.3416	0.1701	0.2283	1.3382	0.2732	**5**
ESP	0.1636	0.1109	0.1618	0.0937	0.2282	0.0923	0.8505	0.4723	**8**
EST	-0.0108	-0.0043	-0.0462	-0.1047	0.1701	-0.0436	-0.0395	0.8356	**13**
FIN	0.3379	0.2835	0.4391	0.2920	0.2864	0.2736	1.9126	0.0387	**1**
FRA	0.1636	0.0533	0.1618	0.1433	0.1701	0.0923	0.7843	0.4993	**9**
GRC	0.0474	0.0533	0.2311	-0.1047	0.0538	0.0470	0.3279	0.6856	**10**
HRV	-0.1851	-0.1769	0.0925	-0.2039	-0.3531	-0.2702	-1.0968	1.2673	**22**
HUN	-0.2432	-0.3496	-0.0462	-0.3526	-0.1206	-0.2249	-1.3372	1.3654	**25**
IRL	-0.0108	-0.0618	0.0925	-0.0055	-0.0624	-0.0436	-0.0917	0.8570	**14**
ITA	0.0474	0.0533	-0.0462	-0.0055	0.0538	0.0923	0.1951	0.7399	**11**
LTU	-0.1270	-0.0618	-0.0462	-0.1047	-0.1206	-0.0436	-0.5039	1.0253	**17**
LUX	-0.0108	0.1109	0.0925	0.0937	-0.1787	0.0017	0.1092	0.7750	**12**
LVA	-0.0689	-0.0043	-0.1849	-0.0551	0.1120	-0.1343	-0.3354	0.9565	**16**
MLT	-0.1851	-0.1769	-0.3236	-0.0055	-0.3531	0.0470	-0.9973	1.2267	**21**
NLD	0.2798	0.2835	0.1618	0.2424	0.1120	0.2736	1.3531	0.2671	**4**
POL	-0.0108	-0.0618	-0.1156	-0.0055	0.0538	-0.0436	-0.1835	0.8944	**15**
PRT	-0.1270	-0.0618	-0.2542	-0.1047	-0.1206	0.0017	-0.6666	1.0917	**18**
ROU	-0.2432	-0.2345	-0.0462	-0.3526	-0.1206	-0.3155	-1.3127	1.3554	**24**
SVK	-0.1851	-0.1769	-0.3236	-0.1047	-0.1787	-0.1343	-1.1033	1.2699	**23**
SVN	-0.1851	-0.2345	-0.0462	-0.0055	-0.2950	0.0017	-0.7647	1.1317	**19**
SWE	0.2217	0.2835	-0.0462	0.2920	0.2282	0.2736	1.2528	0.3080	**6**

Source: author

method and in 7th place according to the distance to a fictitious object method. Belgium has consistent scores across all methods, as it ranks 3rd in all three parameters. On the other hand, Bulgaria has significant differences between methods - its overall LPI score is 3.2, which places it in 10th place, but it ranks as high as 19th according to the ranking method and even 26th according to the distance to a fictitious object method, indicating an inconsistent assessment of its logistics performance. Similarly, the Czech Republic has an overall LPI score of 3.3, which places it in 9th place, while it ranks 16th according to the ranking method and 20th according to the distance to a fictitious object method, again indicating differences in the evaluation of the different methods. These disparities suggest that different ranking methods may lead to different results, and it is important to consider several aspects when evaluating countries' logistics performance.

5. Conclusions

Conclusions from the ranking of the EU27 countries on the basis of individual LPI indicators such as Ability to track and trace consignments, Competence and quality of logistics services, Ease of arranging competitively priced shipments, Efficiency of customs clearance process, Frequency with which shipments reach consignee within scheduled or expected time and Quality of trade and transport-related infrastructure have provided us with valuable insights into the positioning of their logistics systems.

Based on both the ranking method and the distance to a fictitious object method, we identified the ranking of the EU27 countries. For both the ranking method and the distance to a fictitious point method, the top three places were taken by Finland, Germany, and Belgium. In

Table 7: Country rankings by different methods

Country	LPI Overall	Ranking method	Method of distance to a fictitious object	Ranking by overall LPI
AUT	4	5	7	**3**
BEL	4	3	3	**3**
BGR	3.2	19	26	**10**
CYP	3.2	20	27	**10**
CZE	3.3	16	20	**9**
DEU	4.1	2	2	**2**
DNK	4.1	4	5	**2**
ESP	3.9	6	8	**4**
EST	3.6	10	13	**6**
FIN	4.2	1	1	**1**
FRA	3.9	7	9	**4**
GRC	3.7	8	10	**5**
HRV	3.3	18	22	**9**
HUN	3.2	19	25	**10**
IRL	3.6	11	14	**6**
ITA	3.7	8	11	**5**
LTU	3.4	14	17	**8**
LUX	3.6	9	12	**6**
LVA	3.5	13	16	**7**
MLT	3.3	16	21	**9**
NLD	4.1	4	4	**2**
POL	3.6	12	15	**6**
PRT	3.4	15	18	**8**
ROU	3.2	19	24	**10**
SVK	3.3	17	23	**9**
SVN	3.3	15	19	**9**
SWE	4	4	6	**3**

Source: author based on the The World Bank (n. d.)

the ranking method, Croatia, Bulgaria, Hungary, Romania, and Cyprus ranked in the last three places, while Bulgaria, Hungary, Romania, and Cyprus This information can serve as a basis for policies and strategies aimed at optimising logistics processes and improving competitiveness within the EU.

However, it is important to note that the LPI is not the only indicator of logistics capability and is not able to consider all factors affecting logistics systems. Therefore, it is necessary to complement the LPI assessment with other indicators and analyses to get a more comprehensive view of the logistics situation in each country. Overall, understanding and assessing the logistics capabilities of the EU27 countries is essential for their sustainable and competitive development in today's.

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