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Research Article

Logistics Location Selection In Migration Management: An Analysis Of Aegean Region

Göç Yönetiminde Lojistik Konum Seçimi: Ege Bölgesi Üzerine Bir Inceleme

Ayşegül TAŞ	Levent YILMAZ	Zeynep Birce ERGÖR
Doç.Dr. Cankaya University	Cankaya University	Dr. Cankaya University
Department of Management	l.ylmz.83@gmail.com	Department of Management
aysegul@cankaya.edu.tr	https://orcid.org/0000-0002-9435-3805	ergor@cankaya.edu.tr
https://orcid.org/0000-0002-3040-4888		https://orcid.org/0000-0002-9895-7040

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Öz

Türkiye coğrafi konumu gereği önemli göç rotaları üzerinde bulunan bir ülkedir. Özellikle son yıllarda artan göç eden insan sayısındaki yoğunluk, Türkiye'deki göç olgusunun farklı yönlerden ele alınarak etkin bir şekilde yönetilmesini gerekli kılmıştır. Bu bağlamda, göç yönetiminde lojistik konum seçimi, önem arz eden konuların başında gelmektedir. Göç yönetiminin sürdürülebilirliği, operasyonel destek faaliyetlerin yürütülmesi ile doğrudan ilişkilidir. Destek faaliyetleri sadece sağlam zemine sahip bir lojistik yapı üzerine inşa edilebilir. Mevcut kaynakların verimli ve etkin kullanımı organizasyon yapısını güçlendirir ve aynı zamanda bu yapı içindeki personeli motive ve teşvik eder, bu da yönetimi güçlendirir. Bu çalışmada, Ege Bölgesi'nde göç yönetiminde operasyonel faaliyetlerin sürdürülmesi konusunda önem taşıyan lojistik desteği sağlamak amacıyla kurulabilecek bir lojistik tesisin yer seçimi sorununa yönelik çözüm önerisi sunulmaktadır. Çalışmada öncelikle Analitik Hiyerarşi Süreci (AHS) yöntemi kullanılarak lojistik yer seçimi kriterleri sıralanmıştır. Ardından, sıralanan kriterler doğrultusunda, MULTIMOORA tekniği kullanılarak lojistik yerler belirlenmiştir.

Anahtar Kelimeler: *Göç, Lojistik, Analitik Hiyerarşi Süreci (AHS), Çok kriterli karar verme, MULTIMOORA*

Abstract

Turkey is located on important migration routes due to its geographical location. Especially in recent years, the increasing density of the number of migrants has made it necessary to effectively manage the migration phenomenon in Turkey by addressing it from different angles. In this context, the choice of logistic location in the fight against migration is one of the important issues in migration management. The sustainability of the fight against migration is directly associated with the feasibility of operational activities. The support activities can only be built on a logistic structure that has sound grounds. The efficient and effective use of supplies strengthens the organizational structure, and at the same time motivates and encourages the personnel within that structure, which reinforces the management. In this study, a solution is proposed for the location selection problem of a logistics facility that can be established in order to provide logistical support that is important for the maintenance of operational activities in the Aegean Sea in the fight against migration. In this respect, the aim of the study is to address the facility location problem by employing

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Analytical Hierarchy Process (AHP) and MULTIMOORA multi-criteria decision making methods. First, logistics location selection criteria rankings are obtained by using AHP. Based on these criteria, logistics locations are determined by MULTIMOORA technique. In conclusion, logistics location selection criteria rankings are offered as a solution for migration.

Key words: *Migration, Logistic, Analytical Hierarchy Process (AHP), Multi-criteria decision making, MULTIMOORA*

Introduction

Logistic facility, which constitutes the core of the subject in this study, is defined as a plant established for to run logistic operations. A storage, or a distribution or maintenance oriented plant can be considered as a logistic facility. Decision making for selecting the appropriate logistic facility is one of the most important processes in logistics management. The optimization of logistics of facility location selection problems and transportation modes are crucial for many companies since they are considered as strategic level decisions of an organization (Maliki et al., 2016). There are several factors that might affect the decisions taken on international facility location with qualitative and quantitative aspects. Major factors appear in "operational-strategic-economic-political-environmental-sociocultural" aspects (MacCarthy and Atthirawong, 2003; Meijboom and Voordijk, 2003; Bohn and Pugatch, 2015; Beine et al., 2016).

There are plenty of studies that focus on logistics operations and logistics location problems for industrial sectors. However, to the best of our knowledge, the research conducted on logistics location selection process in operational facilities of military and government are scarce. In particular, regarding continuously growing migration both around the world and in Turkey, the logistics location problem of such facilities should be considered seriously.

Migration affects almost all countries of the world in terms of scope and complexity and is increasingly it is becoming a growing phenomenon (Özkul and Dengiz, 2018). When the migration patterns over the world are examined, it is observed that Turkey has always been among the most important transit routes of migration throughout the history due to its geographical location and strategic position. Turkey, excluding the permanent migration movements in history, is said to stand as a transit country to the other continents in the migration flows due to economic, political and climatic changes. In addition, to be able to settle and employ immigrants,Turkey's necessary to be prepared for all possible situations and ready rate of forced or voluntary migration of ethnic Turkish communities living in neighboring countries (Çetin, 2008). Turkey emerges both as a target and a transit country because of its geographical location and its state of development with respect to surrounding countries. The main reasons behind the migration in Turkey are listed as better life standards for immigrants, demand for cheap labor in Turkey and strict border controls of other countries (Tolay, 2015). It is also noted that, some immigrants do not attempt to stay in Turkey for lifetime, they just consider Turkey as a transit country to Europe. Immigrants enter Turkey in order to migrate to Greece first, by crossing the Aegean Sea; and then to European countries such as Italy, Germany, France, Canada, and Switzerland. (Elitok and Straubhaar, 2010; Wissink et al., 2013; Crawley and Hagen-Zanker, 2019; Düvell, 2019). In this transit route, Aegean Sea has a crucial role which needs to be considered while examining the global irregular migration mobility problem. Therefore, the geographic and strategic positions of Turkey, which is surrounded by sea on three sides with a coastal length of 8,500 kilometers, and the Aegean Region with its coastline measuring more than 2,600 kilometers (representing the longest coastline compared to the other sides of the two Black Sea and Mediterranean) makes this region critically important. In this regard, ensuring the logistic support for the operational activities in the Aegean Region appears as a matter of priority in struggling with irregular

migration mobility. However, the lack of regional logistics support providing facilities in the region creates a problem that needs to be addressed.

This study aims to examine the selection of logistic facility location problem in Aegean Region by using Analytical Hierarchy Process (AHP) and MULTIMOORA multi-criteria decision making methods. The main contributions of this paper can be stated as follows: First, this study attempts to fulfill the gap in the selection of regional logistics support providing facilities related to migration by employing multi-criteria decision making techniques. Second, this research suggests a solution to establish a logistics facility that will address the operational activities against irregular migration mobility in the Aegean Sea. Third, the study specifically differs from others in the way that using, by not only using AHP method but also employing MULTIMOORA technique to offer a more supportive solution to the logistic facility location the problem. In addition to well-known and widely used AHP method, MULTIMOORA which is considered as an appropriate tool for ranking or selecting the best alternative, is a relatively new technique and performs better in achieving satisfactory results (Chakraborty, 2011; Karande and Chakraborty, 2012; Adali and Işık, 2017). The paper is designed as follows: First section gives a brief introduction about the aim and motivation of the research. Second section focuses on the methodologies used in the context of a literature survey. Third section presents the result of Analytical Hierarchy Process (AHP) and MULTIMOORA applications. Finally, the last section of the paper is reserved for the discussion and concluding remarks.

2. Methodology

2.1. Definition of the selection problem

Facility location selection problem is an area of research that have been investigated for over a century, and it continues to gain popularity and interest with the advances in implementation.

Table 1 and Table 2 presents the sample implementation studies listed by Arabani and Farahani (2012) and the research conducted on facility location selection, respectively.

Table 1. Implementations Related to Arabani and Farahani Site Selection.

Paper (Author(s) / Year)	Content Type		Working Area
	Case Study	Industrial	
Mokhtarian, (2011)	x		Petroleum Industries
Bozkaya et al., (2010)	x		Transportation
Yao et al., (2010)	x		Chemical Industry
Esnaf and Kucukdeniz, (2010)	x		Turkey Road Industry
Vahidnia et al., (2009)		x	Health Care
Gebennini et al., (2009); Manzini and	x		Electronic Industry
Yang et al., (2007)		x	Fire Stations
Taheri and Zomaya, (2007)		x	Telecommunication
Mamada et al., (2005)		x	Evacuation Management
Gue, (2003)		x	Military

Table 2. Research on Facility Location Selection

	Paper (Author(s) / Year)	About the Study
1	Ghadge, A. et al., (2016)	A sustainable facility location solution for the distribution network of product returns highly encountered in online marketing in the uncertain environments. A case analysis was conducted to optimize the decision for single or double distribution center options.
2	Drezner, T., et al. (2016)	Explores the allocation of budget shares depending on an investigation of competitive location problem from the perspectives of adding new facilities and expanding existing facilities or by merging these two perspectives.
3	Srivastava, S.K., et al., (2016).	Investigates a dynamic single facility location and the relocation problem of a firm aims to improve cost and service performance in a set of existing facilities/customers.
4	Nazam, M., et al., (2015)	Evaluates a multi-criteria decision problem about the risk assessment of green supply chain management initiatives by proposing a fuzzy AHP-TOPSIS model. Also applies the model to a case of textile manufacturing industry and confirms this new approach works successfully.
5	Zhang, M., et al., (2012)	A facility location research for the cases of facility failure due to unexpected disasters or emergencies, in order to minimize costs and maximize the supply/coverage rates.
6	Yang, J. and Lee, H., (1997)	AHP method was employed for the selection problem of 3 potential facility locations in a decision problem dependent on 4 main location factors of market, transportation, labor and community and 3 sub-factors under each of these.
7	Canel C., and Khumawala B.M., (1996)	A case study on the location selection from 8 potential facility locations in order to address the insufficiency of a US-based chemical company's manufacturing facilities which fall short to supply for the increasing demands of the customers in the US, South America, Europe and the Far East.

2.2.Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a specific widely used approach for cumulative hierarchical weighting and a method of structuring, measurement and synthesis for multi-criteria decision making problems. As a consequence of the practical structure of the method, it has been used in various fields such as allocation of resources, predictions, risk analysis, planning, performance management and efficiency evaluation (Acar and Koyluoglu, 2020, Rathi et al, 2015, Amini and Alinezhad, 2017).

The idea of AHP was first developed in 1970s when Saaty was employed at U.S. Defense Department to study on complex problems such as disarmament, Middle East problem, and development of a transportation systems in Sudan. Saaty noticed that the modelling approach was getting more complex and that it was less effective than expected. He set off on a quest of an alternative decision making method for solving complex decision problems; and looked for a method that is mathematically simple and practical. As a result of his studies, he developed what is known as AHP today (Saaty, 1994).

AHP has particular application in group decision making and is implemented globally in a wide range of areas such as government, business, industry, medical services, shipbuilding and education. Rather than providing a precise problem definition, the AHP guides decision makers to understand their problems and find the optimal solutions for their problems. It is a technique that ranks the relative priority of all criteria depending on decision makers' assessments. Decision makers respond to surveys that are based on Saaty's 9 point scales; and thus make a paired comparison for all criteria and sub-criteria. The prioritization of decision alternatives is a result of overall evaluation of all criteria together. There are numerous techniques used for multi-criteria decision making. Among these techniques, AHP is superior and successfully implemented in that it dissolves a complicated multi criteria decision making problem into a systematic hierarchy procedure easily and effectually (Sailaja, et al., 2015).

2.3. Multi-Objective Optimization on Basis of Ratio Analysis (MULTIMOORA)

MOORA method was firstly introduced in 2006 by Brauers and Zavadskas during its application to transit economies after the introduction of ratio system part in 2004 (Brauers, 2008). This new method was introduced as a recent methodology for "Multi-objective Optimization with Discrete Alternatives: MOORA" (Brauers and Zavadskas, 2006). This methodology describes a matrix of responses for objective alternatives on which ratios are applied. Another reference point method is used for comparison to the points that comprise the best sides of alternatives. In significance coefficient approach, the criteria are compared based on their importance. In full multiplication form, alternatives are defined with respect to objective functions and they are ranked against each other as minimums and maximums through multiplication. MULTI-MOORA method is a procedure that synthesizes ratio-, reference point, significance coefficient and full multiplication form and a final step to rank alternatives in accordance with their weights.

2.4. Identification of Elements that Influence Problem Solution and the Criteria to be used in the Study

Review of existing literature provided a list of factors that were used in facility location selection. It was observed that each study employed different approaches that were specific to their own problem area, and that they used factors that were characteristics of the problem itself. Generally, the factors that are prioritized by international businesses are market location strategies, and factors related to raw materials, qualified labor, and costs. Furthermore, in location of national and/or regional facilities, decision making problems were observed to focus mostly on factors related to distribution channels, labor and industry.

State of the art provides no standard set of factors that would be valid in all cases for businesses or institutions. The first section puts forward that the factors in each study independent of each other are grouped according to their quantitative and qualitative properties, regional or location properties, or as main and sub-factors. In fact, the review of literature shows that in the identification of factors, elements that affect the problem are considered; and based on their positive and negative effects, the factors for solving the problem are defined. The term criteria will be used hereinafter to refer to such factors. The criteria that were previously listed in literature

are compiled, and from these, 11 criteria were selected to be used for the purposes of the present study. These selected criteria are listed below (Table3):

Table 3. Criteria To Be Used In This Study

Criteria to be used in this study (C_i)	
C_1	Proximity to city or provincial center
C_2	Proximity to organized industrial sites
C_3	Proximity to motorways
C_4	Proximity to ports
C_5	Distance to the other maintenance facilities/shipyards in the region
C_6	Opportunity of territory expansion
C_7	Proximity to demand points it will serve/support
C_8	Proximity to suppliers
C_9	Proximity to research/laboratory/investigation centers (university)
C_{10}	Land costs
C_{11}	Proximity to airports

3. Results

3.1. Weighting of Criteria via AHP

The criteria that are argued in the study need to be prioritized to address the decision of the institution. First, AHP method was used to weigh the criteria within themselves.

In order to weigh the criteria by using AHP method, three decision makers who were experts in operations, logistics and infrastructure were interviewed. The interviewees were informed briefly about the aim of the study, AHP method and Saaty Scale before the interview. The experts were asked to compare 11 criteria pairwise with respect to each other and to make their choices using Saaty's 9-point scale presented in Table 4.

Table 4. Saaty's Scale of Preference in AHP

NUMERICAL RATE	VERBAL JUDGEMENT OF PREFERENCE
1	Equal Importance
3	Weak Importance
5	Strong (or Essential) Importance
7	Demonstrated Importance
9	Absolute Importance
2,4,6, and 8	Intermediate Values between the Two Adjacent Judgements

In the interviews, the experts were asked to make a pairwise comparisons of criterion C1 to criteria C2, C3,…,C11; criterion C2 to criteria C3,C4,…,C11; criterion C3 to criteria C4, C5,…,C11; criterion C4 to criteria C5,C6,…,C11; criterion C5 to criteria C6, C7,…,C11, criterion C6 to criteria C7,C8,…,C11; criterion C7 to criteria C7,C8,…,C11; criterion C8 to criteria C9,C10,C11; criterion C9 to criteria C10, C11; and criterion C10 to criterion C11, on the 1-to-9 scale of Saaty.

Consistency ratio is calculated by AHP method. When the Consistency Ratio (CR) is below 10%, the valid results of the study are considered. When the CR was tested to be below desired level in an interview, the responses were taken into account to arrive at a common decision. The geometric average of all the decision maker responses on the constructs with consistency levels below expected are taken, establishing the Common Group Decision Matrix. The consistency of Common Group Decision is tested through AHP, as well. According to Common Group Decision, CR levels below 10% indicate consistency and acceptability of the method.

Therefore, according to priority vectors in group decision making, the following criteria weights, which are presented from the highest to the lowest values in Table 5, are observed:

Table 5. The Weights of The Criteria

C_i	Criteria used in the study	Weights
C_8	Proximity to suppliers	0.2386
C_9	Proximity to research/laboratory/investigation centers (university)	0.2342
C_6	Opportunity of territory expansion	0.1057
C_3	Proximity to motorways	0.0866
C_7	Proximity to demand points it will serve/support	0.0695
C_1	Proximity to city or provincial center	0.0663
C_2	Proximity to organized industrial sites	0.0558
C_{11}	Proximity to airports	0.0416
C_4	Proximity to ports	0.0388
C_{10}	Land costs	0.0364
C_5	Distance to the other maintenance facilities/shipyards in the region	0.0266

3.2. Problem Solution via MULTIMOORA

After defining the criteria to be used in the study and determining their weights, the alternatives are ranked by using a relatively new technique, MULTIMOORA method, for the purpose of selecting the logistics location facilities. The values to be used for alternatives, are presented in Table 6.

Table 6. Values To Be Used For Alternatives.

CRITERIA USED IN THE STUDY (C_i)		VALUES TO BE USED FOR ALTERNATIVES	OBJECTIVE FUNCTION
C_1	Proximity to city or provincial center	The last census results in the alternative cities (people)	Maximization
C_2	Proximity to organized industrial sites	Geometric mean of distances to organized industrial sites (OIS) in the Aegean Region or neighbor cities	Minimization
C_3	Proximity to motorways	Distance to closest motorways (Km)	Minimization
C_4	Proximity to ports	Geometric mean of distances to ports in the Aegean Region (Km)	Minimization
C_5	Distance to the other maintenance facilities/shipyards in the region	Distance to the maintenance facilities in the region (Km)	Minimization
C_6	Opportunity of territory expansion	Surface area of OISs (Km^2)	Maximization
C_7	Proximity to demand points it will serve/support	Geometric mean of distances to 24 demand points (Km)	Minimization
C_8	Proximity to suppliers	Number of firms in the OIS	Maximization
C_9	Proximity to research/laboratory/investigation centers (university)	Number of universities	Maximization
C_{10}	Land costs	The cost of OIS industrial area per m^2 (TL)	Minimization
C_{11}	Proximity to airports	Geometric mean of distances to active airports in the Aegean Region (Km)	Minimization

The quantitative values that are calculated for alternatives on 11 criteria were compared using MULTIMOORA method. In this MULTIMOORA method, multiple solutions were provided through MOORA-Ratio, MOORA-Reference Point and MOORA-Significance Coefficient methods, the results obtained through these three methods were synthesized through MULTIMOORA for a final evaluation. Following alternative cities/districts were investigated:

A_1: Mugla, A_2: Aydın, A_3: İzmir, A_4: Manisa, A_5: Bergama.

The ranking results obtained through three MULTIMOORA applications are presented on Table 7:

Table 7. Ranking Result

	MOORA-Ratio	MOORA-Reference Point	MOORA-Significance Coefficient Methods
A_1	5	4	5
A_2	3	2	3
A_3	1	3	1
A_4	2	1	2
A_5	4	5	4

In the MULTIMOORA method, multiple solutions through MOORA-Ratio, MOORA-Reference Point and MOORA-Significance Coefficient methods were synthesized through MULTIMOORA for a final evaluation. When the MULTIMOORA synthesis is considered, decision makers are observed to evaluate the criteria according to their perceptions. In this study, by using geometric means of rankings, the final evaluation phase is completed. Table 8 below presents the results of this study which ranks the mean scores of alternatives from lowest to the highest value.

Table 8. Multimoora Ranking Results

Geometric Average Points	MULTIMOORA Ranking	Alternatives
4,6	5	A_1
2,6	3	A_2
1,4	1	A_3
1,6	2	A_4
4,3	4	A_5

4. Concluding Remarks

This study investigates the facility location selection problem of a public institution which intends to establish a logistics facility that will address the operational activities against irregular migration mobility in the Aegean Sea. Three experts were interviewed on eleven criteria, and the consistency of their responses were tested through AHP method. As the consistency ratio of experts' responses were observed to be at desired levels, their responses were taken as common group decision. The weightings of the eleven criteria were set after the testing of common group decision through AHP. In accordance with the weightings based on the common group decision in the first part of the study;

i. Proximity to demand points (C_8) had the primary importance with a significance coefficient of 0.02386

ii. Proximity to suppliers (C_9) held the secondary importance with a significance coefficient of 0.2342,

iii. Proximity to maintenance facilities (C_6) was the third important criteria with a significance coefficient of 0.1057,

iv. Proximity to motorways (C_3) was the fourth important criteria with a significance coefficient of 0.0866,

v. Opportunity of territory expansion (C_7) was the fifth important criteria with a significance coefficient of 0.0695.

In the weight rankings, the experts in other fields were also observed to share the opinion that proximity to demand points, suppliers and maintenance facilities as part of a logistics support are important in the sustainability of operational activities:

i. In transportation, motorways were prioritized against seaways or airways,

ii. Costs should be the last factor that needs to be considered in this sensitive issue of migration in the Aegean Sea. The first phase for the mathematical solution of the problem is thus completed.

At the second phase of the study, MOORA-Ratio, MOORA-Reference Method and solutions based on simple quantitative values were used for ranking alternatives. With the MOORA-Significance Coefficient Method, evaluation of perceptions was also included through the criteria weightings in the first phase of the study. The final discussion was made by MULTIMOORA synthesis of results.

In this research, we attempted to examine and offer a solution to the worldwide irregular migration mobility observed in Aegean Sea. In this context, we focused on logistic location selection which is considered as one of the most essential aspects of migration, especially in cases of emergencies. It is critically important to be in the right place at the right time with the right materials in order to prevent the deaths of immigrants due to delayed interventions for urgent situations that need immediate actions.

Aegean Sea, where numerous irregular migrants have lost their lives on their way to Europe, is specifically one of those territories that is considerably exposed to the irregular migration mobility. Accordingly, because of its major role in this global problem by being a transit route for immigrants, Aegean Sea is determined as the region to define the logistics locations for urgent interventions. This study mainly aims to provide a contribution to the solution of the irregular migration mobility emerging in Aegean Sea, by examining the selection of logistic facility locations in the region. With this aim in mind, first the criteria for logistics locations were determined and prioritized by using AHP method. Second, the selection of logistics location facilities was supported by employing MULTI MOORA method which is a relatively new technique. We used AHP method, because among the other multi-criteria decision making models, AHP is considered as one of the most successful techniques with its flexibility and ability to control the inconsistencies (Ramanathan, 2001). Another distinctive strength of the method is that, first it enables the decomposition of multi-criteria decision problem into its components and then constitutes the hierarchical ranking of criteria. After prioritizing the criteria used by AHP method, we applied MULTIMOORA technique for several reasons: First, MULTIMOORA is a nonlinear model which makes it to be more appropriate than other multi-criteria decision making models in examining nonlinear human behaviors. Second, it is considered as a useful method by being flexible and efficient in the selection and ranking of the best alternative for the problems with set of alternatives. Lastly, it generates more satisfactory and supportive results in the investigation of multi-criteria decision making problems. (Chakraborty, 2011; Karande and Chakraborty, 2012; Adali and Isik, 2017).

The research problem addressed in this study, presents an implication for the logistical infrastructure needed to address the irregular migration mobility in the Aegean Region. Even though the coastal cities/districts were selected as alternatives in this study, due to the geographical characteristics of the Aegean Region, other alternative cities/districts might be added if this study design is to be used in implementation. At this point, cities/districts other than coastal alternatives may be included in the evaluations depending on the needs and approaches to problem solution. In addition to these, for a healthy implementation of this decision in real life, the decision making problem might be further detailed to take into consideration other criteria such as organizational structure, strategic goals and objectives, social needs of the workers, their duties, workforce capacity.

Multi-criteria decision making methods, with their analytical approach to problems, might be used in many areas in daily life; and by businesses and institutions in personnel selection, logistics, and strategic or operational decision making processes. In this context, this study is considered to be a basis for further studies in that it is an exemplary work that might be used in scientific decision support systems and mechanisms.

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Araştırma Makalesi

Logistics Location Selection In Migration Management: An Analysis Of Aegean Region

Göç Yönetiminde Lojistik Konum Seçimi: Ege Bölgesi Üzerine Bir Inceleme

Ayşegül TAŞ	Levent YILMAZ	Zeynep Birce ERGÖR
Doç.Dr. Cankaya University	Cankaya University	Dr. Cankaya University
Department of Management	l.ylmz.83@gmail.com	Department of Management
aysegul@cankaya.edu.tr	https://orcid.org/0000-0002-9435-3805	ergor@cankaya.edu.tr
https://orcid.org/0000-0002-3040-4888		https://orcid.org/0000-0002-9895-7040

Genişletilmiş Türkçe Özet

Giriş

Türkiye coğrafi konumu gereği önemli göç rotaları üzerinde bulunan bir ülkedir. Özellikle son yıllarda artan göç eden insan sayısındaki yoğunluk, Türkiye'deki göç olgusunun farklı yönlerden ele alınarak etkin bir şekilde yönetilmesini gerekli kılmıştır. Bu bağlamda, göçle mücadelede lojistik konum seçimi, göç yönetiminde önem arz eden konuların başında gelmektedir. Göçle mücadelenin sürdürülebilirliği, operasyonel destek faaliyetlerin yürütülmesi ile doğrudan ilişkilidir. Destek faaliyetleri sadece sağlam zemine sahip bir lojistik yapı üzerine inşa edilebilir. Mevcut kaynakların verimli ve etkin kullanımı organizasyon yapısını güçlendirir ve aynı zamanda bu yapı içindeki personeli motive ve teşvik eder, bu da yönetimi güçlendirir. Bu çalışmada, Ege Bölgesi'nde göçle mücadelede operasyonel faaliyetlerin sürdürülmesi konusunda önem taşıyan lojistik desteği sağlamak amacıyla kurulabilecek bir lojistik tesisin yer seçimi sorununa yönelik çözüm önerisi sunulmaktadır. Çalışma, Ege Bölgesi'nde lojistik tesis konum sorununun analitik hiyerarşi süreci (AHP) ve MULTIMOORA çok kriterli karar verme yöntemleri kullanılarak incelenmesini amaçlamaktadır. Bu makalenin temel katkıları şu şekilde ifade edilebilir: Birincisi, bu çalışma, çok kriterli karar verme teknikleri ile göçle ilgili tesisler sağlayarak bölgesel lojistik desteğinin seçimindeki boşluğu gidermeye çalışmaktadır. İkinci olarak, bu araştırma, Ege Denizi'ndeki göç sorununa karşı operasyonel faaliyetleri ele alacak bir lojistik tesisi kurulmasına yönelik bir çözüm önermektedir. Üçüncü olarak, çalışma, önceki çalışmalardan farklı olarak, göç konusunda lojistik tesis konumu sorununa sadece AHP yöntemi kullanarak değil, aynı zamanda sıralama veya en iyi alternatif seçmek için uygun bir araç olarak kabul edilen MULTIMOORA tekniği kullanarak da destekleyici bir çözüm önerisi sunmaktadır.

Yöntem

Literatürde daha önce listelenen kriterler derlenmiş ve bunlardan bu çalışmanın amaçları için kullanılmak üzere 11 kriter belirlenmiştir. Bu seçilen kriterler şöyledir: Şehir merkezine yakınlık, organize sanayi bölgelerine yakınlık, otoyollara yakınlık, limanlara yakınlık, bölgede bulunan diğer bakım tesislerine/tershanelere olan mesafe, bölgesel gelişme fırsatı, hizmet/destek talep noktalarına yakınlık, tedarikçilere yakınlık, araştırma/laboratuvar/araştırma merkezlerine yakınlık (üniversite vb), arazi maliyetleri ve havalimanlarına yakınlık. İlk olarak, AHP yöntemi ile kriterleri ağırlıklandırmak amacıyla operasyon, lojistik ve altyapı konusunda uzman üç karar verici ile görüşülmüş ve uzmanlardan, 11 kriteri birbirine göre karşılaştırmaları ve Saaty'nin geliştirmiş olduğu 9 puanlı tercih ölçeğini kullanarak seçimlerini yapmaları istenmiştir. Sonuçlar Tablo 5'de gösterilmektedir. Çalışmada kullanılan kriterlerin ağırlıkları belirledikten sonra alternatifler, lojistik yer seçimi amacıyla görece yeni bir teknik olan MULTIMOORA yöntemi kullanılarak sıralanmıştır. 11 kriterde alternatifler için hesaplanan nicel değerler MULTIMOORA yöntemi kullanılarak karşılaştırılmıştır. Bu son aşamada, MOORA-Oran, MOORA-Referans Noktası ve MOORA-Anlam Katsayısı yöntemleri ile birden fazla çözüm sağlanmış, bu üç yöntemle elde edilen sonuçlar son değerlendirme için MULTIMOORA ile sentezlenmiştir. Alternatifler, Muğla (A_1), Aydın (A_2), İzmir, (A_3), Manisa (A_4) ve Bergama (A_5) şehirleri/ilçeleri için analiz edilmiştir.

Çalışmada kullanılan Analitik Hiyerarşi Süreci (AHP) yöntemi, diğer çok kriterli karar verme modelleri arasında, esneklik ve tutarsızlıkları kontrol etme becerisi ile en başarılı tekniklerden biri olarak kabul edilmektedir (Ramanathan, 2001). Yöntemin bir diğer ayırt edici gücü ise, ilk olarak çok kriterli karar sorununun bileşenlerine ayrıştırılma imkanı vermesi ve daha sonra ölçütlerin hiyerarşik sıralamasını oluşturmasıdır. Çalışmada MULTIMOORA tekniğinin tercih edilmesindeki temel sebepler ise şöyledir: Öncelikle, MULTIMOORA doğrusal olmayan insan davranışlarının incelenmesinde diğer çok kriterli karar verme modellerinden daha uygun hale getiren doğrusal olmayan bir modeldir. İkinci olarak, alternatifler kümesi ile sorunlar için en iyi alternatif seçimi ve sıralamasında esnek ve verimli olarak yararlı bir yöntem olarak kabul edilmektedir. Son olarak, çok kriterli karar verme sorunlarının araştırılmasında daha tatmin edici ve destekleyici sonuçlar doğurur. (Çakraborty, 2011; Karande ve Chakraborty, 2012; Adalı ve Işık, 2017).

Bulgular

Çalışmada Analitik Hiyerarşi Süreci (AHP) ve MULTIMOORA teknikleri kullanılarak yapılan analizler sonucunda elde edilen bulgular aşağıdaki tablolarda (orijinal metinde: Tablo 5 ve Tablo 8) sırasıyla gösterilmektedir:

Tablo 5. Kriterlerin Ağırlıkları

C_i	Çalışmada Kullanılan Kriterler	Ağırlıklar
C_8	Tedarikçilere yakınlık	0.2386
C_9	Araştırma/laboratuvar/araştırma merkezlerine yakınlık (üniversite vb)	0.2342
C_6	Bölgesel gelişme fırsatı	0.1057
C_3	Otoyollara yakınlık	0.0866
C_7	Hizmet/destek talep noktalarına yakınlık	0.0695
C_1	Şehir merkezine yakınlık	0.0663
C_2	Organize sanayi bölgelerine yakınlık	0.0558

C_{11}	Havalimanlarına yakınlık	0.0416
C_4	Limanlara yakınlık	0.0388
C_{10}	Arazi maliyetleri	0.0364
C_5	Bölgede bulunan diğer bakım tesislerine/tershanelere olan mesafe	0.0266

Tablo 8. MULTIMOORA Sıralama Sonuçları

Geometrik Ortalama Puanları	MULTIMOORA Sıralaması	Alternatifler
4,6	5	A_1
2,6	3	A_2
1,4	1	A_3
1,6	2	A_4
4,3	4	A_5

Tartışma

Çalışmanın AHP yöntemi kullanılarak yürütülen ilk analiz aşaması sonucunda elde edilen bulgular, ortak grup kararına dayalı ağırlıklara uygun olarak elde edilmiştir. Bu bağlamda, talep noktalarına yakınlık (C8) 0,02386 tedarikçilere yakınlık (C9) anlamlılık katsayısı 0,2342 ile ikincil öneme sahip, Bakım tesislerine yakınlık (C6) 0,1057 anlamlılık katsayısı ile üçüncü önemli kriter, otoyollara yakınlık (C3) 0,0866 anlamlılık katsayısı ile dördüncü önemli kriter, toprak genişletme fırsatı (C7) 0,0695 anlamlılık katsayısı ile beşinci önemli kriter olmuştur. Ağırlık sıralamasında, diğer alanlardaki uzmanların, lojistik hizmet/destek talep noktalarına yakınlığın, tedarikçilerin ve bakım tesislerinin operasyonel faaliyetlerin sürdürülebilirliğinde önemli kriterler olduğu görüşünü paylaştıkları gözlenmiştir. Ayrıca, ulaşımda otoyollara, deniz yolları veya hava yollarına kıyasla öncelik verildiği ve Ege Denizi'nde göç konusunda dikkate alınması gereken son kriterlerden birinin "maliyetler" olması gerektiği ortaya çıkan diğer sonuçlardır.