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RESEARCH ARTICLE

An Evaluation of the logistics Performance Index Using the ENTROPY-based ORESTE Method

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ABSTRACT
Logistics performance measurement has become increasingly important for countries as the competitive environment has increased. For this purpose, the World Bank has begun publishing logistics performance index (LPI) reports. The LPI ranking of countries is determined by the experts' scoring system. By re-analyzing this scoring and reevaluating it without the need for expert opinion, this study analyzed the evaluation of country rankings according to criteria weights from several different angles. This study aims to provide a detailed analysis of the World Bank's 2023 report using the ENTROPY-based ORESTE method, which has not previously been used in LPI evaluation and provides a more accurate and robust approach to the research. Although several studies have explored this similar topic in the literature, using a new method and comparing the criteria weights by including them in the analysis gave the present study a broader perspective. LPI analysis is an important tool for assessing and improving a country's competitiveness, and it can help investors compare logistics infrastructure and processes across countries. This can help stakeholders to better plan and make direct investments. Logistics researchers can use the LPI to examine sectoral and economic trends and forecast future developments. Furthermore, the LPI can be used in academia to train and raise awareness about assessment, logistics, and supply chain management programs. This is an important resource for training future logistics professionals and managers and providing policymakers and practitioners with a more refined tool for identifying areas for improvement and investment in logistics infrastructure.

Keywords: Logistics performance index, World Bank, ENTROPY, ORESTE

1. Introduction

The globalization of the economy, increased product and market diversity, and internationalization of trade have all contributed to the growing importance of the logistics sector. Logistics is inextricably linked to the economy because it encompasses the activities involved in effectively organizing all types of material and information flows from production to consumption. Therefore, logistics activities have evolved into an important tool for countries and regions seeking economic superiority and competitiveness. Hence, logistics has emerged as the most important issue and need nationwide and worldwide. In addition to a commercial approach, logistics, which is an important need, has introduced the concept of a logistics performance index (LPI). Logistics can be defined as the process of delivering resources such as products, services, and people where and when they are required. Without logistics support, establishing a marketing or production organization is extremely challenging. Logistics combines transportation, inventory, storage, material handling, and packaging information. The logistics business is responsible for the geographical location of the raw material, the operation of the process, and the completion of the work by meeting the needs at the lowest possible cost (Hayaloğlu, 2015).

Logistics is derived from the Greek word "logisticos," which means "the science of calculating," "book making," or "the skill of calculation" (Koban and Keser, 2007). Turkish logistics is derived from the Greek word *logistikos*. This term is known as *logistique* in French, *unterbringungswesen* in German, and logistics in English (Sürmen and Aygün, 2006). Logistics is "the process of strategically managing the procurement, movement, and storage of materials, products, and finished inventory through the organization and marketing channels in such a way as to maximize current and future profitability, while ensuring cost efficiency in fulfilling orders" (Christopher, 2011).

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The logistics business area covers all processes, from product and service supply to customer delivery. Its main purpose is to ensure effective product or service management and orderly operation of each stage of the supply chain. The World Bank's LPI study shows that countries have better logistics infrastructure. It also presents the issues they face and the qualifications they possess. The LPI is a multifaceted and comprehensive index developed for evaluation purposes. The first LPI study, conducted in 2007, used seven criteria, with six criteria used in subsequent years (Gergin and Baki, 2015). This index is used to assess a country's supply chain management effectiveness. The LPI is used to compare countries around the world, determining whether logistics operations are efficient and effective. This index is important for understanding, improving, and comparing a country's trade and economic performance. Countries with a high LPI score typically have more effective logistics processes and can compete in international trade. The LPI provides detailed information on the logistics environment, basic logistics processes and organizations, as well as countries' time and cost performance. Furthermore, LPI plays a role in revealing the countries' logistics-related problems, reform priorities in public–private sector dialogue, tracking time-sensitive developments, and implementing reforms as soon as possible.

This study used the ENTROPY method, which is an objective method for weighting criteria in World Bank data. It served as the study's decision matrix; no subjective data was required. After the criteria have been weighted, the Organization, Rangement Et Synthese De Donnes Relationnelles (ORESTE) method, which has not previously been applied to LPIs for ranking, will be used to analyze the ranking of countries more rigorously. For the first time in the literature, the evaluation of LPIs with ENTROPI-based ORESTE to evaluate LPIs has strengthened the study. After using an objective method like ENTROPY and determining the criteria weights, the goal was to evaluate from a new perspective using a method like ORESTE, which has not been studied much in the literature.

The remaining sections of the paper are as follows. Section 2 analyzes the literature review, including studies on the ENTROPY method and the LPI. Section 3 discusses the study's methodology, including steps from the ENTROPY and ORESTE methods and the proposed integrated approach. Section 4 uses data from the World Bank's (2023) LPI to prioritize criteria and classify countries. It also includes a sensitivity analysis. Finally, Section 5 presents the concluding remarks and future recommendations.

2. Literature Review on Applied Methodology

This section provides a literature review of the tools and techniques of multi-criterion decision-making (MCDM), specifically ENTROPY and ORESTE. This section consists of three subsections. First, the following subsections discuss the widely applicable ORESTE method. Subsequently, the literature on the ENTROPY method is discussed. Finally, the literature on using the MCDM to apply the LPI is presented.

Jafari (2013) assessed the ORESTE and Shannon's ENTROPY methods, prioritizing identified risks based on their frequency of occurrence, the impact they will have after the occurrence, and the likelihood of detection before the incident. Xingli and Huchang (2018) proposed a multi-expert MCDM to solve the problem of selecting creative and innovative product designs. They combined an enhanced quality function deployment method with a complicated fuzzy linguistic representation model, probabilistic linguistic term set, and ORESTE ranking method. Liao et al. (2018) proposed a new MCDM that is motivated by the ORESTE method. They developed a new global preference score function to aggregate the criterion weights and values, expressed as hesitant fuzzy linguistic elements. Meanwhile, Chatterjee and Chakraborty (2013) studied the almost unexplored MCDM ORESTE and used it to solve five AMS selection problems. For assessing thermal comfort in underground mines, Luo et al. (2019) found a suitable methodology. Meanwhile, Adalı and Işk (2017) used the ORESTE methodology to select a web design firm.

For the ENTROPY method, some notable studies are as follows: Jamin et al. (2019) proposed a multiscale cross-entropy measure to analyze the dynamical characteristics of the coupling behavior between two sequences at multiple scales. Zhao et al. (2018) chose primarily from the function of ecosystem factors and natural environmental factors associated with residents' daily lives. The ENTROPY method was used to calculate the weights of the indicators. The results show that western China is significantly more vulnerable than eastern China. Meanwhile, Al-Aomar (2010) investigated the problem of determining subjective and objective criteria weights by combining the AHP and Shannon's ENTROPY methods. Levy et al. (2017) developed a tool for performing analytic continuation of spectral functions using the maximum ENTROPY method. Shao et al. (2016) used the TOPSIS-ENTROPY method to construct an index system of urban sustainable development that includes three aspects: society, economy, and environment. According to Jüngel (2015), the key idea is to use a transformation of variables determined by the ENTROPY density, which is defined by the gradient-flow formulation.

The final section includes studies that take into account the LPI index. For instance, Göçer et al. (2022) developed a methodological framework for recommending logistics policies to improve specific countries' LPI scores. Beysenbaev et al. (2020) proposed improvements to the World Bank's current LPI. The LPI is based on a global survey of logistics experts, which may bias toward a subjective view of various countries' logistics systems, resulting in a potentially skewed rating. Atalan (2020) calculated the LPI values for the next period by comparing the current LPI values of OECD members. Bozkurt and Mermertaş (2019) studied

logistics performance by comparing the performance of the G8 countries and Turkey to identify and analyze the advantages and disadvantages of the countries. Although the study reveals the countries' advantages and disadvantages, it also provides recommendations for these countries. Ulutaş and Karaköy (2019) used World Bank data in their analysis, which included MCDM techniques. Karaköy and Ölmez (2019) studied logistics in Balkan countries to analyze performance. In their study, logistics were used to analyze the performance index, MCDM, ENTROPY, and OCRA techniques. Rezaei et al. (2018) studied the evaluation of the LPI and the effect of indicators on LPI using the best–worst indicator weight analysis. Moreover, Ayaydın et al. (2017) used the Gray Relational Analysis Method to assess the financial performance of ten logistics companies from the Fortune Turkey magazine's top 500 list. Başar and Bozma (2017) used pooled panel data analysis to study LPI's macroeconomic and political determinants in 71 countries during the period. Using LPI and component data, Yapraklı and Ünalan (2017) analyzed Turkey's logistics performance over the last decade. Ozceylan et al. (2016) studied the methodology of a multi-criterion decision logistic performance based on GIS to evaluate provinces in Turkey. Marti et al. (2014) used the center of gravity approach to assess the importance of the LPI in international trade, predicting that any improvement in the index for developing countries would lead to increased trade. Çakır and Perçin (2013) used CRITIC, SAW (Simple Additive Weighting), TOPSIS, and VIKOR methods to assess the financial performance of ten logistics companies from Fortune Turkey magazine's top 500 list. To integrate the obtained rankings, the Borda counting method was employed.

The results of the literature review, the fact that the ORESTE method is currently not widely used, and the use of the ENTROPY-based ORESTE method for the first time in the literature have added a more objective approach to the paper.

3. Methodology

The ENTROPY method was used as an objective and powerful method for criteria weighting, and the country rankings were analyzed by incorporating them into the ORESTE method, which used the criteria weights found here.

3.1. ENTROPY

Rudolph Clausius first defined ENTROPY, the second law of thermodynamics, in 1965 as a measure of disorder and uncertainty in a system (Zhang-Gu et al., 2011). The concept of ENTROPY, which is now widely used in mathematics and engineering sciences, particularly in physics, was applied to information theory by Shannon (1948). The ENTROPY method is used to measure the amount of useful information provided by the available data (Wu-Sun et al. 2011), and it consists of four steps (Johansson et al., 2014).

Step 1: To eliminate the effects of different index dimensions in the decision matrix on the disparity, various methods can standardize the indices. According to the benefit and cost indices, the criteria are normalized using Equations (1) and (2).

$$r_{ij} = \frac{x_{ij}}{max_{ij}} (i = 1, \ldots, m; j = 1, \ldots, n) \tag{1}$$

$$r_{ij} = \frac{min_{ij}}{x_{ij}} (i = 1, \ldots, m; j = 1, \ldots, n) \tag{2}$$

Step 2: To eliminate outliers in different units of measurement, P_{ij} is calculated by normalization.

$$r_{ij} = \frac{x_{ij}}{\Sigma_{j=1}^{n}} (i = 1, 2. \ldots, m; j = 1, 2. \ldots n) \tag{3}$$

i: alternatives,
j: criteria
r_{ij}: normalized values
x_{ij}: given utility values

Step 3: In this step, the ENTROPY of E_j is calculated with the help of Equation (4).

$$E_j = -h\Sigma_{i=1}^{m} r_{ij} ln(r_{ij}), j = 1, 2, ..., h = \frac{1}{ln(m)} \tag{4}$$

r_{ij} ln(r_{ij}) is defined 0 if r_{ij}= 0
h: (ln(n)) -1 k: ENTROPY coefficient

E_j : ENTROPY value P
ij: normalized values

Step 4: In Step 4, the uncertainty dj is calculated using Equation (5).

$$Dj = 1 - Ej; \forall j \tag{5}$$

Step 5: With the help of Equation (6), the wj weights are calculated as the level of importance of the criterion wj.

$$Wj = \frac{Dj}{\Sigma_{j=1}^{n} Dj}, j = 1, 2, \ldots n \tag{6}$$

3.2. ORESTE

One of the relationship-based ranking methods is ORESTE, which means senior, important, or favored. The ORESTE method has been used in the literature for agricultural decision problems such as material selection (Chatterjee et al., 2012), rehabilitation projects (Eliseo, 2009), port ranking (Jafari et al., 2013), landmine detection strategy selection (Leener et al., 2002), and risk prioritization (Jafari et al., 2013). In the ORESTE method, the finite set A ={a1,a2, ...,an} has n elements defined as a set of alternatives, and the alternatives are defined as the set of k elements. C ={c1,c2,. . . ck} is assessed using a set of criteria. The relative importance of criteria preorder, weak preorder, or weak preorder instead of weights in determining the preference structure known as weak order (Pastijn et al., 1989). S = (P or I) denotes the criteria in the preliminary ranking. P (preference), the asymmetric criterion, expresses preference for the other criterion; I (indifference), which expresses preference for the criterion and a symmetric relationship, indicates no difference between the other criterion. ORESTE solves decision-making problems in two stages (Eliseo et al., 2009).

- Based on the order of criteria and the order of alternatives depending on the criteria, and the full global preliminary ranking of alternatives (ORESTE I)
- 2. Following the contradiction and indifference analyses, the alternatives are considered to create a partial preliminary ranking (ORESTE II).

The ORESTE method establishes a weak preference structure for classification for each criterion (j = 1, 2,..., k) during the analysis phase. The final objective is to show the results of evaluating the alternatives on a global scale based on each criterion to establish the preference structure.
An example of each stage of the ORESTE method is shown below.

Determination of the decision problem: A = {a1, a2, a3} The set will be evaluated over the set of 4 criteria C = {c1, c2, c3, c4}.

Determination of relative importance by preliminary ranking: First, a weak ranking preference structure will be created to determine the relative importance of the criteria. The criteria will be ranked in order of importance from higher to lower in this step, and the relationships between the criteria will be expressed symmetrically/asymmetrically. The criteria's ranking and relationships are as follows when shown,

c1 P c2 I c3 P c4

The most and least important criteria are c1 and c4, respectively; c2 and c3 criteria are not superior to each other.
Similarly, the relative importance of alternatives is determined as follows:

c1: a1 P a2 I a3
c2: a2 P a3 P a1
c3: a1 I a2 I a3
c4: a3 I a1 P a2

According to criterion c1, the alternatives are ranked as a1, a2, and a3. Moreover, the relationship between the criteria is expressed as "a1 is superior to a2, a2 and a3 are of equal importance."

Determination of Besson Rank values: After determining the relative importance of the criteria and alternatives through

preliminary ranking, Besson Rank values must be calculated in order to digitize the evaluations for use in the analysis. Besson Rank (Besson, 1975) is a classification system named after Besson, which he developed in 1975. The Besson rank system is based on assigning rank values to criteria and alternatives in order of importance. If there is no superiority between the criteria/alternatives (I, if there is a symmetric relationship), Besson rank values are calculated by taking the arithmetic mean of the ranks of the criteria/alternatives, resulting in the same value for each. For example, it has the same importance as the first-ranked criterion.

For another criterion ranked second, the Besson rank values are (1 + 2)/2 = 1.5.

The Besson rank values of the criteria are expressed as *r(ci)*, while the Besson rank value of the alternative j an evaluated using the ci criterion is expressed as *rci(aj)*. According to this representation, the Besson rank values computed for the sample problem are:

r(c1)=1 r(c2)=2,5 r(c3)=2,5 r(c4)=4
rc1(a1)=1 rc1(a2)=2,5 rc1(a3)=2,5
.....
rc4(a3)=1,5 rc4(a1)=1,5 rc4(a2)=3

Calculation of projection distances: Based on the criterion/alternative rank value, projection distances allow one to determine the relative position of alternatives with respect to a chosen origin point. Many methods exist for calculating projection distances. Pastijn and Leysen's (1989) study on R A projection distance calculation method that varies depending on the value of the proposed methodology. Using this method, R becomes
$R \epsilon R_0$
R = 1: Average rank (Weighted arithmetic mean)
R = -1: Rank based on harmonic mean
R = 2: Rank based on quadratic mean
R = -∞ : min *(r(ci) , rci(aj))*
R = +∞ : max *(r(ci) , rci(aj))*
Projection distances that vary for different R values,

$$DRi(aj) = \left[\frac{1}{2} \times rc_i^R + \frac{1}{2} \times rc_i(a_{j)}^R\right]^{\frac{1}{R}} \tag{7}$$

is calculated with the equation. In this study, the average rank method was used in the calculation (R = 1). Meanwhile, The place in the projection distance of the sample problem is calculated according to criterion c1 for alternative a1, *r (c1) = 1* and using the parameters *rc1(a1) = 1*,

$$D_1(a_1) = \tfrac{1}{2} \times (1+1)=1$$

will be calculated as.

Determination of global ranks: The step of determining global rankings is the assignment of Besson rank values to all projection distances. The projection distances calculated in the previous step have Besson rank values based on the order in which they are located.

Determination of average ranks: In the step of calculating average ranks, the global rank obtained in the previous step is added to each alternative. To calculate average ranks, we use the following equation:

$$r(aj) = \Sigma_{i=1}^{m} ri(aj) \tag{8}$$

No additional processing is required because the average ranks obtained are interpreted solely based on ranking. The average ranks obtained are ranked from smallest to largest, and the alternatives' rankings are obtained based on the decision maker.

3.3. Integrated Approach

The proposed approach incorporates the ENTROPY and ORESTE methods. ENTROPY was used to find the weights of the criteria in the first stage of the approach, and the weights of each criterion were found. The ORESTE method first normalized the decision matrix, and then found the weight classification of the normalized matrix's criteria. The next step assigned the sum of the global rankings for each alternative, and the final step obtained the global ranking of each alternative. The criteria weights found in ENTROPY are used in the Bayer rank after the decision matrix is normalized, and the ORESTE method determines the criteria weight rankings. Figure 1 shows the flow chart for the integrated method.

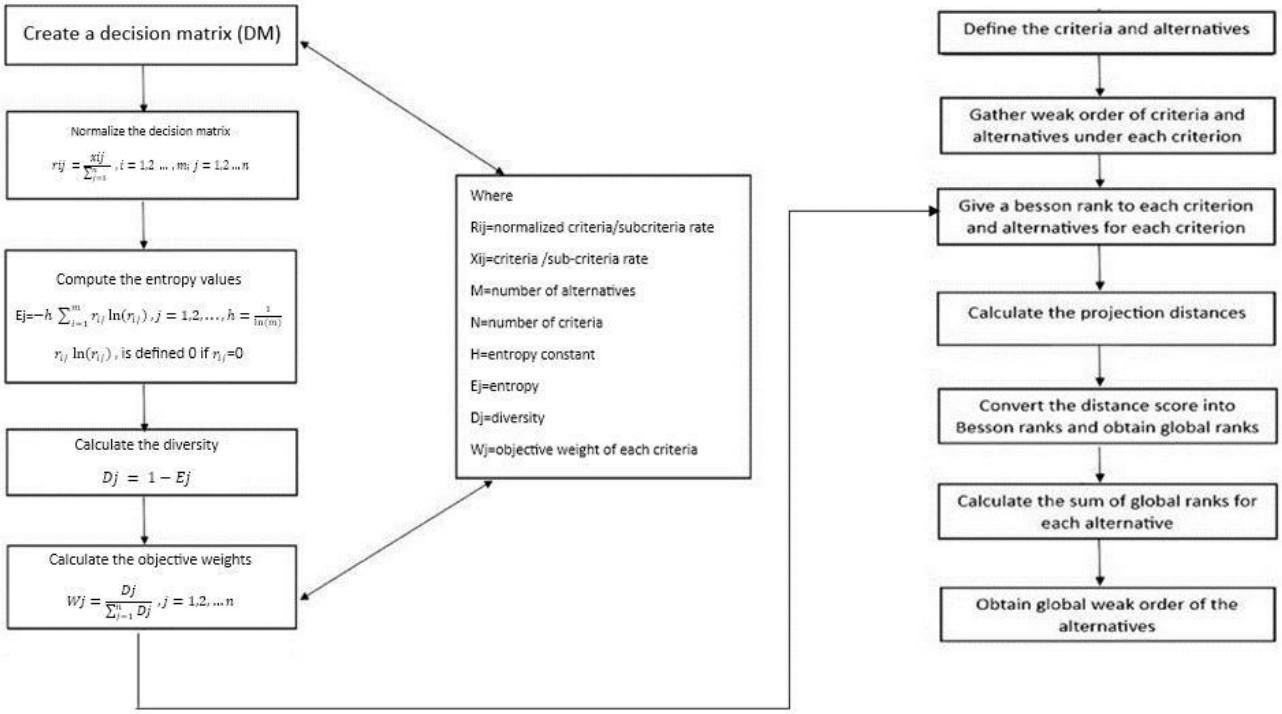

Figure 1. The framework of the proposed ENTROPY-based ORESTE method

4. Application

4.1. World Bank's Logistic Performance Index (2023) Data

The 2023 LPI survey ran from September 6 to November 5, 2022. It contains 4,090 country assessments completed by 652 logistics professionals from 115 countries across the World Bank's regions. Unlike previous editions, the 2023 survey did not include questions about logistics quality in the country from which these professionals operate or an assessment of domestic performance to keep the survey concise and easy to answer. The team also encountered difficulties surveying 2020/2021 due to the COVID-19 pandemic, ultimately postponing it until 2022 (World Bank Report 2023).

The World Bank's LPI analyzes countries through six criteria:

1. Customs (p_1)
2. Infrastructure (p_2)
3. International shipments (p_3)
4. Logistic competence and equality (p_4)
5. Timeliness (p_5)
6. Tracking and tracking (p_6)

4.2. Ranking the Countries

The World Bank 2023 data served as a decision matrix. Table 1 shows the weights of the criteria obtained using the ENTROPY method. The determined criterion weights were ranked using the logic of the ORESTE method, with the largest criterion coming first, and the close values were assigned the arithmetic mean value. The decision matrix (Table 2) was then normalized, the weight ranking of the criteria was obtained, and the Bessian rank was found in the following step. Moreover, to find the Bessian rank, each country received a rank (Table 3).

Table 1. Criteria weight obtained by the ENTROPY method

Criteria	**P_1**	**P_2**	**P_3**	**P_4**	**P_5**	**P_6**
Values	0,185226	0,224795	0,121313	0,169444	0,184529	0,114692636

Table 2. Decision matrix

Country	P_1	P_2	P_3	P_4	P_5	P_6	Country	P_1	P_2	P_3	P_4	P_5	P_6	Country	P_1	P_2	P_3	P_4	P_5	P_6	Country	P_1	P_2	P_3	P_4	P_5	P_6
Singapore	*4,2*	*4,6*	*4*	*4,4*	*4,4*	*4,3*	*Iceland*	*3,7*	*3,6*	*3,3*	*3,5*	*3,7*	*3,6*	*Cyprus*	*2,9*	*2,8*	*3,1*	*3,2*	*3,4*	*3,5*	*Sri Lanka*	*2,5*	*2,4*	*2,8*	*2,7*	*3*	*3,3*
Finland	4	4,2	4,1	4,2	4,2	4,3	Ireland	3,4	3,5	3,6	3,6	3,7	3,7	Hungary	2,7	3,1	3,4	3,1	3,4	3,6	Bahamas	2,7	2,5	3,1	2,5	2,6	3
Denmark	*4,1*	*4,1*	*3,6*	*4,1*	*4,3*	*4,1*	*Israel*	*3,4*	*3,7*	*3,5*	*3,8*	*3,7*	*3,8*	*Kuwait*	*3,2*	*3,6*	*3,2*	*2,9*	*3,3*	*2,8*	*Belarus*	*2,6*	*2,7*	*2,6*	*2,6*	*2,6*	*3,1*
Germany	3,9	4,3	3,7	4,2	4,2	4,1	Luxembourg	3,6	3,6	3,6	3,9	3,5	3,5	Romania	2,7	2,9	3,4	3,3	3,5	3,6	Djibouti	2,6	2,3	2,5	2,8	2,7	3,6
The Netherlands	*3,9*	*4,2*	*3,7*	*4,2*	*4,2*	*4*	*Malaysia*	*3,3*	*3,6*	*3,7*	*3,7*	*3,7*	*3,7*	*Botswana*	*3*	*3,1*	*3*	*3,4*	*3*	*3,3*	*El Salvador*	*2,4*	*2,2*	*2,6*	*2,7*	*2,9*	*3,2*
Switzerland	4,1	4,4	3,6	4,3	4,2	4,2	New Zealand	3,4	3,8	3,2	3,7	3,8	3,8	Egypt, Arab Rep.	2,8	3	3,2	2,9	2,9	3,6	Georgia	2,6	2,3	2,7	2,6	2,8	3,1
Austria	*3,7*	*3,9*	*3,8*	*4*	*4,2*	*4,3*	*Poland*	*3,4*	*3,5*	*3,3*	*3,6*	*3,8*	*3,9*	*North Macedonia*	*3,1*	*3*	*2,8*	*3,2*	*3,2*	*3,5*	*Kazakhstan*	*2,6*	*2,5*	*2,6*	*2,7*	*2,8*	*2,9*
Belgium	3,9	4,1	3,8	4,2	4	4,2	Bahrain	3,3	3,6	3,1	3,3	3,4	4,1	Panama	3	3,3	3,1	3	2,9	3,4	Papua New Guinea	2,4	2,4	2,6	2,7	3	3,3
Canada	*4*	*4,3*	*3,6*	*4,2*	*4,1*	*4,1*	*Latvia*	*3,3*	*3,3*	*3,2*	*3,7*	*3,6*	*4*	*Bosnia and Herzegovina*	*2,7*	*2,6*	*3,1*	*2,9*	*3,2*	*3,2*	*Paraguay*	*2,4*	*2,5*	*2,7*	*2,6*	*2,8*	*3*
Hong Kong SAR, China	3,8	4	4	4	4,2	4,1	Qatar	3,1	3,8	3,1	3,9	3,6	3,5	Chile	3	2,8	2,7	3,1	3	3,2	Ukraine	2,4	2,4	2,8	2,6	2,6	3,1
Sweden	*4*	*4,2*	*3,4*	*4,2*	*4,1*	*4,2*	*Thailand*	*3,3*	*3,7*	*3,5*	*3,5*	*3,6*	*3,5*	*Indonesia*	*2,8*	*2,9*	*3*	*2,9*	*3*	*3,3*	*Bangladesh*	*2,3*	*2,3*	*2,6*	*2,7*	*2,4*	*3*
United Arab Emirates	3,7	4,1	3,8	4	4,1	4,2	India	3	3,2	3,5	3,5	3,4	3,6	Peru	2,6	2,5	3,1	2,7	3,4	3,4	Congo, Rep.	2,3	2,1	2,6	2,9	2,7	2,9
France	*3,7*	*3,8*	*3,7*	*3,8*	*4*	*4,1*	*Lithuania*	*3,2*	*3,5*	*3,4*	*3,6*	*3,1*	*3,6*	*Uruguay*	*2,9*	*2,7*	*2,7*	*3,1*	*3,3*	*3,2*	*Dominican Republic*	*2,6*	*2,7*	*2,4*	*2,6*	*2,4*	*3,1*
Japan	3,9	4,2	3,3	4,1	4	4	Portugal	3,2	3,6	3,1	3,6	3,2	3,6	Antigua and Barbuda	2,2	2,7	2,9	2,9	3,2	3,4	Guatemala	2,3	2,4	2,8	2,7	2,7	2,6
Spain	*3,6*	*3,8*	*3,7*	*3,9*	*4,1*	*4,2*	*Saudi Arabia*	*3*	*3,6*	*3,3*	*3,3*	*3,5*	*3,6*	*Benin*	*2,7*	*2,5*	*2,9*	*3*	*3,2*	*2,7*	*Guinea-Bissau*	*2,7*	*2,4*	*2,9*	*2,9*	*2,3*	*2,4*
Taiwan, China	3,5	3,8	3,7	3,9	4,2	4,2	Türkiye	3	3,4	3,4	3,5	3,5	3,6	Colombia	2,5	2,9	3	3,1	3,1	3,2	Mali	2,6	2	2,6	2,5	2,7	3,1
Korea, Rep.	*3,9*	*4,1*	*3,4*	*3,8*	*3,8*	*3,8*	*Croatia*	*3*	*3*	*3,6*	*3,4*	*3,4*	*3,2*	*Costa Rica*	*2,8*	*2,7*	*2,8*	*2,9*	*2,9*	*3,2*	*Nigeria*	*2,4*	*2,4*	*2,5*	*2,3*	*2,7*	*3,1*
United States	3,7	3,9	3,4	3,9	4,2	3,8	Czech Republic	3	3	3,4	3,6	3,2	3,7	Honduras	2,8	2,7	3	2,7	2,6	3,2	Russian Federation	2,4	2,7	2,3	2,6	2,5	2,9
Australia	*3,7*	*4,1*	*3,1*	*3,9*	*4,1*	*3,6*	*Malta*	*3,4*	*3,7*	*3*	*3,4*	*3,4*	*3,2*	*Mexico*	*2,5*	*2,8*	*2,8*	*3*	*3,1*	*3,5*	*Uzbekistan*	*2,6*	*2,4*	*2,6*	*2,6*	*2,4*	*2,8*
China	3,3	4	3,6	3,8	3,8	3,7	Oman	3	3,2	3,4	3,2	3,9	3,1	Namibia	2,8	2,8	3	2,9	2,8	2,9	Albania	2,4	2,7	2,8	2,3	2,3	2,5
Greece	*3,2*	*3,7*	*3,8*	*3,8*	*3,9*	*3,9*	*Philippines*	*2,8*	*3,2*	*3,1*	*3,3*	*3,3*	*3,9*	*Argentina*	*2,7*	*2,8*	*2,7*	*2,7*	*2,9*	*3,1*	*Algeria*	*2,3*	*2,1*	*3*	*2,2*	*2,5*	*2,6*
Italy	3,4	3,8	3,4	3,8	3,9	3,9	Slovak Republic	3,2	3,3	3	3,4	3,3	3,5	Montenegro	2,6	2,5	2,8	2,8	3,2	3,2	Armenia	2,5	2,6	2,2	2,6	2,3	2,7
Norway	*3,8*	*3,9*	*3*	*3,8*	*3,7*	*4*	*Slovenia*	*3,4*	*3,6*	*3,4*	*3,3*	*3*	*3,3*	*Rwanda*	*2,5*	*2,9*	*2,4*	*3*	*3*	*3,1*	*Bhutan*	*2,7*	*2,2*	*2,3*	*2,6*	*2,3*	*2,6*
South Africa	3,3	3,6	3,6	3,8	3,8	3,8	Vietnam	3,1	3,2	3,3	3,2	3,4	3,3	Serbia	2,2	2,4	2,9	2,7	2,9	3,4	Central African Republic	2,4	2,6	2,1	2,9	2,4	2,6
Congo, Dem. Rep.	*2,3*	*2,3*	*2,5*	*2,4*	*2,5*	*2,8*	*Togo*	*2,3*	*2,3*	*3*	*2,4*	*2,3*	*2,8*	*Sudan*	*2,1*	*2,3*	*2,4*	*2,4*	*2,3*	*2,7*	*Cuba*	*2*	*2,2*	*2,1*	*2,2*	*2,4*	*2,6*
Ghana	2,7	2,4	2,4	2,5	2,2	2,7	Trinidad and Tobago	2,2	2,4	2,5	2,4	2,5	2,9	Burkina Faso	2	2,3	2,4	2,4	2,2	2,4	Yemen, Rep.	1,7	1,9	1,7	2,6	2,3	2,8
Grenada	*2,6*	*2,5*	*2,6*	*2,2*	*2,3*	*3,1*	*Zimbabwe*	*2,2*	*2,4*	*2,5*	*2,3*	*2,7*	*2,8*	*Fiji*	*2,3*	*2,2*	*2,3*	*2,3*	*2,2*	*2,3*	*Angola*	*1,7*	*2,1*	*2,4*	*2,3*	*2,3*	*2,1*
Guinea	2,4	2,4	2,2	2,7	2,7	2,5	Bolivia	2,1	2,4	2,5	2,4	2,5	2,4	Gambia, The	1,8	2,3	2,6	2,3	2,4	2,6	Cameroon	2,1	2,1	2,2	2,1	1,8	2,1
Jamaica	*2,2*	*2,4*	*2,4*	*2,5*	*2,8*	*2,9*	*Cambodia*	*2,2*	*2,1*	*2,3*	*2,4*	*2,8*	*2,7*	*Iran, Islamic Rep.*	*2,2*	*2,4*	*2,4*	*2,1*	*2,4*	*2,7*	*Haiti*	*2,1*	*1,8*	*2,3*	*2*	*2,1*	*2,5*
Mauritius	2,4	2,5	1,9	2,5	2,9	3,1	Gabon	2	2,2	2,6	2	2,5	3	Kyrgyz Republic	2,2	2,4	2,4	2,2	2,3	2,4	Somalia	1,5	1,9	2,4	1,8	1,8	2,3
Moldova	*1,9*	*1,9*	*2,7*	*2,8*	*2,8*	*3*	*Guyana*	*2,3*	*2,4*	*2,1*	*2,6*	*2,2*	*2,6*	*Madagascar*	*1,8*	*1,8*	*2,9*	*2,2*	*2*	*2,6*	*Afghanistan*	*2,1*	*1,7*	*1,8*	*2*	*1,6*	*2,3*
Mongolia	2,5	2,3	2,5	2,3	2,4	2,7	Iraq	2,1	2,2	2,5	2,2	2,4	3	Mauritania	2,1	2	2,2	2,5	2,5	2,8	Libya	1,9	1,7	2	1,9	1,8	2,2
Nicaragua	*2*	*1,9*	*2,8*	*2,8*	*2,4*	*2,9*	*Lao PDR*	*2,3*	*2,3*	*2,3*	*2,4*	*2,4*	*2,8*	*Syrian Arab Republic*	*2,2*	*2,2*	*2,3*	*2,2*	*2,3*	*2,5*						
Tajikistan	2,2	2,5	2,5	2,8	2	2,9	Liberia	2,1	2,4	2,8	2,4	2,4	2,3	Venezuela, RB	2,1	2,4	2	2,5	2,3	2,5						

Table 3. The Bessian rank and total rank result.

Country	P_1	P_2	P_3	P_4	P_5	P_6	TOTAL	RANKING
Singapore	3,5	1	17	9	3,5	23	57	1
Finland	*17*	*17*	*11,5*	*35,5*	*28,5*	*23*	*133*	*2*
Denmark	9	50	111,5	59,5	6	88	324	7
Germany	*45*	*6*	*69*	*35,5*	*28,5*	*88*	*272*	*4*
The Netherlands	45	17	69	35,5	28,5	125,5	321	5
Switzerland	*9*	*2*	*111,5*	*11,5*	*28,5*	*55,5*	*218*	*3*
Austria	88	80	40,5	77	28,5	23	337	9
Belgium	*45*	*50*	*40,5*	*35,5*	*96,5*	*55,5*	*323*	*6*
Canada	17	6	111,5	35,5	69	88	327	8
Hong Kong SAR, China	*61,5*	*69*	*17*	*77*	*28,5*	*88*	*341*	*10*
Sweden	17	17	199,5	35,5	69	55,5	394	12
United Arab Emirates	*88*	*50*	*40,5*	*77*	*69*	*55,5*	*380*	*11*
France	88	111,5	69	133,5	96,5	88	587	16
Japan	*45*	*17*	*240*	*59,5*	*96,5*	*125,5*	*584*	*15*
Spain	119,5	111,5	69	101,5	69	55,5	526	14
Taiwan, China	*128,5*	*111,5*	*69*	*101,5*	*28,5*	*55,5*	*495*	*13*
Korea, Rep.	45	50	199,5	133,5	143	166	737	18
United States	*88*	*80*	*199,5*	*101,5*	*28,5*	*166*	*664*	*17*
Australia	88	50	319,5	101,5	69	249,5	878	21
China	*190,5*	*69*	*111,5*	*133,5*	*143*	*211*	*859*	*20*
Greece	229,5	143	40,5	133,5	122	152,5	821	19
Italy	*160*	*111,5*	*199,5*	*133,5*	*122*	*152,5*	*879*	*22*
Norway	61,5	80	379	133,5	171	125,5	951	26
South Africa	*190,5*	*183*	*111,5*	*133,5*	*143*	*166*	*928*	*25*
United Kingdom	128,5	143	152,5	176	96,5	211	908	23
Estonia	*229,5*	*224,5*	*199,5*	*176*	*143*	*88*	*1061*	*30*
Iceland	88	183	240	234,5	171	249,5	1166	33
Ireland	*160*	*224,5*	*111,5*	*216*	*171*	*211*	*1094*	*31*
Israel	160	143	152,5	133,5	171	166	926	24
Luxembourg	*119,5*	*183*	*111,5*	*101,5*	*220,5*	*310*	*1046*	*29*
Malaysia	190,5	183	69	176	171	211	1001	27
New Zealand	*160*	*111,5*	*274,5*	*176*	*143*	*166*	*1031*	*28*
Poland	160	224,5	240	216	143	152,5	1136	32
Bahrain	*190,5*	*183*	*319,5*	*285*	*262,5*	*88*	*1329*	*37*
Latvia	190,5	249,5	274,5	176	207	125,5	1223	34
Qatar	*262,5*	*111,5*	*319,5*	*101,5*	*207*	*310*	*1312*	*36*
Thailand	190,5	143	152,5	234,5	207	310	1238	35
India	*295,5*	*279*	*152,5*	*234,5*	*262,5*	*249,5*	*1474*	*39*
Lithuania	229,5	224,5	199,5	216	363	249,5	1482	41
Portugal	*229,5*	*183*	*319,5*	*216*	*339,5*	*249,5*	*1537*	*42*
Saudi Arabia	295,5	183	240	285	220,5	249,5	1474	39
Türkiye	*295,5*	*237*	*199,5*	*234,5*	*220,5*	*249,5*	*1437*	*38*
Croatia	295,5	326,5	111,5	270,5	262,5	434,5	1701	47
Czech Republic	*295,5*	*326,5*	*199,5*	*216*	*339,5*	*211*	*1588*	*43*

Table 3. Continued

	Malta	160	143	379	270,5	262,5	434,5	1650	45
Oman	*295,5*	*279*	*199,5*	*330,5*	*122*	*502*	*1729*	*49*	
	Philippines	358,5	279	319,5	285	295,5	152,5	1690	46
Slovak Republic	*229,5*	*249,5*	*379*	*270,5*	*295,5*	*310*	*1734*	*50*	
	Slovenia	160	183	199,5	285	394	387,5	1609	44
Vietnam	*262,5*	*279*	*240*	*330,5*	*262,5*	*387,5*	*1762*	*51*	
	Brazil	334	279	434,5	285	339,5	310	1982	55
Bulgaria	*262,5*	*304*	*379*	*285*	*295,5*	*310*	*1836*	*53*	
	Cyprus	334	367	319,5	330,5	262,5	310	1924	54
Hungary	*402*	*304*	*199,5*	*351,5*	*262,5*	*249,5*	*1769*	*52*	
	Kuwait	229,5	183	274,5	420	295,5	634,5	2037	58
Romania	*402*	*345,5*	*199,5*	*285*	*220,5*	*249,5*	*1702*	*48*	
	Botswana	295,5	304	379	270,5	394	387,5	2031	56
Egypt, Arab Rep.	*358,5*	*326,5*	*274,5*	*420*	*447,5*	*249,5*	*2077*	*60*	
	North Macedonia	262,5	326,5	475,5	330,5	339,5	310	2045	59
Panama	*295,5*	*249,5*	*319,5*	*371,5*	*447,5*	*351,5*	*2035*	*57*	
	Bosnia and Herzegovina	402	453,5	319,5	420	339,5	434,5	2369	63
Chile	*295,5*	*367*	*531*	*351,5*	*394*	*434,5*	*2374*	*64*	
	Indonesia	358,5	345,5	379	420	394	387,5	2285	61
Peru	*460,5*	*485*	*319,5*	*519*	*262,5*	*351,5*	*2398*	*67*	
	Uruguay	334	410,5	531	351,5	295,5	434,5	2357	62
Antigua and Barbuda	*674,5*	*410,5*	*434,5*	*420*	*339,5*	*351,5*	*2631*	*70*	
	Benin	402	485	434,5	371,5	339,5	687,5	2720	73
Colombia	*510,5*	*345,5*	*379*	*351,5*	*363*	*434,5*	*2384*	*65*	
	Costa Rica	358,5	410,5	475,5	420	447,5	434,5	2547	68
Honduras	*358,5*	*410,5*	*379*	*519*	*556,5*	*434,5*	*2658*	*71*	
	Mexico	510,5	367	475,5	371,5	363	310	2398	66
Namibia	*358,5*	*367*	*379*	*420*	*493*	*603,5*	*2621*	*69*	
	Argentina	402	367	531	519	447,5	502	2769	75
Montenegro	*460,5*	*485*	*475,5*	*468*	*339,5*	*434,5*	*2663*	*72*	
	Rwanda	510,5	345,5	700,5	371,5	394	502	2824	76
Serbia	*674,5*	*568*	*434,5*	*519*	*447,5*	*351,5*	*2995*	*79*	
	Solomon Islands	549	453,5	434,5	420	447,5	434,5	2739	74
Sri Lanka	*510,5*	*568*	*475,5*	*519*	*394*	*387,5*	*2855*	*77*	
	Bahamas, The	402	485	319,5	627	556,5	540,5	2931	78
Belarus	*460,5*	*410,5*	*588,5*	*588,5*	*556,5*	*502*	*3107*	*82*	
	Djibouti	460,5	664,5	643	468	531	249,5	3017	81
El Salvador	*549*	*709*	*588,5*	*519*	*447,5*	*434,5*	*3248*	*87*	
	Georgia	460,5	664,5	531	588,5	493	502	3240	85
Kazakhstan	*460,5*	*485*	*588,5*	*519*	*493*	*603,5*	*3150*	*83*	
	Papua New Guinea	549	568	588,5	519	394	387,5	3006	80
Paraguay	*549*	*485*	*531*	*588,5*	*493*	*540,5*	*3187*	*84*	
	Ukraine	549	568	475,5	588,5	556,5	502	3240	85
Bangladesh	*619*	*664,5*	*588,5*	*519*	*653,5*	*540,5*	*3585*	*98*	
	Congo, Rep.	619	751	588,5	420	531	603,5	3513	94

Table 3. Continued

	Malta	160	143	379	270,5	262,5	434,5	1650	45
Oman	*295,5*	*279*	*199,5*	*330,5*	*122*	*502*	*1729*	*49*	
	Philippines	358,5	279	319,5	285	295,5	152,5	1690	46
Slovak Republic	*229,5*	*249,5*	*379*	*270,5*	*295,5*	*310*	*1734*	*50*	
	Slovenia	160	183	199,5	285	394	387,5	1609	44
Vietnam	*262,5*	*279*	*240*	*330,5*	*262,5*	*387,5*	*1762*	*51*	
	Brazil	334	279	434,5	285	339,5	310	1982	55
Bulgaria	*262,5*	*304*	*379*	*285*	*295,5*	*310*	*1836*	*53*	
	Cyprus	334	367	319,5	330,5	262,5	310	1924	54
Hungary	*402*	*304*	*199,5*	*351,5*	*262,5*	*249,5*	*1769*	*52*	
	Kuwait	229,5	183	274,5	420	295,5	634,5	2037	58
Romania	*402*	*345,5*	*199,5*	*285*	*220,5*	*249,5*	*1702*	*48*	
	Botswana	295,5	304	379	270,5	394	387,5	2031	56
Egypt, Arab Rep.	*358,5*	*326,5*	*274,5*	*420*	*447,5*	*249,5*	*2077*	*60*	
	North Macedonia	262,5	326,5	475,5	330,5	339,5	310	2045	59
Panama	*295,5*	*249,5*	*319,5*	*371,5*	*447,5*	*351,5*	*2035*	*57*	
	Bosnia and Herzegovina	402	453,5	319,5	420	339,5	434,5	2369	63
Chile	*295,5*	*367*	*531*	*351,5*	*394*	*434,5*	*2374*	*64*	
	Indonesia	358,5	345,5	379	420	394	387,5	2285	61
Peru	*460,5*	*485*	*319,5*	*519*	*262,5*	*351,5*	*2398*	*67*	
	Uruguay	334	410,5	531	351,5	295,5	434,5	2357	62
Antigua and Barbuda	*674,5*	*410,5*	*434,5*	*420*	*339,5*	*351,5*	*2631*	*70*	
	Benin	402	485	434,5	371,5	339,5	687,5	2720	73
Colombia	*510,5*	*345,5*	*379*	*351,5*	*363*	*434,5*	*2384*	*65*	
	Costa Rica	358,5	410,5	475,5	420	447,5	434,5	2547	68
Honduras	*358,5*	*410,5*	*379*	*519*	*556,5*	*434,5*	*2658*	*71*	
	Mexico	510,5	367	475,5	371,5	363	310	2398	66
Namibia	*358,5*	*367*	*379*	*420*	*493*	*603,5*	*2621*	*69*	
	Argentina	402	367	531	519	447,5	502	2769	75
Montenegro	*460,5*	*485*	*475,5*	*468*	*339,5*	*434,5*	*2663*	*72*	
	Rwanda	510,5	345,5	700,5	371,5	394	502	2824	76
Serbia	*674,5*	*568*	*434,5*	*519*	*447,5*	*351,5*	*2995*	*79*	
	Solomon Islands	549	453,5	434,5	420	447,5	434,5	2739	74
Sri Lanka	*510,5*	*568*	*475,5*	*519*	*394*	*387,5*	*2855*	*77*	
	Bahamas, The	402	485	319,5	627	556,5	540,5	2931	78
Belarus	*460,5*	*410,5*	*588,5*	*588,5*	*556,5*	*502*	*3107*	*82*	
	Djibouti	460,5	664,5	643	468	531	249,5	3017	81
El Salvador	*549*	*709*	*588,5*	*519*	*447,5*	*434,5*	*3248*	*87*	
	Georgia	460,5	664,5	531	588,5	493	502	3240	85
Kazakhstan	*460,5*	*485*	*588,5*	*519*	*493*	*603,5*	*3150*	*83*	
	Papua New Guinea	549	568	588,5	519	394	387,5	3006	80
Paraguay	*549*	*485*	*531*	*588,5*	*493*	*540,5*	*3187*	*84*	
	Ukraine	549	568	475,5	588,5	556,5	502	3240	85
Bangladesh	*619*	*664,5*	*588,5*	*519*	*653,5*	*540,5*	*3585*	*98*	
	Congo, Rep.	619	751	588,5	420	531	603,5	3513	94

Table 3. Continued

	Malta	160	143	379	270,5	262,5	434,5	1650	45
Oman	*295,5*	*279*	*199,5*	*330,5*	*122*	*502*	*1729*	*49*	
	Philippines	358,5	279	319,5	285	295,5	152,5	1690	46
Slovak Republic	*229,5*	*249,5*	*379*	*270,5*	*295,5*	*310*	*1734*	*50*	
	Slovenia	160	183	199,5	285	394	387,5	1609	44
Vietnam	*262,5*	*279*	*240*	*330,5*	*262,5*	*387,5*	*1762*	*51*	
	Brazil	334	279	434,5	285	339,5	310	1982	55
Bulgaria	*262,5*	*304*	*379*	*285*	*295,5*	*310*	*1836*	*53*	
	Cyprus	334	367	319,5	330,5	262,5	310	1924	54
Hungary	*402*	*304*	*199,5*	*351,5*	*262,5*	*249,5*	*1769*	*52*	
	Kuwait	229,5	183	274,5	420	295,5	634,5	2037	58
Romania	*402*	*345,5*	*199,5*	*285*	*220,5*	*249,5*	*1702*	*48*	
	Botswana	295,5	304	379	270,5	394	387,5	2031	56
Egypt, Arab Rep.	*358,5*	*326,5*	*274,5*	*420*	*447,5*	*249,5*	*2077*	*60*	
	North Macedonia	262,5	326,5	475,5	330,5	339,5	310	2045	59
Panama	*295,5*	*249,5*	*319,5*	*371,5*	*447,5*	*351,5*	*2035*	*57*	
	Bosnia and Herzegovina	402	453,5	319,5	420	339,5	434,5	2369	63
Chile	*295,5*	*367*	*531*	*351,5*	*394*	*434,5*	*2374*	*64*	
	Indonesia	358,5	345,5	379	420	394	387,5	2285	61
Peru	*460,5*	*485*	*319,5*	*519*	*262,5*	*351,5*	*2398*	*67*	
	Uruguay	334	410,5	531	351,5	295,5	434,5	2357	62
Antigua and Barbuda	*674,5*	*410,5*	*434,5*	*420*	*339,5*	*351,5*	*2631*	*70*	
	Benin	402	485	434,5	371,5	339,5	687,5	2720	73
Colombia	*510,5*	*345,5*	*379*	*351,5*	*363*	*434,5*	*2384*	*65*	
	Costa Rica	358,5	410,5	475,5	420	447,5	434,5	2547	68
Honduras	*358,5*	*410,5*	*379*	*519*	*556,5*	*434,5*	*2658*	*71*	
	Mexico	510,5	367	475,5	371,5	363	310	2398	66
Namibia	*358,5*	*367*	*379*	*420*	*493*	*603,5*	*2621*	*69*	
	Argentina	402	367	531	519	447,5	502	2769	75
Montenegro	*460,5*	*485*	*475,5*	*468*	*339,5*	*434,5*	*2663*	*72*	
	Rwanda	510,5	345,5	700,5	371,5	394	502	2824	76
Serbia	*674,5*	*568*	*434,5*	*519*	*447,5*	*351,5*	*2995*	*79*	
	Solomon Islands	549	453,5	434,5	420	447,5	434,5	2739	74
Sri Lanka	*510,5*	*568*	*475,5*	*519*	*394*	*387,5*	*2855*	*77*	
	Bahamas, The	402	485	319,5	627	556,5	540,5	2931	78
Belarus	*460,5*	*410,5*	*588,5*	*588,5*	*556,5*	*502*	*3107*	*82*	
	Djibouti	460,5	664,5	643	468	531	249,5	3017	81
El Salvador	*549*	*709*	*588,5*	*519*	*447,5*	*434,5*	*3248*	*87*	
	Georgia	460,5	664,5	531	588,5	493	502	3240	85
Kazakhstan	*460,5*	*485*	*588,5*	*519*	*493*	*603,5*	*3150*	*83*	
	Papua New Guinea	549	568	588,5	519	394	387,5	3006	80
Paraguay	*549*	*485*	*531*	*588,5*	*493*	*540,5*	*3187*	*84*	
	Ukraine	549	568	475,5	588,5	556,5	502	3240	85
Bangladesh	*619*	*664,5*	*588,5*	*519*	*653,5*	*540,5*	*3585*	*98*	
	Congo, Rep.	619	751	588,5	420	531	603,5	3513	94

4.3. Comparison and Sensitivity Analysis

The thesis started with a more sensitive analysis of the World Bank report. This analysis aimed to assign different values to the criteria using MCDM and show that the ORESTE method provides a structured, rational, consistent, and more agile approach to decision problems. Each criterion was weighted according to the ENTROPY method. The ranking of 139 countries was analyzed using the ORESTE method after applying the ENTROPY method to find the criteria weights. Different criteria weights were used to demonstrate the method's increased accuracy and agility. The decision matrix for the World Bank report was compiled. The ORESTE method's first step was to assign a sequence number to the criteria. The decision matrix was then standardized, and all values were normalized between 0 and 1 using min (1) and max (5) values.

This subsection used a sensitivity analysis to validate the proposed approaches. To interpret the analysis more sensitively, the criterion weights were found using all the steps of the ENTROPY method, then another analysis was performed taking each criterion weight with equal importance to interpret it from a different perspective. Moreover, the criterion weights found in two different studies with Criteria Importance Through Intercriteria Correlation (CRITIC) and Step-Wise Weight Assesment Ratio Analysis (SWARA), which are different from the evaluations of the LPI made in the literature, were taken and analyzed using ORESTE to the criterion weights from four different angles (Table 4). First, the criteria weights were determined using the ENTROPY method. A second evaluation was carried out with equal weights assigned to each criteria. The third evaluation (Türkoğlu and Duran,2023) analyzed the criteria weights found by the CRITIC method in Regional Comprehensive Economic Partnership (RCEP) countries using MCDM. As a fourth evaluation (Kısa and Ayçin, 2019), the logistics performances of OECD countries were analyzed using the criteria weights found by the SWARA method.

Table 4. Criterion weights according to the cases considered

	Criterion Weights					
Considered Cases	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
Base Case (by ENTROPY of current study)	0,185226	0,224795	0,121313	0,169444	0,184529	0,114693
Case 1: Equal value criteria weights	0,166667	0,166667	0,166667	0,166667	0,166667	0,166667
Case 2: Türkoğlu & Duran (2023)	0,27466	0,2957	0,27561	0,24949	0,27531	0,26886
Case 3: Kısa & Ayçin (2019)	0,14	0,195	0,173	0,2	0,134	0,151

Table 5. Results of the ranking orders of the country concerning four cases.

COUNTRIES	BASE CASE	CASE 1	CASE 2	CASE 3	COUNTRIES	BASE CASE	CASE 1	CASE 2	CASE 3	COUNTRIES	BASE CASE	CASE 1	CASE 2	CASE 3	COUNTRIES	BASE CASE	CASE 1	CASE 2	CASE 3
Singapore	1	1	1	1	**Norway**	26	26	26	26	**Malta**	45	45	45	45	**Benin**	73	74	73	73
Finland	2	2	2	2	**South Africa**	25	25	25	25	**Oman**	49	49	48	49	**Colombia**	65	66	65	64
Denmark	7	7	6	5	**United Kingdom**	23	23	23	23	**Philippines**	46	46	47	46	**Costa Rica**	68	68	68	68
Germany	4	4	4	4	**Estonia**	30	30	30	29	**Slovak Republic**	50	50	50	50	**Honduras**	71	71	71	72
The Netherlands	5	8	7	8	**Iceland**	33	33	33	33	**Slovenia**	44	44	44	44	**Mexico**	66	67	67	67
Switzerland	3	3	3	3	**Ireland**	31	31	31	31	**Vietnam**	51	51	52	51	**Namibia**	69	69	70	70
Austria	9	9	9	9	**Israel**	24	24	24	24	**Brazil**	55	55	55	55	**Argentina**	75	75	75	75
Belgium	6	5	5	7	**Luxembourg**	29	29	29	30	**Bulgaria**	53	53	53	53	**Montenegro**	72	72	72	71
Canada	8	6	8	6	**Malaysia**	27	27	27	28	**Cyprus**	54	54	54	54	**Rwanda**	76	76	76	76
Hong Kong SAR, China	10	10	10	10	**New Zealand**	28	28	28	27	**Hungary**	52	52	51	52	**Serbia**	79	80	79	80
Sweden	12	12	12	12	**Poland**	32	32	32	32	**Kuwait**	58	58	57	59	**Solomon Islands**	74	73	74	74
United Arab Emirates	11	11	11	11	**Bahrain**	37	37	37	37	**Romania**	48	48	49	48	**Sri Lanka**	77	77	77	77
France	16	15	16	16	**Latvia**	34	35	35	34	**Botswana**	56	56	56	58	**Bahamas, The**	78	78	78	78
Japan	15	16	15	15	**Qatar**	36	36	36	36	**Egypt, Arab Rep.**	60	60	60	60	**Belarus**	82	82	82	82
Spain	14	14	14	14	**Thailand**	35	34	34	35	**North Macedonia**	59	57	57	56	**Djibouti**	81	81	80	79
Taiwan, China	13	13	13	13	**India**	39	39	39	40	**Panama**	57	59	57	57	**El Salvador**	87	85	86	86
Korea, Rep.	18	18	18	18	**Lithuania**	41	41	40	39	**Bosnia and Herzegovina**	63	62	63	62	**Georgia**	85	86	85	85
United States	17	17	17	17	**Portugal**	42	42	42	42	**Chile**	64	64	64	66	**Kazakhstan**	83	83	83	83
Australia	21	22	22	22	**Saudi Arabia**	39	40	41	41	**Indonesia**	61	61	61	61	**Paraguay**	84	84	84	84
China	20	21	21	20	**Türkiye**	38	38	38	38	**Peru**	67	65	66	65	**Ukraine**	85	87	87	87
Greece	19	19	19	19	**Croatia**	47	47	46	47	**Uruguay**	62	63	62	63	**Bangladesh**	98	98	98	98
Italy	22	20	20	21	**Czech Republic**	43	43	43	43	**Antigua and Barbuda**	70	70	69	69	**Papua New Guinea**	80	79	81	81
Congo, Rep.	94	94	95	95	**Congo, Dem. Rep.**	111	111	111	111	**Bolivia**	118	120	117	118	**Madagascar**	128	128	128	129
Dominican Republic	88	88	88	88	**Ghana**	107	108	108	108	**Cambodia**	119	118	119	119	**Mauritania**	123	124	123	124
Guatemala	91	91	90	92	**Grenada**	97	96	97	96	**Gabon**	117	117	118	117	**Syrian Arab Republic**	131	132	131	132
Guinea-Bissau	89	89	89	89	**Guinea**	105	106	105	106	**Guyana**	121	121	121	121	**Venezuela, RB**	127	127	126	127
Mali	92	92	92	91	**Jamaica**	102	103	102	104	**Iraq**	120	119	120	120	**Cuba**	133	133	133	133
Nigeria	96	97	96	97	**Mauritius**	90	90	91	90	**Lao PDR**	116	116	116	116	**Yemen, Rep.**	129	129	130	128
Russian Federation	95	95	94	94	**Moldova**	100	100	100	99	**Liberia**	115	115	115	115	**Angola**	134	134	134	134
Uzbekistan	93	93	93	93	**Mongolia**	113	113	113	113	**Sudan**	125	125	125	125	**Cameroon**	136	136	136	136
Albania	101	102	103	101	**Nicaragua**	108	107	107	107	**Burkina Faso**	130	130	129	130	**Haiti**	135	135	135	135
Algeria	112	112	112	112	**Tajikistan**	103	101	101	103	**Fiji**	132	131	132	131	**Somalia**	137	137	137	137
Armenia	106	105	106	105	**Togo**	104	104	104	102	**Gambia, The**	124	123	124	123	**Afghanistan**	138	138	138	138
Bhutan	114	114	114	114	**Trinidad and Tobago**	110	109	109	109	**Iran, Islamic Rep.**	122	122	122	122	**Libya**	139	139	139	139
Central African Republic	99	99	99	100	**Zimbabwe**	109	110	110	110	**Kyrgyz Republic**	126	126	127	126					

Table 5 shows the country rankings analyzed with the ORESTE method using the proposed method (ENTROPY), the equal importance of each criterion, and the criterion weights of CRITIC and SWARA methods studied in the literature. The studies in the literature supported the proposed method, and the fact that there was no significant difference in country rankings demonstrated that the method was agile. Although the country rankings were unclear in the World Bank data, the methods used to rank each country differed. Libya had the lowest LPI score in each method, whereas Singapore showed the highest.

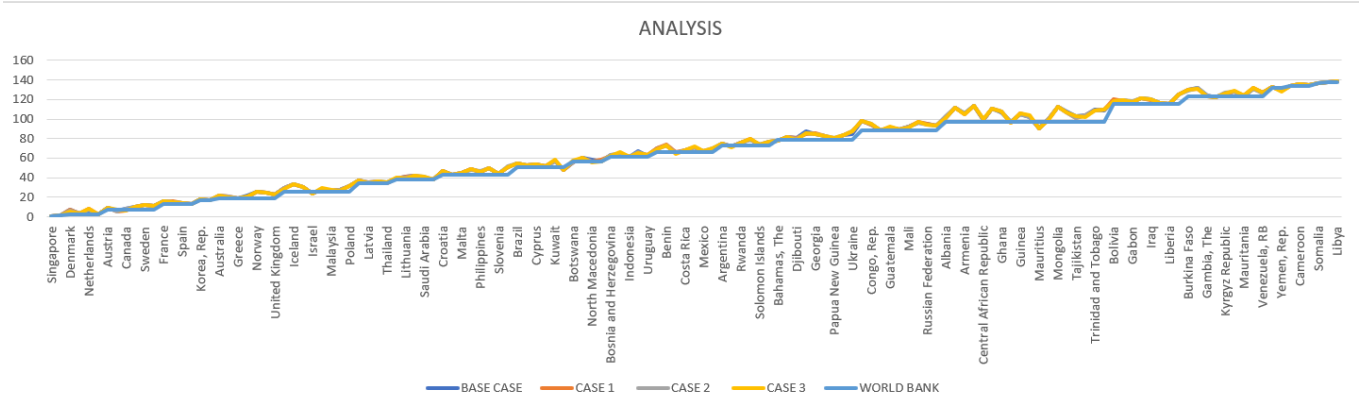

Figure 2. Sensitivity analysis results.

Figure 2 shows the comparison of 139 countries according to the aforementioned four analyses and with the World Bank. The World Bank data do not clearly rank these countries, but the four analyses ranked each country, with no significant difference with the World Bank data. The data in the literature support the proposed method.

5. Conclusion and Recommendations

This study analyzed the logistics, one of today's most important topics, and the LPI, one of its fundamental steps, were analyzed using scientific methods. The World Bank report implemented a scoring system based on expert opinions, and the countries' LPI scores were calculated for each criterion by taking the final average. The need for a more objective and precise re-assessment of the evaluation, based on examining the World Bank report, prompted the adoption of an unused method in the literature, making the study unique and allowing for a meticulous analysis of the assessment. The study was re-analyzed objectively without needing an expert, taking criterion weights from four perspectives. The country rankings were analyzed while keeping the ORESTE method constant in terms of criterion weights. When compared to World Bank data, it was discovered that there is no clear ranking for each country, and in some cases, more than one country has the same ranking. However, each country's ranking differs in the proposed methods depending on the criteria weights used. Future research could improve the literature by using fuzzy logic to determine criteria weights, investigating country groups, and expanding the analysis beyond rankings to provide a comprehensive evaluation of logistics performance. Longitudinal studies can be used to analyze the dynamics of countries' logistics performance over time. Examining these trends and changes in logistics performance over time can help identify the primary drivers of change, assess the impact of policy interventions on logistics performance, incorporate sustainability metrics and indicators into the assessment framework, and broaden the analysis. This could include evaluating the environmental and social impacts of logistics activities, such as carbon emissions, resource use, and working conditions, to gain a more comprehensive understanding of logistics performance. Finally, by evaluating the LPIs of the countries, the most exported countries can be identified, their logistics performance can be thoroughly analyzed, and exporters can view the logistics performance analysis of the countries to which they will export.

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