ACADEMIC REVIEW OF HUMANITIES AND SOCIAL SCIENCES
Volume: 3 Issue: 1 Year: 2020, pp. 125-138

ARHUSS
ISSN: 2636-7645

ASSESSMENT OF ISTANBUL GRAND AIRPORT (IGA) AS A GLOBAL CARGO BASE BY THE TOPSIS METHOD

Murat Düzgün[1]

Received Date (Başvuru Tarihi): 23/02/2020
Accepted Date (Kabul Tarihi): 02/06/2020
Published Date (Yayın Tarihi): 15/06/2020

ABSTRACT

The aim of this study is to evaluate the major airports in the scope of air-cargo according to the selected criteria in the global scope and to compare the airports. For this purpose, New Istanbul Airport, Germany Frankfurt Airport, Singapore Changi Airport and Memphis International Airport in the United States were included in the scope of the review. In this study, the literature was reviewed in detail and 9 criteria were determined. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method was used for the analysis of these criteria. According to the results of the analysis and approved that, Istanbul New Airport is in the first rank according to the 4 selected airports and 9 selected criteria.

Keywords

Airport,
Air Cargo,
Logistics,
TOPSIS.

YENİ İSTANBUL HAVALİMANI'NIN KÜRESEL BİR KARGO ÜSSÜ OLARAK TOPSIS YÖNTEMİYLE DEĞERLENDİRİLMESİ

ÖZ

Bu çalışmanın amacı, hava-kargo kapsamındaki önemli havalimanlarının seçilen kriterlere göre küresel kapsamda değerlendirilmesi ve havalimanlarının karşılaştırılmasıdır. Bu amaca yönelik olarak, Yeni İstanbul Havalimanı(IGA), Almanya Frankfurt Havalimanı(FRA), Singapur Changi Havalimanı(SIN) ve Amerika Birleşik Devletleri'nde bulunan Memphis Havalimanı(MEM) inceleme kapsamına alınmıştır. Söz konusu çalışmada detaylı literatür taraması yapılmış ve seçici 9 kriter belirlenmiştir. Yapılan çalışmanın analiz sürecinde ise TOPSIS(Technique for Order Preference by Similarity to Ideal Solution) yönteminden yararlanılmıştır. Yapılan analiz sonucuna göre, İstanbul Yeni Havalimanı karşılaştırılan 4 havalimanı ve seçilen 9 kritere göre birinci sırada yer aldığı kanıtlanmıştır.

Anahtar Kelimeler

Havalimanı,
Hava Kargo,
Lojistik,
TOPSIS.

Citation: Düzgün, M.(2020), Assessment of İstanbul Grand Airport (Iga) as a Global Cargo Base by the Topsis Method, ARHUSS, 3(1): 125-138.

[1] *Dr. Öğr. Üyesi, İstanbul Medipol Üniversitesi,İşletme ve Yönetim Bilimleri Fakültesi, Havacılık Yönetimi Bölümü,* mduzgun@medipol.edu.tr

1. INTRODUCTION

In recent years, the development of logistics has been getting faster and more complicated as in many fields. Logistic operations, which were carried out at a slow pace and smoothly in the past, have so far undergone some changes similar to those in many industries. It is the most important and the most popular phase of logistics. Included in the primary industries that should exist in life, transportation is one of the indispensable things in human life. Thanks to the developing transportation systems, smooth access, delivery and comfort have started to take place in human life.

Air transportation plays an important role in the development of logistics and transportation. This is mainly due to the fact that it can save time and offers the capability to carry sensitive products requiring greater attention by air. In other words, the transportation of food, medical supplies, livestock, valuable commodities, medical products and hazardous materials that may deteriorate in a short time indicates the indispensable importance of air transportation. Given the aforementioned points, air transport has an indispensable importance for the logistics industry and transportation.

Today, the increasing air cargo traffic caused by globalization has made airports more significant for the national economy. Therefore, international airports greatly contribute to international trade and economies of countries, because countries are in a fierce competition with each other regarding foreign trade. Countries constantly invest in the transportation industry to take the lead in competition between each other. The construction of the new Istanbul Airport is a positive action to enhance Turkey's role in foreign trade.

This study is intended to assess the new Istanbul Airport globally based on the selected criteria and to compare it to Germany's Frankfurt Airport, Singapore's Changi Airport and Memphis Airport in the United States, which are the major airports of other countries regarding air cargo, according to the given data. The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method was used in the analysis process of this study.

This study has many unique aspects compared to the studies in the literature. First, the existence of few studies in the literature for Istanbul Airport makes this study far more important. In addition to the mentioned point, the conduct of a study on Istanbul Airport using the TOPSIS method makes the novelty of this study clearer. Considering all these points mentioned, the thought is that it will make a valuable contribution to the literature both in terms of methodological novelty and due to the analysis of Istanbul Airport.

This study has five parts. The first part is the introductory part that includes basic and theoretical information. In the second part of the study, a literature review will be carried out, summarizing similar studies in the literature. The third part will detail the method used in the study, providing formulas. The fourth part will include the details of the application based on the comparison of Istanbul Airport to other airports. The suggestions for the results obtained will be given in the last part.

2. LITERATURE REVIEW

Altin et al. (2017) ranked the performances of the 20 largest airports in Europe in terms of the number of passengers. These airports were ranked by multi-criteria decision-making methods and assessed by data envelopment analysis. The weighted values of criteria were calculated by the ENTROPI method. The study revealed that half of the 20 airports were operating effectively and other airports needed to enhance their efficiency.

Bakir and Akan (2018) assessed the service quality of the busiest airports in Europe. 8 service quality criteria were determined. The weighted values of criteria were calculated by the ENTROPI method. Airports were assessed using the TOPSIS method. The study established that the airport with the highest service quality was Munich Airport, and suggested that a significant improvement in quality performance would be seen with the new Istanbul Airport coming into operation.

As part of their study, Uzulmez et al. (2018) compared Istanbul Airport and Seoul Incheon International Airport in terms of integrated transportation. This study aimed to compare the current and future modes of transportation in various ways. As the method, the comparison by qualitative research methods was chosen. Upon the research conducted, it was concluded that the rail and maritime modes of transportation are the two key factors that would reduce the burden of road transportation at Istanbul Airport. Uzulmez et al. (2018) remarked that it was highly difficult for an airport to maintain its hub position without a qualified transportation system integration.

Kupfer et al. (2013) investigated the analysis of airport selection for cargo operations in Europe. They conducted the said study due to the lack of literature on airport competition. The multiple LOGIT model was used as a method, and a survey was employed. 26 airlines were selected as part of the study. The results of the study demonstrated that the presence of shippers was the most important factor. Additionally, relocating cargo operations to non-busy airports was offered as a suggestion. It was revealed that more studies were needed on the supply chain for the selection of airports.

As part of their study, Chung et al. (2015) examined the operational efficiency of international cargo airports in the Asia Pacific region. In their study, the multi-dimensional scaling approach was used as the method. 11 airports operating as an international cargo airport in the Asia Pacific region were identified, and classification was done based on the criteria set according to the airports. The result of the study established, considering the operational efficiency, that Hong Kong International Airport had more advantages due to its over 100 connections to 160 cities and 40 cities in China. However, it was found that Incheon Airport was more efficient according to the criteria of the number of runways, gates, load terminal areas and facilities. On the other hand, the study suggested that Hong Kong Airport was expected to become a cargo base in the future.

As part of their study, Larrodé et al. (2018) investigated the analysis of opportunities for an airport to grow as the one specializing in cargo. The study used the AHP method. To that end, Zaragoza Airport was analyzed. Expert opinions were used by employing the AHP model. The study established that the factors related to airport charges and transportation costs were the most effective factors for the growth of air cargo logistics.

The study conducted by Durak (2016) aimed to set the criteria affecting airline selection in the air cargo transportation industry and to estimate the significance level of these criteria. The study encompassed Turkey's air cargo industry to analyze, using 4 airlines operating in Turkey for application. One of the mathematical decision-making methods, AHP was used in the analysis process. The result of the related study revealed that the criterion with the highest significance was the "Price" criterion with 45.4%, followed by the "Speed" criterion with 17.3%, based on the significance level of key criteria.

The study carried out by Yavas and Ozsoy (2013) investigated the air cargo industry. Within the scope of the study, they addressed the Turkish air cargo industry and investigated its position in Europe. The study included the air cargo statistics of some airports in Europe. The result of the study provided some suggestions for Turkey to have a larger share in the European market, such as the planning actions required to foster and encourage air cargo activities at other national airports and the projects aiming at the establishment of cargo villages in regions near to airports.

As part of their study, Ozcan et al. (2018) investigated the optimum flight point selection by using multi-criteria decision-making methods. The Analytical Hierarchy Process (AHP) was used as the method to identify the weighted values of criteria. The five cities used to select the flight point were ranked employing the TOPSIS method. Based on data analysis, the optimum choice for flight point alternatives was identified as Abu Dhabi.

3. STUDY METHOD

This part outlines the TOPSIS method and its stages;

3.1. TOPSIS

The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method requires few input parameters from its user, resulting in outputs that are very easy to comprehend. When making a decision by this method, it is expected that an alternative chosen will be close to the positive ideal solution and distant from the negative ideal solution. If our goal is profit, the closeness to the positive ideal solution means maximizing the profit, and the distance to the negative ideal solution means minimizing the cost. In other words, the TOPSIS method choses the alternatives that are close to the positive ideal solution and distant from the negative ideal solution. The TOPSIS method is one of the most common techniques used in the literature due to its rationality and ease of comprehension, simplicity in calculation and the possibility of weighting assessment criteria (Cakir & Percin, 2013, 452; akt. Ertugrul I., & Ozcil, A. (2014)). The steps of the TOPSIS method are given below.

Step 1: Define the Problem: As with other decision-making methods, the first phase of the TOPSIS method is to define the problem clearly after identification. Defining the problem is very important in terms of setting the criteria properly and making sure that there are no omissions.

Step 2: Set Criteria: In this phase, all the necessary criteria for the solution of the problem and all the alternatives subject to assessment should be set completely so that relations are analyzed and identified in the most accurate way.

Step 3: Develop the Decision Matrix: In the lines of the decision matrix, the decision points whose superiorities are wanted to be listed and in the columns, there are evaluation factors to be used in decision making. Matrix A is the starting matrix created by the decision maker. Following the identification all criteria and alternatives, the decision matrix is developed for alternatives by obtaining and combining the data of each criterion. This matrix can be shown as follows;

FACTORS

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}$$

DECISION

In the matrix aij, m gives the number of decision points, n the number of evaluation factors. The sum of the weighted values of the criteria to be used with the decision matrix for such a Multi-Criteria Decision Making problem is used as the W vector equal to 1. For the weighted values of criteria whose sum is not equal to 1, the mathematical operations performed should be checked and the errors made during these operations should be corrected. The weighted value of criteria should be calculated such that their sum is equal to 1.

$$\mathbf{W = [W_1\, R_{11} + W_2\, R_{12} \,.......\, W_n\, R_{1n}] = 1}$$

Step 4: Normalize the Decision Matrix: The decision matrix should be normalized before starting calculations to be made by the TOPSIS method. The operation is performed using the square root of the sum of squares of the elements in each criterion column. Each element is normalized by dividing it by the square root of the sum of squares of the column to which it belongs. The normalized decision matrix is calculated as follows.

The normalized matrix is obtained as follows;

$$N_{ij} = \begin{bmatrix} n_{11} & n_{12} & \cdots & n_{1p} \\ n_{21} & n_{22} & \cdots & n_{2p} \\ . & & & . \\ . & & & . \\ . & & & . \\ n_{m1} & n_{m2} & \cdots & n_{mp} \end{bmatrix}$$

Step 5: Weight the Normalized Decision Matrix: In this phase, all the normalized decision matrix values are weighted by multiplying the significance weight of each criterion.

$$V_{ij} = \begin{bmatrix} w_1 n_{11} & w_2 n_{12} & \cdots & w_n n_{1p} \\ w_1 n_{21} & w_2 n_{22} & \cdots & w_n n_{2p} \\ . & & & . \\ . & & & . \\ . & & & . \\ w_1 n_{m1} & w_2 n_{m2} & \cdots & w_n n_{mp} \end{bmatrix} \Rightarrow V_{ij} = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1p} \\ v_{21} & v_{22} & \cdots & v_{2p} \\ . & & & . \\ . & & & . \\ . & & & . \\ v_{m1} & v_{m2} & \cdots & v_{mp} \end{bmatrix}$$

Step 6: Establish Positive Ideal and Negative Ideal Solution Values: After the weighted normalized matrix (V matrix) is found, the maximum values of each column are determined, subject to adherence to the structure of the problem. In other words, the maximum values for each column are determined, if our goal is maximization. These maximum values are our positive ideal solution values. Then, the minimum values of each column are calculated. These are negative ideal solution values (Muhlis Ozdemir, pg.137)

Positive ideal solution values:

$$A^* = \left\{ (\max_i v_{ij} \; \boxed{\text{including}} \right\}$$

$$\Rightarrow A^* = \{v_1^*, v_2^*, \ldots, v_n^*\} \; \boxed{\text{Maximum values for each column,}}$$

Negative ideal solution values:

$$A^{-} = \left\{ (\min_{i} v_{ij} \boxed{\text{including}} \right\}$$

$$\Rightarrow A^{-} = \left\{ v_1^{-}, v_2^{-}, \ldots, v_n^{-} \right\} \boxed{\text{Maximum values for each column.}}$$

Step 7: Calculate Distance Values: In this phase, the distances from each alternative to negative ideal and positive ideal solutions will be calculated. The Euclidean distance is used when calculating values of distance from positive ideal and negative ideal points. The attempt is made to establish the shortest Euclidean distance from the ideal solution and the longest distance from the negative ideal solution (Dora, pg. 137-138).

Positive ideal distance:

$$S_i^{*} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^{*})^2}$$

Negative ideal distance:

$$S_i^{-} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^{-})^2}$$

Step 8: Calculating the Relative Closeness: The method is based on the reasoning that the alternative that is most distant from the negative ideal solution is the one that is closer to the positive ideal solution, where the relative closeness values of alternatives are calculated for the final evaluations as follows.

$$C_i^{*} = \frac{S_i^{-}}{S_i^{-} + S_i^{*}}$$

Step 9: Rank Alternatives: Since the relative closeness value for each alternative is calculated depending on the distance from the negative ideal solution, the alternative with the highest relative closeness value is the most ideal alternative. To evaluate other alternatives included in the problem, all alternatives are ranked from high to low.

4. APPLICATION

Step 1: **Define the Problem:** It is the step where the new Istanbul Airport is assessed globally based on the selected criteria, and compared with major airports of other countries in relation to air cargo.

Step 2: **Set Criteria:** A wide variety of criteria that affect the global assessment of airports are used. In the light of the literature review, the criteria are set as follows:

C1: Number of Terminals

C2: Cargo Traffic

C3: Passenger Traffic

C4: Distance from the Airport to the City Center

C5: Area

C6: LPI Score

C7: Cargo Logistics Competence

C8 Passenger Capacity

C9: Number of Current Active Airlines

The 9 criteria listed above are the most basic criteria used to assess airports. These criteria can be differentiated in parallel with requirements. During the solution of the problem, the names of these criteria will not be used individually. Instead, the criteria codes given at the beginning of each item will be used for convenience. The following part will analyze these criteria before proceeding with the solution of the problem.

Number of Terminals (C1): The airport terminal is an airport component which is built to allow passenger to step into the airport and board the plane before the final departure, and serves as an important criterion for assessing airports.

Cargo Traffic (C2): Cargo traffic is a criterion that plays a very important role in comparing airports within the scope of air cargo. Cargo traffic data is provided monthly by airports. Additionally, the Cargo traffic of airports affects national economies.

Passenger Traffic (C3): Passenger traffic is the sum of passengers going to and from airports.

Distance from the Airport to the City Center (C4): Airports are constructed in the outer parts of the city. Another important criterion for people and companies to prefer airports, especially in crowded metropolises with intense traffic, is the distance to the city center.

Area (C5): The area is the size of the land on which airports are constructed. The facilities of airports are determined by the size of the area.

LPI (Logistics Performance Index) Score (C6): The Logistics performance index aims to create a competitive environment between countries and seeks to assess the circumstances to enable countries to improve their logistics performance. The LPI provides detailed information about the logistics environment, key logistics processes and organizations of the countries and their time and cost performance.

Cargo Logistics Competence (C7): This criterion relates to the developed countries in logistics. The airports of countries that are highly competent in cargo logistics will be at the forefront of air cargo. The cargo logistics competence of countries is set by the World Bank every year (2018).

Passenger Capacity (C8): It is the maximum number of passengers that an airport can accommodate.

Number of Current Active Airlines (C9): This criterion is the number of active airlines at an airport, engaged in passenger transportation and trade activities.

Step 3: Develop the Decision Matrix: A decision matrix that contains airports and assessment criteria is developed. The data is taken from the airports' own websites and the statistics of the State Airports Authority. All criteria are equally weighted. The resulting decision matrix is shown in Table 1:

	K1	K2	K3	K4	K5	K6	K7	K8	K9
ISTANBUL AIRPORT	2	648892	66691172	35	76,5	3,15	3,05	90000000	150
FRANKFURT AIRPORT	2	523218	20416897	12	23	4,2	4,31	95000000	98
MEMPHIS AIRPORT	1	2333942	1251868	19	39	3,89	3,87	25000000	50
CHANGI AIRPORT	4	502000	17610000	24	54	4	4,1	85000000	120
	max	max	max	min	max	max	max	max	max
Weights	0,11111111	0,111111111	0,111111111	0,111111111	0,111111111	0,111111111	0,111111111	0,111111111	0,111111111
Ideal	4	2333942	66691172	12	76,5	4,2	4,31	95000000	150
Non-Ideal	1	502000	1251868	35	23	3,15	3,05	25000000	50

Table 1: Decision Matrix

<u>Step 4:</u> Normalize the Decision Matrix: For normalization of the decision matrix, the values under each criterion are normalized by dividing them by the square root of the sum of the squares of all alternatives for that criterion.

	K1	K2	K3	K4	K5	K6	K7	K8	K9
ISTANBUL AIRPORT	-0,30151134	-0,079921903	0,5	0	-0,83765198	0	0	-0,57621487	-0,76240421
FRANKFURT AIRPORT	-0,30151134	-0,01154442	0,5	0,764123818	0	-0,68167448	-0,68713077	-0,62053909	-0,36595402
MEMPHIS AIRPORT	0	-0,996734275	0,5	0,531564395	-0,25051274	-0,48041821	-0,44718034	0	0
CHANGI AIRPORT	-0,90453403	0	0,5	0,365450522	-0,48536844	-0,55183172	-0,57260898	-0,53189065	-0,53368294

Table 2: Normalization of the Decision Matrix

<u>Step 5:</u> Weight the Normalized Decision Matrix: The next process is the weighting of the normalized decision matrix. In this phase, all the normalized decision matrix values are weighted by multiplying the significance weight of each criterion. The weighted decision matrix is shown in Table 3:

	K1	K2	K3	K4	K5	K6	K7	K8	K9
ISTANBUL AIRPORT	-0,03350126	-0,008880211	0,055555556	0	-0,09307244	0	0	-0,06402387	-0,08471158
FRANKFURT AIRPORT	-0,03350126	-0,001282713	0,055555556	0,084902646	0	-0,07574161	-0,07634786	-0,06894879	-0,04066156
MEMPHIS AIRPORT	0	-0,110748253	0,055555556	0,059062711	-0,02783475	-0,0533798	-0,0496867	0	0
CHANGI AIRPORT	-0,10050378	0	0,055555556	0,040605614	-0,05392983	-0,06131464	-0,06362322	-0,05909896	-0,0592981
Ideal	0	0	0,055555556	0	0	0	0	0	0
Non-Ideal	-0,10050378	-0,110748253	0,055555556	0,084902646	-0,09307244	-0,07574161	-0,07634786	-0,06894879	-0,08471158

Table 3: Weighting of the Normalized Decision Matrix

<u>Step 6:</u> Establish Positive Ideal and Negative Ideal Solution Values: The tables 4 and 5 given below show positive ideal and negative ideal solution values.

	K1	K2	K3	K4	K5	K6	K7	K8	K9
ISTANBUL AIRPORT	0,03350126	0,008880211	0	0	0,093072443	0	0	0,064023874	0,084711578
FRANKFURT AIRPORT	0,03350126	0,001282713	0	-0,08490265	0	0,075741609	0,076347864	0,068948788	0,040661558
MEMPHIS AIRPORT	0	0,110748253	0	-0,05906271	0,027834749	0,053379801	0,049686705	0	0
CHANGI AIRPORT	0,10050378	0	0	-0,04060561	0,053929827	0,061314636	0,06362322	0,059098961	0,059298105

Table 4: Positive Ideal Solution Values

	K1	K2	K3	K4	K5	K6	K7	K8	K9
ISTANBUL AIRPORT	0,06700252	0,101868041	0	-0,08490265	0	0,075741609	0,076347864	0,004924913	0
FRANKFURT AIRPORT	0,06700252	0,109465539	0	0	0,093072443	0	0	0	0,044050021
MEMPHIS AIRPORT	0,10050378	0	0	-0,02583994	0,065237693	0,022361808	0,026661159	0,068948788	0,084711578
CHANGI AIRPORT	0	0,110748253	0	-0,04429703	0,039142616	0,014426973	0,012724644	0,009849827	0,025413474

Table 5: Negative Ideal Solution Values

Step 7: Calculate Distance Values: The values of distance from each alternative to negative ideal and positive ideal solutions are shown in Table 6:

	si+	si-
ISTANBUL AIRPORT	0,145391816	0,18348
FRANKFURT AIRPORT	0,162189779	0,16454
MEMPHIS AIRPORT	0,147805698	0,16783
CHANGI AIRPORT	0,171681692	0,12989

Table 6: Distance to Positive and Negative Ideal Solutions

Step 8: Calculating the Relative Closeness: The values based on this calculation are given in Table 7:

	ci
ISTANBUL AIRPORT	0,557907439
FRANKFURT AIRPORT	0,503603574
MEMPHIS AIRPORT	0,531714469
CHANGI AIRPORT	0,430717838

Table 7: Calculation of the Relative Closeness

Step 9: Rank Alternatives: The ranking based on the analysis is given in Table 8:

	RANKING RESULTS
ISTANBUL AIRPORT	1
FRANKFURT AIRPORT	3
MEMPHIS AIRPORT	2
CHANGI AIRPORT	4

Table 8: Ranking of Alternatives

5. CONCLUSION

Based on the results of the TOPSIS analysis, Istanbul Airport ranks first among the 4 airports compared in line with the selected 9 criteria. It is followed by the rest of the airports in the following respective ranking: Memphis International Airport, Frankfurt Airport and Singapore's Changi Airport. In the light of the data obtained, Istanbul Airport is found to be the leader in terms of C3, C5 and C9 criteria, Memphis International Airport in terms of C2 criteria, Frankfurt Airport in terms of C4, C6, C7 and C8 criteria and Singapore's Changi Airport in terms of C1 criteria. If intended, addition to the future studies may employ criterion weights that are not evenly distributed, or use different criteria weightings, or change the number of airports compared, or compare airports by different criteria, or modify the number of criteria. Also we can evaluate the Air Cargo terminal by checking out C2, C6 and C7. Istanbul Cargo Terminal is not in the first place in these three parameters (C2, C6 and CR) but we can ignore these parameters because of not taken into account in this regards by comparing importance of other parameters.

REFERENCES

Altın, F. G., Karaatlı, M., & Budak, İ. (2017). Avrupa'nın En Büyük 20 Havalimanının Çok Kriterli Karar Verme Yöntemleri Ve Veri Zarflama Analizi İle Değerlendirilmesi. *Suleyman Demirel University Journal Of Faculty Of Economics & Administrative Sciences*, *22*(4).

Bakır, M., & Şahap, A. K. A. N. Havaalanlarında Hizmet Kalitesinin Entropi Ve Topsıs Yöntemleri İle Değerlendirilmesi: Avrupa'nın En Yoğun Havaalanları Üzerine Bir Uygulama. *Elektronik Sosyal Bilimler Dergisi*, *17*(66),632-651.

Üzülmez, M., Ateş, S. S., & Akın, C. (2018). Comparıson Of Istanbul 3rd Aırport And Seul Incheon Internatıonal Aırport In Terms Of Integrated Transportatıon. *Electronic Turkish Studies*, *13*(22).

Kupfer, F., Kessels, R., Goos, P., Van de Voorde, E., & Verhetsel, A. (2013). A discrete choice approach for analysing the airport choice for freighter operations in Europe.

Chung, T. W., Ahn, W. C., Jeon, S. M., & Van Thai, V. (2015). A benchmarking of operational efficiency in Asia Pacific international cargo airports. *The Asian Journal of Shipping and Logistics*, *31*(1), 85-108.

Larrodé, E., Muerza, V., & Villagrasa, V. (2018). Analysis model to quantify potential factors in the growth of air cargo logistics in airports. *Transportation research procedia*, *33*, 339-346.

Durak, M. Ş. (2016). *Türkiye hava kargo taşımacılığı sektöründe havayolu seçim kriterlerinin analitik hiyerarşi yöntemi ile incelenmesi* (Master's thesis, Anadolu Üniversitesi).

Yavaş, V., & Özsoy, D. TÜRK HAVA KARGO SEKTÖRÜNÜN AVRUPA'DAKİ YERİ VE ÖNEMİ.

Jantachalobon, N. (2018). A model for assessing suitability of air cargo hub in Southeast Asia using AHP and TOPSIS. *Journal of Applied Engineering Science*, *16*(1), 19-27.

Asoğlu, İ., & Eren, T. (2018). AHP, TOPSIS, PROMETHEE Yöntemleri ile Bir İşletme için Kargo Şirketi Seçimi. *Yalova Sosyal Bilimler Dergisi*, *8*(16), 102-122.

Özcan, B., Akman, G., Başlı, H., & Gündüz, E. B. (2018). Çok Kriterli Karar Vermede AHP ve TOPSIS Yöntemleriyle Uçuş Noktası Seçimi. *Journal of Institue Of Science and Technology*, *34*(3).

Elgün, M. N., & AŞIKOĞLU, N. O. (2016). Lojistik köy kuruluş yeri seçiminde TOPSIS yöntemiyle merkezlerin değerlendirilmesi. *Afyon Kocatepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *18*(1).

Ilgaz, A. (2018). LOJİSTİK SEKTÖRÜNDE PERSONEL SEÇİM KRİTERLERİNİN AHP VE TOPSİS YÖNTEMLERİ İLE DEĞERLENDİRİLMESİ. *Süleyman Demirel Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *1*(32), 586-605.

Tamer, E. R. E. N., & Seyda, G. Ü. R. (2017). ONLINE ALIŞVERİŞ SİTELERİ İÇİN AHP ve TOPSIS YÖNTEMLERİ İLE 3PL FİRMA SEÇİMİ. *Hitit Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *10*(2), 819-834.

Ertuğrul, İ., & Özçil, A. (2014). Çok kriterli karar vermede TOPSIS ve VIKOR yöntemleriyle klima seçimi. *Çankırı Karatekin Üniversitesi İİBF Dergisi*, *4*(1), 267-282.

Çok Kriterli Karar Verme Yöntemleri, Özdemir, 2018, Avcılar

Çok Kriterli Karar Verme Yöntemleri, Çelikbilek, 2018, Ankara