Evaluation of Logistics Performance of The OECD Member Countries with Integrated Entropy and Waspas Method

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ABSTRACT

The Logistics Performance Index (LPI) developed by the World Bank is important in evaluating countries' logistics activities. Moreover, the LPI creates a competitive environment among various countries. It also provides an opportunity for countries to develop their logistics performances based on their geographic positions. This study uses the World Bank's recently published LPI data of 2018. Based on this data, the logistics performances of 38 OECD member countries are determined by integrating the ENTROPY and WASPAS methods. The result of the calculations conducted using the ENTROPY method shows that in order of importance the logistics performance criteria are infrastructure, customs, logistics quality and competence, tracking and tracing, international shipments, and timeliness, according to their significance. Therefore, the infrastructure criterion is the most important in comparing the logistics performances of the OECD member countries. As a result of the analyzes carried out by the WASPAS method using the criterion weights determined by the ENTROPY method, the logistics performance rankings of the OECD member countries are obtained. According to the ranking results, the first five countries are Germany, Sweden, Denmark, Netherland, and Austria. In addition, the analysis results obtained by the integrated ENTROPY and WASPAS method were compared with the LPI rankings of the sample taken from the World Bank report results.

Key Words: *logistics, logistics performance index, ENTROPY, WASPAS*
JEL Classification: *C44, L91, R40*

OECD'ye Üye Olan Ülkelerin Lojistik Performansının Bütünleşik ENTROPİ ve WASPAS Yöntemiyle Değerlendirilmesi

ÖZ

Dünya Bankası tarafından geliştirilen Lojistik Performans Endeks (LPI), ülkelerin bulundukları konumlarını tespit etmesi bakımından önemlidir. Lojistik performans endeks değerlendirmeleri, ülkeler arasında rekabet ortamı yaratmasının yanı sıra ülkelerin bulundukları konum itibariyle lojistik performanslarını geliştirmeleri için de fırsat sağlar. Bu çalışmada, Dünya Bankası tarafından en son yayınlanan 2018 yılına ilişkin lojistik performans indeks verileri kullanılmıştır. Buna göre, OECD'ye üye olan otuz sekiz ülkenin lojistik performansları bütünleşik olarak ENTROPİ ve WASPAS yöntemleri kullanılarak belirlenmiştir. ENTROPİ yöntemiyle yapılan hesaplamalar sonucunda lojistik performans kriterlerinin önem ağırlıklarına göre; altyapı, gümrük, lojistik kalite ve yetkinlik, takip ve izleme, uluslararası sevkiyatlar, zamanlama kriterleri olduğu belirlenmiştir. Dolayısıyla, OECD'ye üye olan ülkelerin lojistik performanslarının kıyaslanmasında en önemli kriterin altyapı kriteri olduğu bulunmuştur. ENTROPİ yöntemiyle belirlenen kriter ağılıkları kullanılarak WASPAS yöntemiyle gerçekleştirilen analizler sonucunda ise OECD'ye üye olan ülkelerin lojistik performans sıralamaları elde edilmiştir. Bu sıralama sonuçlarına göre ilk beş

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ülkenin Almanya, İsveç, Danimarka, Hollanda ve Avusturya olduğu sonucuna ulaşılmıştır. Buna ilaveten, bütünleşik ENTROPİ ve WASPAS yöntemiyle elde edilen analiz sonuçları, Dünya Bankası rapor sonuçlarından alınan örneklemin LPI sıralamaları ile karşılaştırılmıştır.

Anahtar Kelimeler: *Lojistik, Lojistik Performans Endeks, ENTROPİ, WASPAS*
JEL Sınıflandırması: *C44, L91, R40*

INTRODUCTION

As the commercial relationships between countries increase with today's competitive world and developing technology, the importance of the term, "logistics," also increases. Although the term, logistics, initially emerged to meet military necessities, it has become part of several aspects of our lives. Logistics include all activities involved in the effective coordination of any type of material and information flow from production to consumption. Logistics can be defined as planning, applying, controlling, and examining the two-way movement of products and information between the first starting point and final consumption point and all the processes that occur during that movement in an effective and productive way (Aytekin, 2018; Şirin and Emanet, 2017: 302).

As the importance of logistics has been globally understood, competition in that area has significantly increased. Firms try to reduce their costs and increase customer satisfaction to be able to get ahead in competition. It is important to measure logistics performance to be able to provide that. Due to the evaluation of logistics performance, firms and countries make their future plans more successfully and obtain a competitive advantage (Şirin and Emanet, 2017)

When the literature about logistics performance is examined, there are several studies conducted in that area. A summary of some of these studies is as follows. Kunadhamraks and Hanaoka (2008) evaluated the effect of intermodal freight transportation, a reasonably innovative methodology, on the logistics performance of Thailand using the FAHP method. In their study, Jiang et al. (2009) found that logistics has a significant effect on business performance, and they suggested an index system. They used the DEMATEL method to analyze the interrelationships among the indices and used the ANP method to weigh the indices. Güner and Coşkun (2012) examined the relationship among economic and social factors of 26 OECD countries using correlation analysis to evaluate whether their logistics performances are affected by social and economic factors or not. Bayraktutan et al. (2012) developed an index to estimate the logistics performances of the provinces in Turkey. Martí et al. (2014) analyzed the effect of each of the LPI criteria on developing economies. They detected possible advances in logistics in five regions by comparing the first LPI data published in 2007 with the most recent data**.** Bayır and Yılmaz (2017) measured the logistics performance of 20 European countries using the World Bank's LPI data for 2016. They used the AHP and VIKOR methods together. Rezaei et al. (2018) determined the weights of the six LPI criteria of the World Bank using the BMW method. Orhan (2019) compared the logistics performances of Turkey and the EU countries using the LPI of 2018 and the ENTROPY weighted EDAS method. Kısa and Ayçin (2019) evaluated the logistics performance of the OECD countries using the integrated SWARA and

EDAS methods. Based on the logistics performance criteria determined by the World Bank, Oğuz et al. (2019) ranked the logistics performance of seven Asian countries using the TOPSIS method. Karaköy and Ölmez (2019) determined the logistics performances of Balkan countries using the integrated ENTROPY and OCRA methods.

The literature review indicates that there is a limited number of studies that have recently applied the LPI using the multiple criteria decision-making methods. This study aims to evaluate the logistics performances of 38 OECD member countries. To achieve this purpose, among the multiple-criteria decision-making methods, the ENTROPY and WASPAS methods are used to evaluate the logistics performances of the OECD countries based on the criteria determined by the World Bank. When the literature is examined, it is seen that ENTROPY and WASPAS methods are applied separately in many studies. However, no other study has been found that uses the integrated ENTROPY and WASPAS methods on Logistics performance evaluation. Therefore, this study will contribute to the literature by integrating the ENTROPY and WASPAS methods to evaluate logistics performance. In this study, the most recently published data (2018) of the criteria of the countries are obtained from the website of the World Bank (http://www.worldbank.org).

The Introduction section of this study provides information about logistics. Then, the second section discusses the ENTROPY method, and the third section presents the WASPAS method and the steps of the method. The application was provided in the fourth section, where the ranking of the logistics performances of the OECD member countries is determined by using the integrated ENTROPY and WASPAS methods. The findings are discussed in the fifth section.

I.ENTROPY

The term ENTROPY was introduced by Rudolp Clausius in 1865 and is defined as a measure of disorder and uncertainty within a system. This term was later developed by Shannon (1948), who provided a basis for the ENTROPY theory. In multiple criteria decision-making problems, criteria have different significance levels, and it is difficult to find a proper weight for each of the criteria. Two different methods can be applied for the weighting operation subjective and objective weighting methods. Whereas the subjective weighting method is based on the decision maker's evaluations, in the objective weighting method, the criteria weights can be determined using mathematical models. The ENTROPY method is developed to find the objective weights. In this method, the weight of each criterion is calculated based on the observation values.

The steps of the ENTROPY method are as follows: (Shannon, 1948: 10-14).

1st Step: The normalization of the decision matrix is calculated using Equation (1). The notations in the formula denote are as follows: i=alternatives, j=criteria, $r_{ij=}$normalized values.

$$r_{ij} = \frac{x_{ij}}{\sum_{1}^{j} x_{ij}} \quad (1)$$

2nd Step: The ENTROPY values are calculated using Equation (2).

$$e_j = -k \sum_{j=1}^{m} r_{ij} \ln(r_{ij}) \quad (2)$$

where k denotes the ENTROPY coefficient; r_{ij} is the normalized values, and e_j indicates the ENTROPY value.

3rd Step: Weight values are obtained using Equation (3).

$$w_j = \frac{1 - e_j}{\sum_{1}^{m} (1 - e_j)} \quad (3)$$

II.WASPAS

The WASPAS method, which was developed by Chakraborty and Zavadskas in 2014, is a multiple criteria decision making (MCDM) approach that combines two different models, the weighted sum model and the weighted product model. The alternatives are ranked according to the aggregated optimality criteria calculated using the outcomes of these two models (Chakraborty and Zavadskas, 2014: 2).

The steps of the WASPAS method can be summarized as follows: (Chakraborty and Zavadskas, 2014: 2-3):

1st Step: The alternatives, criteria are determined.

2nd Step: The criteria weights are determined using one of the MCDM methods.

3rd Step: After determining the criteria weights, the beginning decision matrix is formed and normalized. The criteria addressed in the decision-making process can either be utility or cost, which is determined based on the construction of the problem. The utility-determining criteria are those that the decision-maker desires to maximize, whereas the cost-determining criteria are those that are desired to be minimized. To normalize the beginning decision matrix, Equations (4) and (5) are used.

For utility-determining criteria: $\overline{x_{ij}} = \frac{x_{ij}}{\max_i x_{ij}}$ (4)

For cost-determining criteria: $\overline{x_{ij}} = \frac{\min_i x_{ij}}{x_{ij}}$ (5)

4th Step: The total relative significance value for each alternative is principally calculated using the total weighted model. Based on this, the total relative significance of the i[th] alternative $Q_i^{(1)}$ is calculated using Equation (6).

$$Q_i^{(1)} = \sum_{j=1}^{n} \overline{x_{ij}} * w_j \quad (6)$$

5th Step: The total relative significance value for each alternative is calculated using the weighted product model**.** Based on this, the second total relative significance of the i[th] alternative $Q_i^{(2)}$ is calculated using Equation (7).

$$Q_i^{(2)} = \prod_j^n \left(\overline{x}_{ij}\right)^{w_j} \quad (7)$$

6th Step: The compound optimality value for each of the alternatives is calculated using Equation (8).

$$Q_i = \lambda Q_i^{(1)} + (1-\lambda) Q_i^{(2)} \quad (8)$$

λ denotes the compound optimality coefficient, and λ takes a value between 0 and 1.

III.APPLICATION

Countries need to control the LPI to evaluate their performances in the logistics sector and determine their objectives in the logistics sector. LPI is conducted by the World Bank to present the inter-country differences in logistics operations. LPI is published every two years by the World Bank as the result of surveys conducted. The rankings in the LPI list is significant for countries as it helps the countries to compare themselves with other countries worldwide in terms of the logistics sector. The LPI values of the countries are initially measured in 2007, and then, the logistics performances of the countries are presented in 2010, 2012, 2014, 2016, and, recently, 2018. (Arvis et al., 2018).

This study aims to determine the logistics performances of the OECD member countries using the data of the LPI published by the World Bank in 2018. To achieve this purpose, among the multiple-criteria decision making methods, the integrated ENTROPY and WASPAS methods are used. The ENTROPY method was chosen to weight the criteria. Because the ENTROPY method is objectively weighted. The WASPAS method was used in ordering the alternatives because it is simple and consists of few steps. The criteria used to determine the LPIs are Customs (C1), Infrastructure (C2), International shipments (C3), Logistics quality and competence (C4), Tracking and tracing (C5), and Timeliness (C6). The alternatives include the 38 OECD member countries. The weights of the criteria are determined using the ENTROPY method and the countries are ranked according to their LPI using the WASPAS method.

A. The Entropy Method

To solve the problem using the ENTROPY method, the decision matrix should be constructed. The decision matrix constructed with the data from the World Bank is presented in Table 1.

Table 1. Decision Matrix

	C1	C2	C3	C4	C5	C6
United States	3,78	4,05	3,51	3,87	4,09	4,08
Germany	4,09	4,37	3,86	4,31	4,24	4,39
Australia	3,87	3,97	3,25	3,71	3,82	3,98
Austria	3,71	4,18	3,88	4,08	4,09	4,25
Belgium	3,66	3,98	3,99	4,13	4,05	4,41
CzechRepublic	3,29	3,46	3,75	3,72	3,70	4,13
Denmark	3,92	3,96	3,53	4,01	4,18	4,41
Estonia	3,32	3,10	3,26	3,15	3,21	3,80
Finland	3,82	4,00	3,56	3,89	4,32	4,28
France	3,59	4,00	3,55	3,84	4,00	4,15
Netherland	3,92	4,21	3,68	4,09	4,02	4,25
United Kingdom	3,77	4,03	3,67	4,05	4,11	4,33
Ireland	3,36	3,29	3,42	3,60	3,62	3,76
Spain	3,62	3,84	3,83	3,80	3,83	4,06
Israel	3,32	3,33	2,78	3,39	3,50	3,59
Sweden	4,05	4,24	3,92	3,98	3,88	4,28
Switzerland	3,63	4,02	3,51	3,97	4,10	4,24
Italy	3,47	3,85	3,51	3,66	3,85	4,13
Iceland	2,77	3,19	2,79	3,61	3,35	3,70
Japan	3,99	4,25	3,59	4,09	4,05	4,25
Canada	3,60	3,75	3,38	3,90	3,81	3,96
Colonbia	2,61	2,67	3,19	2,87	3,08	3,17
Korea	3,40	3,73	3,33	3,59	3,75	3,92
Costa Rica	2,63	2,49	2,78	2,70	2,96	3,16
Latvia	2,80	2,98	2,74	2,69	2,79	2,88
Lithuania	2,85	2,73	2,79	2,96	3,12	3,65
Luxembourg	3,53	3,63	3,37	3,76	3,61	3,90
Hungary	3,35	3,27	3,22	3,21	3,67	3,79
Mexico	2,77	2,85	3,10	3,02	3,00	3,53
Norway	3,52	3,69	3,43	3,69	3,94	3,94
Poland	3,25	3,21	3,68	3,58	3,51	3,95
Portugal	3,17	3,25	3,83	3,71	3,72	4,13
Slovakia	2,79	3,00	3,10	3,14	2,99	3,14
Slovenia	3,42	3,26	3,19	3,05	3,27	3,70
Chile	3,27	3,21	3,27	3,13	3,20	3,80
Turkey	2,84	3,17	3,30	3,06	3,18	3,66
New Zeland	3,71	3,99	3,43	4,02	3,92	4,26
Greece	2,84	3,17	3,30	3,06	3,18	3,66
Total	129,30	135,38	129,29	136,04	138,71	148,67

Then, the decision matrix is normalized using the formula in Equation (1). After normalizing the decision matrix, the ENTROPY value for each value is constructed using Equation (2). The normalized values are multiplied with their logarithmic values and summarized. The result is then multiplied by the *k* ENTROPY coefficient to determine the ENTROPY values. Here, the ENTROPY coefficient *k* is the logarithmic version of the number of the OECD member countries.

Table 2. ENTROPY Values

ENTROPİ	C1	C2	C3	C4	C5	C6
ej değeri	0,998	0,997	0,999	0,998	0,998	0,999

After the ENTROPY values are determined, the weight values of each of the criteria are determined using Equation (3). To calculate the weight values, each of the calculated ENTROPY values is deducted from 1, and the values of the row

are summed up. The ENTROPY value deducted from the value of 1 is divided by the sum of the row to obtain the criteria weights.

Table 3. ENTROPY Criteria Weights

ENTROPİ	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**
wj değeri	0,186	0,239	0,117	0,185	0,159	0,114

The results of the weighting conducted using the ENTROPY method indicate that the most significant criteria are infrastructure, with a significance coefficient (0,239), followed by customs (0,186), logistics quality and competence (0,185), tracking and tracing (0,159), international shipments (0,117), and timeliness (0,114).

B. The Waspas Method

After the criteria weights are calculated using the ENTROPY method, the WASPAS method is used to rank the alternatives. The steps of the WASPAS method are included to determine the criteria and alternatives and to find the weights of the criteria. The weights of the criteria are determined using the ENTROPY method and are presented in Table 3. The decision matrix is normalized in the following step. The cost and utility-determining criteria need to be determined. All the criteria addressed in the application are utility-determining criteria. The decision matrix is normalized using Equation (4). The normalized decision matrix is presented in Table 4.

Table 4. The Normalized Decision Matrix

	C1	**C2**	**C3**	**C4**	**C5**	**C6**
United States	0,92	0,92	0,88	0,90	0,95	0,93
Germany	1,00	1,00	0,97	1,00	0,98	1,00
Australia	0,95	0,91	0,81	0,86	0,88	0,90
Austria	0,91	0,96	0,97	0,95	0,95	0,96
Belgium	0,90	0,91	1,00	0,96	0,94	1,00
CzechRepublic	0,80	0,79	0,94	0,86	0,86	0,94
Denmark	0,96	0,90	0,88	0,93	0,97	1,00
Estonia	0,81	0,71	0,82	0,73	0,74	0,86
Finland	0,93	0,92	0,89	0,90	1,00	0,97
France	0,88	0,91	0,89	0,89	0,93	0,94
Netherland	0,96	0,96	0,92	0,95	0,93	0,96
United Kingdom	0,92	0,92	0,92	0,94	0,95	0,98
Ireland	0,82	0,75	0,86	0,83	0,84	0,85
Spain	0,88	0,88	0,96	0,88	0,89	0,92
Israel	0,81	0,76	0,70	0,79	0,81	0,81
Sweden	0,99	0,97	0,98	0,92	0,90	0,97
Switzerland	0,89	0,92	0,88	0,92	0,95	0,96
Italy	0,85	0,88	0,88	0,85	0,89	0,94
Iceland	0,68	0,73	0,70	0,84	0,78	0,84
Japan	0,98	0,97	0,90	0,95	0,94	0,97
Canada	0,88	0,86	0,85	0,90	0,88	0,90
Colonbia	0,64	0,61	0,80	0,66	0,71	0,72
Korea	0,83	0,85	0,83	0,83	0,87	0,89
Costa Rica	0,64	0,57	0,70	0,63	0,68	0,72
Latvia	0,68	0,68	0,69	0,62	0,64	0,65
Lithuania	0,70	0,62	0,70	0,69	0,72	0,83
Luxembourg	0,86	0,83	0,84	0,87	0,84	0,89
Hungary	0,82	0,75	0,81	0,75	0,85	0,86
Mexico	0,68	0,65	0,78	0,70	0,70	0,80
Norway	0,86	0,84	0,86	0,86	0,91	0,89
Poland	0,80	0,73	0,92	0,83	0,81	0,90

Portugal	0,77	0,74	0,96	0,86	0,86	0,94
Slovakia	0,68	0,69	0,78	0,73	0,69	0,71
Slovenia	0,84	0,75	0,80	0,71	0,76	0,84
Chile	0,80	0,73	0,82	0,72	0,74	0,86
Turkey	0,69	0,73	0,83	0,71	0,73	0,83
New Zeland	0,91	0,91	0,86	0,93	0,91	0,97
Greece	0,69	0,73	0,83	0,71	0,73	0,83

After obtaining the normalized decision matrix, the total relative significance level for each of the alternatives is initially calculated based on the weighted total model using Equation (6), and the total relative significance level for each of the alternatives is calculated based on the weighted multiplication model using Equation (7)**.** Then, the compound optimality value is calculated for each of the alternatives using Equation (8). Here, the value of λ=0,50 is used to calculate the values of *Qi*.

Table 5. Qi values of each of the alternatives

Alternatives	**Qi**	**Ranking**
Germany	0,992	1
Sweden	0,954	2
Japan	0,953	3
Netherland	0,949	4
Austria	0,946	5
Belgium	0,941	6
Denmark	0,937	7
United Kingdom	0,936	8
Finland	0,933	9
Switzerland	0,918	10
United States	0,918	11
New Zeland	0,913	12
France	0,904	13
Spain	0,896	14
Australia	0,89	15
Canada	0,877	16
Italy	0,876	17
Norway	0,867	18
Luxembourg	0,853	19
Czech Republic	0,85	20
Korea	0,849	21
Portugal	0,834	22
Ireland	0,817	23
Poland	0,815	24
Hungary	0,796	25
Israel	0,781	26
Slovenia	0,773	27
Chile	0,769	28
Estonia	0,766	29
Iceland	0,754	30
Greece	0,741	31
Turkey	0,741	32
Slovakia	0,707	33
Mexico	0,703	34
Lithuania	0,695	35
Colonbia	0,675	36
Latvia	0,663	37
Costa Rica	0,643	38

The ranking obtained based on the compound optimality value calculated for each of the alternatives is presented in Table 5. According to the outcomes of the study in which the ENTROPY and WASPAS methods are used in an integrated way to determine the logistics performances of the OECD member countries, the countries ranking is in the following order: Germany, Sweden, Japan, Netherland, Austria, Belgium, Denmark, United Kingdom, Finland, Switzerland, United States, New Zealand, France, Spain, Australia, Canada, Italy, Norway, Luxembourg, Czech Republic, Korea, Portugal, Ireland, Poland, Hungary, Israel, Slovenia, Chile, Estonia, Iceland, Greece, Turkey, Slovakia, Mexico, Lithuania, Colombia, Latvia, and Costa Rica.

In addition, the analysis results obtained by the integrated ENTROPY and WASPAS methods are compared with the sample taken from the World Bank Report results. This comparison is given in Table 6. As can be seen in Table 6, the LPI ranking of 22 countries kept their ranks and the other 16 countries have minor changes.

Table 6. Comparison Of LPI Ranking

Alternatives	Ranking by LPI Sample	Alternatives	Ranking by WASPAS Method	Alteration
Germany	1	Germany	1	Kept its rank
Sweden	2	Sweden	2	Kept its rank
Belgium	3	Japan	3	Increased its rank
Austria	4	Netherlands	4	Increased its rank
Japan	5	Austria	5	Decreased its rank
Netherlands	6	Belgium	6	Decreased its rank
Denmark	7	Denmark	7	Kept its rank
United Kingdom	8	United Kingdom	8	Kept its rank
Finland	9	Finland	9	Kept its rank
Switzerland	10	Switzerland	10	Kept its rank
United States	11	United States	11	Kept its rank
New Zealand	12	New Zeland	12	Kept its rank
France	13	France	13	Kept its rank
Spain	14	Spain	14	Kept its rank
Australia	15	Australia	15	Kept its rank
Italy	16	Canada	16	Increased its rank
Canada	17	Italy	17	Decreased its rank
Norway	18	Norway	18	Kept its rank
Czech Republic	19	Luxembourg	19	Increased its rank
Portugal	20	Czech Republic	20	Decreased its rank
Luxembourg	21	Korea	21	Increased its rank
Korea	22	Portugal	22	Decreased its rank
Poland	23	Ireland	23	Increased its rank
Ireland	24	Poland	24	Decreased its rank
Hungary	25	Hungary	25	Kept its rank
Chile	26	Israel	26	Increased its rank
Slovenia	27	Slovenia	27	Kept its rank
Estonia	28	Chile	28	Decreased its rank
Israel	29	Estonia	29	Decreased its rank
Iceland	30	Iceland	30	Kept its rank
Greece	31	Greece	31	Kept its rank
Turkey	32	Turkey	32	Kept its rank
Mexico	33	Slovakia	33	Kept its rank
Slovak Republic	34	Mexico	34	Decreased its rank
Lithuania	35	Lithuania	35	Kept its rank
Colombia	36	Colonbia	36	Kept its rank
Latvia	37	Latvia	37	Kept its rank
Costa Rica	38	Costa Rica	38	Kept its rank

CONCLUSION

The LPI prepared by the World Bank is an important data source for the logistics sector. Using this data, the countries can evaluate themselves.

This study uses MCDM methods in an integrated way to evaluate the logistics performances of the OECD countries. By using the data obtained from the World Bank LPI reports, the logistics performance values of 38 countries are obtained for each of the performance evaluation criteria. First, the significance weights of the performance evaluation criteria are calculated using the ENTROPY method. According to these calculations, infrastructure is the most significant criteria, followed by customs, logistics quality and competence, tracking and tracing, international shipments, and timeliness. The significance weights of the criteria obtained using the ENTROPY method are combined with the WASPAS method to evaluate and rank the country performances. The result of the analyses obtained integrated ENTROPY and WASPAS method shows that the first five countries with the highest logistics performances are Germany, Sweden, Japan, Netherland, and Austria, respectively, and the five countries with the lowest logistics performance are Mexico, Lithuania, Colombia, Latvia, and Costa Rica. After that, the analysis results obtained by the integrated ENTROPY and WASPAS method are compared with the sample taken from the World Bank Report results. When the ranking obtained from the results of the analysis carried out with integrated ENTROPY and WASPAS method compared with logistics performance index ranking in the sample, 7 countries (Japon, Netherlands, Canada, Luxembourg, Korea, Ireland and Israel) increased their ranks, 9 countries (Belgium, Austria, Italy, Czech Republic, Portugal, Poland, Chile, Estonia and Mexico) decreased their ranks and 22 countries (Germany, Sweden, Denmark, United Kingdom, Finland, Switzerland, United States, New Zealand, France, Spain, Australia, Norway, Hungary, Slovenia, Iceland, Greece, Turkey, Slovakia, Lithuania, Colombia, Latvia and Costa Rica) kept their ranks.

According to the study results, Turkey is ranked 32nd. To be able to rank in the upper lines in the logistics performance, Turkey needs to pay attention to the following most important three criteria: infrastructure, customs, and logistics quality and competence. Moreover, conducting research will be beneficial to increasing infrastructure investment, improving customs operations, and providing quality and competent logistics.

In future studies, logistics performance evaluations can be done using different multiple decision-making methods. In this study, the weights of the criteria are determined using the ENTROPY method. The weights of the criteria can be also determined using different objective or subjective evaluation methods.

Araştırma ve Yayın Etiği Beyanı

Makalenin tüm süreçlerinde Yönetim ve Ekonomi Dergisi'nin araştırma ve yayın etiği ilkelerine uygun olarak hareket edilmiştir.

Yazarların Makaleye Katkı Oranları

Makalenin tamamı yazar tarafından kaleme alınmıştır.

Çıkar Beyanı

Yazarın herhangi bir kişi ya da kuruluş ile çıkar çatışması yoktur.

REFERENCES

Arvis, J. F. Ojala, L. Wiederer C. Shepherd, B. Raj, A. Dairabayeva, K. and Kiiski, T. (2018). The Logistics Performance Index And Its Indicators. Connecting To Compete 2018. The World Bank, USA.

Aytekin, M. (2018). Lojistikte Yatay İşbirliği, Ekin Basın Yayın Dağıtım, Bursa.

Bayır, T. ve Yılmaz Z.(2017). AB Ülkelerinin Lojistik Performans Endekslerinin AHP Ve VIKOR Yöntemleri İle Değerlendirilmesi. *Middle East Journal of Education*, Cilt3, Sayı2, 73-92.

Bayraktutan, Y. Tüylüoğlu Ş. Özbilgin M. (2012). Lojistik Sektöründe Yoğunlaşma Analizi ve Lojistik Gelişmişlik Endeksi: Kocaeli Örneği. *Uluslararası Alanya İşletme Fakültesi Dergisi*, Cilt4, Sayı3, 61-71.

Chakraborty, S. and Zavadskas, E. (2014). Applications of WASPAS Method In Manufacturing Decision Making. *Informatica*,Vol. 23, Iss.1, 1-25.

Güner, S. ve Coşkun, E. (2012). Comparison Of Impacts Of Economic And Social Factors On Countries Logistics Performance: A Study with OECD Countries, *Research in Logistics and Production*, Vol.2, Iss.4, 329-343.

Jiang, J. Chen, H. and Zhang, X. (2009). Index System of Logistics Performance In Supply Chain. Second International Conference on Transportation Engineering, 2851-2856.

Karaköy, Ç. ve Ölmez, U. (2019). Balkan Ülkelerinde Lojistik Performans Endeksi Değerlendirilmesi. International Symposium On Innovative Approaches Engineering and Naturel Science, 22-24.11.2019, Samsun, 178-180.

Kısa, A.C.G. ve Ayçin, E.(2019). OECD Ülkelerinin Lojistik Performanslarının SWARA Tabanlı EDAS Yöntemi ile Değerlendirilmesi. *Çankırı Karatekin Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, Cilt9, Sayı1, 301-325

Kunadhamraks, P. and Hanaoka, S. (2008). Evaluating The Logitics Performance of Intermodal Transportation in Thailand. *Asia Pacific Journal of Marketing and Logistics*, Vol.20, Iss.3, 323- 342.

Martí, L, Puertas R. and Garcia, L. (2014). The Importance Of The Logistics Performance Index In International Trade. *Applied Economics*, Vol.46, Iss. 24, 2982- 2992.

Rezaei, J. van Roekel, W.S. and Tavasszy, L. (2018). Measuring The Relative Importance Of The Logistics Performance Index Indicators Using Best Worst Method. *Transport Policy*, Vol.68, 158-169

Oğuz, S. Alkan, G. ve Yılmaz, B. (2019). Seçilmiş Asya Ülkelerinin Lojistik Performanslarının TOPSIS Yöntemi ile Değerlendirilmesi. *IBAD Sosyal Bilimler Dergisi*, Özel Sayı, 497-507.

Orhan, M. (2019). Türkiye ile Avrupa Birliği Ülkelerinin Lojistik Performanslarının Entropi Ağırlıklı Edas Yöntemiyle Karşılaştırılması. *Avrupa Bilim ve Teknoloji Dergisi*, Cilt 17, 1222-1238

Shannon C. E. (1948), A Mathematical Theory of Communication, *The Bell System Technical Journal*, Vol. 27, 10-14.

Şirin, B. ve Emanet H. (2017). Lojistik Performans Endeksi Kapsamında Orta Asya Türk Cumhuriyetleri'nin Lojistik Performanslarının Analizi, International Conference On Eurasian Economies, Bişkek, 302-309.