Journal of Economics Bibliography
www.kspjournals.org
Volume 3 April 2016 Issue 1S

Selection of Logistics Center Location with MOORA Method for Black Sea Region of Turkey

By Coşkun HAMZAÇEBİ † Gül İMAMOĞLU & Ahmet ALÇI

Abstract. Logistics activities are becoming more important with the increase in global competition. For this reason logistics centers are being established in order to facilitate logistics activities and to provide a more effective realization. The interest in the logistics center is increasing all over the world. Our country is also aimed to establish logistics centers in different regions for development plans. In this study, which provinces would be appropriate for the establishment of logistics centers in the Black Sea region is determined with MOORA Method using by 10 different criteria. While Samsun takes the first place in the results of analysis to establish the logistics center, Trabzon and Zonguldak are considered available cities to build logistics center.
Keywords. Logistics center, MOORA, Location problem.
JEL. J61, L86, Q55.

1. Introduction

As decreasing costs, firm acquire priorities including to enhance their market shares, firm continuity and providing competitive edge in the sector in today's market conditions where global competition has been increasing over time. Logistics costs, which create an important item in product costs, are also regarded in this concept and they are tried to be decreased. One of the ways to decrease the logistics costs is to preferred logistics centers, which decrease transportation and storage costs as utilizing condensation effects (Hamzaçebi & İmamoğlu, 2014). As a word meaning, logistics is defined in Merrian-Webster dictionary as "maintaining a complicated movement or event which requires planning and organizing processes as covering many people" (URL 1).

Attention to logistics centers has been increased in developing and developed countries, throughout the world. Logistics centers firstly were established in United States of America. The first examples in Europe were seen in France and then Italy and Germany (Aydın & Öğüt, 2008). Establishing logistics centers in our country were planned in coverage of development studies in several regions. Although logistics centers have different definitions in different sources, they generally represent an area in a safety environment, in which all kinds of logistics activities, including transportation, storage and distribution, can be carried out with multiple transportation facilities and covering public institutions like customs (Kayıkçı, 2010). Another qualification of logistics centers is to eliminate traffic load resulting from freight transportation in cities. For this purpose, logistics centers are generally

† Karadeniz Technical University, Department of Industrial Engineering, Kanuni Campus, Trabzon, Turkey.
. +90 462 3772950
. hamzacebi@ktu.edu.tr

established in points out of cities where the transportation is convenient (Aydın & Öğüt, 2008).

Providing benefits in the purpose of logistics center establishment could only be possible with strategic location selection. There are many studies in the available literature which use different techniques for logistics center location selection. Kayıkçı (2010) provided two different decision making models for logistics center location selection with Fuzzy Analytic Hierarchical Process and Artificial Neural Network techiques. In another study in the literature, a model is suggested for logistics center location selection with a mix technique including axiomatic fuzzy set and TOPSIS techniques (Li et al., 2011). Kampf et al. (2011), as determining important criteria for public logistics centers, offered supportive software using weighted sums approach. Georgijevic et al. (2012) developed a mathematical model which was based on enhanced capacity limits, fixed cost and location selection-assigning model in order to determine the amount, locations and sizes of public logistics centers so that they applied the model for a numerical case study in Serbia to show the efficiency of the model. Ka (2011) offered a mix method which was consisted of fuzzy AHP and ELECTRE methods for dry product storage centers which was planned to be established in China.

Regmi and Hanaoka (2013) created two different model for logistics centers location selection in Laos with AHP and goal programming techniques and they showed that obtained results were consistent with each other. Yang et al. (2006) suggested a model in which they combined tabu search algorithm, genetic algorithm and fuzzy simulation for logistics distribution center and they showed the application of this model in a numerical case study. Ji et al. (2013) established an optimization method for a regional express distribution center location selection and solved the model with fuzzy C-means clustering algorithm. Markovic et al. (2013) suggested MODIPROM technique depending on PROMETHEE method for logistics center location selection. Hamzaçebi and İmamoğlu (2014) presented a goal programming model for logistics center location selection which was planned for East Black Sea Region of Turkey.

In this study, by considering 10 different criteria, which are determined through literature research, for MOORA multiple criteria decision making technique; the city on which the logistics center should be established for Black Sea Region is determined. In the second section of this study, Black Sea Region is introduced; in the third section, a brief knowledge about the MOORA technique is given; in the fourth section, the case study is presented and the last section is the conclusion part.

2. Black Sea Region

As one of seven geographic regions of Turkey, Black Sea is located in 109802,9 km^2 area and consist of almost 14% of total country land; so that it is the third biggest region of Turkey (URL 2). Another specification of the region is to have the longest area in the direction of east to west. It could be said that the region is not clustered in as other regions are, and it spreads in the edge of Black Sea as a line. This shows that the edge cities are far away from each other. 18 cities in the region could be listed as in alphabetic order as follows; Amasya, Artvin, Bartın, Bayburt, Bolu, Çorum, Düzce, Giresun, Gümüşhane, Karabük, Kastamonu,Ordu, Rize, Samsun, Sinop, Tokat, Trabzon, Zonguldak

7.547.841 population of the region consists of almost 10% of total country population. Population distribution of the region is provided in Table 1 in terms of cities (URL 3). As could be observed in Table 1, the cities with the highest population are as Samsun, Trabzon and Ordu.

Table 1. *City Population in Black Sea Region*

Cities	Population	Cities	Population
Amasya	322.283	Karabük	225.145
Artvin	167.082	Kastamonu	359.808
Bartın	188.436	Ordu	741.371
Bayburt	75.797	Rize	324.152
Bolu	281.080	Samsun	1.251.722
Çorum	529.975	Sinop	201.311
Düzce	346.493	Tokat	613.990
Giresun	419.555	Trabzon	757.898
Gümüşhane	135.216	Zonguldak	606.527

Export volume belong to the region for 2012 was 3.513.990.000 USD and its contribution to country as 2,3% while import volume for the same year was 3.648.408.000 USD and its contribution as 1,9%. Export and import volumes for cities are provided in Table 2. It is important that the foreign trade scarcity of the region in comparison with the geographic size within country is striking.

Table 2. *City Import and Export Volume in Black Sea Region*

Cities	Export (1000 USD)	Import (1000 USD)	Cities	Export (1000 USD)	Import (1000 USD)
Amasya	65.015	84.972	Karabük	167.424	482.827
Artvin	77.594	72.806	Kastamonu	30.383	29.571
Bartın	14.116	15.211	Ordu	334.142	104.245
Bayburt	348	5.145	Rize	389.437	25.941
Bolu	99.505	179.394	Samsun	422.749	1.006.611
Çorum	166.369	98.436	Sinop	27.292	9.331
Düzce	86.272	85.588	Tokat	37.346	20.454
Giresun	175.028	9.851	Trabzon	1.099.596	157.722
Gümüşhane	216	4.007	Zonguldak	321.158	1.256.296

Only Amasya, Karabük, Samsun, Tokat and Zonguldak cities have railway transportation opportunity in Black Sea Region. Therefore, as a general evaluation, it could be claimed that Black Sea Region experiences railway transportation scarcity in region-wide. Railway map for the region is provided in Image 1 (URL 4). Additionally, it could be stated that there are missing parts in terms of airline transportation in region-wide. There are only usable 6 airports in the whole region. These airports are located in Amasya, Samsun, Sinop, Tokat, Trabzon and Zonguldak cities.

Image 1. *Railway Map for Black Sea Region*

3. MOORA Method

MOORA (Multi-Objective Optimization by Ratio Analysis) method is one of the multiple criteria decision making techniques. Although MOORA is very new method, it has been used for different application areas. Since it is an easy to use method and it enables for researcher to reach conclusion fast, MOORA is regarded as a method which will be used more frequently in the future.

As being the first study on which MOORA method is implemented, in the transition economy, general information about MOORA method is presented. It is stated that it is an alternative technique among other methods in multiple criteria decision making problems and it is a superior technique especially in terms of reference point technique (Brauers & Zavadskas, 2006). MOORA method was used to make a selection among alternatives for the best road design and to apply a methodology to evaluate multiple criteria for multiple purpose optimization study of road design alternatives, as being another study, which was conducted in subject matter (Brauers et al., 2008).

Gadakh (2011) reported that the MOORA method could be used for its applicability and flexibility features for solving several complex decision making problems in production environment for the study of parameter optimization in grinding process. The author applied MOORA to find the best alternative among all alternatives depending on multiple criteria in different decision making processes (Gadakh, 2011). Chakraborty (2011) has used MOORA technique for production systems. The author reported that determination of best alternative for industrial robot, flexible production system and computer aided numerical control machines, fast prototype acquiring process and automatic evaluation process can be considered as multiple criteria decision makin problem (Chakraborty, 2011).

Önay and Çetin (2012) ranked touristic destinations in Istanbul in terms of their awareness levels with TOPSIS and MOORA methods from multiple criteria decision making methods. Karande and Chakraborty (2012) used MOORA method for product design and material selection for production process.

MOORA (Multi-Objective Optimization on the basis of Ratio Analysis) is defined as a analyzing process in optimum fashion for two or more specifications or purposes which is conflicted under some limits (Brauers & Zavadskas, 2009; Chakraborty, 2011).

It could be seen that various MOORA techniques are present in literature. These techniques could be listed as MOORA-Ratio method, MOORA-Reference Point approach, MOORA-Full Multiplicative Form and MULTI-MOORA. Although the method selection is depending on the researcher initiative, the most frequently used methods are found as ratio method and reference point approach methods of MOORA in the related studies. In basis of MOORA method, there is data matrix in which criteria and alternatives are located. The general form of this matrix is provided below;

$$X = \begin{bmatrix} X11 & X12 & \dots & X1n \\ X21 & X22 & \dots & X2n \\ \dots & \dots\ \dots & & \dots \\ Xm1 & Xm2 & \dots & Xmn \end{bmatrix}$$

Data matrix is the basic of each MOORA method. Although different mathematical equations are applied to data in different methods, the data in this matrix is primarily normalized in each method.

3.1. MOORA-Ratio Method

Data should be normalized as the first step of the method.

$$x_{ij}^{*} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{n}(X_{ij})\text{^}2}} \quad , \quad \forall j \; where \tag{1}$$

i= 1,2…m: the amount of alternatives

j= 1,2…n: the amount of criteria

X_{ij}: performance value measured for jth criterion of ith alternative

X_{ij}^{*}: normalized value of performance value measured for jth criterion of ith alternative

In ranking process with MOORA Ratio method, the sum of value of criteria whose purpose is to minimize for each alternative is subtracted from the sum of normalized value of criteria whose purpose is to maximize for each alternative. Therefore, single value for each alternative is obtained and alternatives are ranked depending on these values.

$$Y_i^{*} = \sum_{j=1}^{c}(X_{ij}^{*}) - \sum_{j=c+1}^{n}(X_{ij}^{*}) \tag{2}$$

Y_i^{*}: order of ith alternative

j=1,2…c: the amount of criteria to be maximized

j= c+1, c+2…n: the amount of criteria to be minimized

In the ranking process, which will be conducted using this method, bigness of Y_i^{*} values are considered.

3.2. MOORA-Reference Point Method

As in Ratio Method, in Reference Point Method, the normalized data values are utilized. Additionally, reference points are established for each criterion. Reference points are assigned as the best value of criteria ordering process and the distance of each value to these points.

$$d_{ij} = |r_j - X_{ij}^{*}| \tag{3}$$

r_j: reference point value of jth criterion

d_{ij}: The absolute value of each normalized value to reference point

After calculating the distance of each value to reference point;

$$Y_i^{*} = \text{Min}_{(i)}\{\text{maks}_{(j)}\, d_{ij}\} \tag{4}$$

The alternative whose Y_i^{*} value is the greatest is considered as the best alternative.

4. Findings and Discussion

4.1. Data Set

In this study, 10 criteria from demographic, economic and social areas, which are effective on logistics activities, were determined with literature review. The cities appropriateness for logistics centers is determined using these criteria. The data belong to 2012 for the 10 criteria were used. Criteria, criteria explanations, data sources and criteria references are presented in Table 3 and the value of each city in respect to the criteria were provided in Table 4.

Table 3. *Criteria Explanation*

Criteria Name	Criteria Explanation	Data Source	Data Reference
Population	The amount of people registered in cities	Turkey Institute of Statistics (TUİK)	Hamzaçebi and İmamoğlu (2014)
Export	Export volume in cities	TUİK	Kayıkçı (2010)
Import	Import volume in cities	TUİK	Kayıkçı (2010)
Industry and Electricity Power	Electricity energy consumption amount which cities use for industrial purposes	TUİK	Es et al.(2014)
Airline Transport	Material volume which cities transport through airline transportation method	TUİK	Es et al. (2014)
Railway	Airline road length within city borders	TUİK	Regmi (2013) Kampf (2011)
Material Handling	Material volume which cities transport through maritime transportation method	Maritime Commerce General Directorate	Kayıkçı (2010)
Vehicle-km	Vehicle volume amount in one km distance in cities	Highways General Directorate(KGM)	Es et al.(2014)
Tonne-km	The amount of material per km which cities transport	KGM	Ka (2011)
Total Distance	Total distances of cities to other cities in Black Sea Region	KGM	Hamzaçebi and İmamoğlu (2014)

Table 4. *Value of each City in Each Criterion (Decision Matrix)*

	Population (Person)	Export (1000 dollar)	Import (1000 dollar)	Airline Transport (tonne)	Industry and Electricity Power (MWh)	Railway (km)	Material Handling (tonne)	Vehicle -km (amount/ km)	Tonne-km (amount/ km)	Total Distance (km)
Amasya	322283	65015	84972	703	158002	69	0	714458	2032898	6168
Artvin	167082	77594	72806	0	117653	0	858186	293020	613385	11302
Bartın	188436	14116	15211	0	117731	0	1464169	203726	259724	8693
Bayburt	75797	348	5145	0	12436	0	0	97422	252161	8933
Bolu	281080	99505	179394	0	502756	0	0	1365722	4617875	8647
Çorum	529975	166369	98436	0	313223	0	0	944663	2694665	6344
Düzce	346493	86272	85588	0	435294	0	0	963171	2693749	9261
Giresun	419555	175028	9851	0	63830	0	764380	717811	1609580	6512
Gümüşhane	135216	216	4007	0	61022	0	0	258607	640907	7646
Karabük	225145	167424	482827	0	662933	120	0	334027	684226	7745
Kastamonu	359808	30383	29571	0	281969	0	453688	596439	1283439	6370
Ordu	741371	334142	104245	0	321679	0	2048626	873595	1747937	6248
Rize	324152	389437	25941	0	212336	0	1139663	577401	1041987	8798
Samsun	1251722	422749	1006611	12635	1074480	148	8910426	1971773	3962832	5806
Sinop	201311	27292	9331	688	105494	0	0	234689	551234	6726
Tokat	613990	37346	20454	219	171930	137	0	568794	1226854	6724
Trabzon	757898	1099596	157722	24719	234198	0	3448843	1269220	1919001	7748
Zonguldak	606527	321158	1256296	635	2008496	69	15585821	583450	953104	9031

4.2. MOORA Implementation

Establishing decision matrix is the first step for the application of MOORA method. After this step, rankings were conducted with MOORA-Ratio and MOORA-Reference methods as following the steps mentioned in the section 3. Additionally, criteria were weighted with the weights, which were obtained in the related literature and rankings were obtained both of the methods. Values relate to criteria weights are presented in Table 5.

Table 5. *Criteria Weights*

Population	Export	Import	Airline Transport	Industry Electricity Power	Railway	Material Handling	Vehicle (km)	Tonne	Total Distance
0.11	0.08	0.08	0.13	0.03	0.15	0.16	0.03	0.09	0.14

While total distance is cost type criterion all the others are benefit type criteria.

Through the given information, the results of 4 different analyses which are conducted with MOORA methods are showed in Table 6.

Table 6. *Ranking of Cities*

	Equal Weight		Weighted	
	MOORA Ratio	MOORA Reference	MOORA Ratio	MOORA Reference
Amasya	9	3	7	10
Artvin	15	7	16	7
Bartın	16	8	15	5
Bayburt	18	9	18	11
Bolu	5	10	8	12
Çorum	8	11	9	13
Düzce	10	12	12	14
Giresun	12	13	10	8
Gümüşhane	17	14	17	15
Karabük	4	15	5	16
Kastamonu	13	16	13	9
Ordu	6	17	6	4
Rize	11	18	11	6
Samsun	1	1	1	1
Sinop	14	4	14	17
Tokat	7	6	4	18
Trabzon	3	2	3	2
Zonguldak	2	5	2	3

4.3. Discussion

In this study, it is aimed to determine the most suitable city of Black Sea Region for logistics center location. The MOORA method was implemented for logistics center location selection in two ways as according to the equal weighted and different weigted criteria evaluation. It is clear in Table 6 that Samsun is the most suitable city in the region for logistics center location.

Samsun takes the first place since it has both airline transportation and maritime transportation opportunities, it is the most crowded city in the region, and the total distance to other cities is minimal so that it is a center city. Additionally, export and import values are higher comparison to many cities in the region.

For the increase demand for logistics centers in the region, the second and third ranks are obtained by Trabzon and Zonguldak, respectively. As could be observed in Table 4, export volume of Trabzon and import volume of Zonguldak are higher than all other cities in the region.

5. Conclusion

Since there are more than one criteria and more than one alternative in logistics center location selection problem which is planned to be established in Black Sea region, it requires to use multiple criteria decision making methods as a solution tool. Problem analysis is conducted with MOORA method which is often used for multicriteria decision problems recently. As a result of analyzing this problem, the conclusion of the necessity to establish the logistics center firstly in Samsun in Black Sea region. Trabzon and Zonguldak cities follow Samsun city. Since the observed problem is closely related to Ministries of Transportation, Economy and Development and associates; the obtained results will be guidance.

References

Aydın, G.T., & Öğüt K.S., (2008). Avrupa ve Türkiye'de lojistik köyleri, *2. Uluslararası Demiryolu Sempozyumu*, İstanbul, 2. Cilt, 1471-1481.

Aydın, G.T., & Öğüt, K.S., (2008). Lojistik köy nedir?, *2. Uluslararası Demiryolu Sempozyumu*, İstanbul, 2. Cilt, 1439-1448.

Balezentis, A., Balezentis, T., & Valkauskas, R., (2010). Evaluating situation of Lithuania in the European union: Structural indicators and MULTIMOORA method, *Technological Economic Development of Economy*, 16(4), 578–602. doi. 10.3846/tede.2010.36

Brauers, W.K.M., & Zavadskas, E.K. (2006). The MOORA methodand its application to privatization in a transition economy, *Control and Cybernetics*, 35(2), 445–469.

Brauers, W.K.M., Zavadskas, E.K., Peldschus, F., & Turskis, Z. (2008). Multi-objective optimization of road design alternatives with an application of the MOORA method, *ISRARC*. doi. 10.3846/1648-4142.2008.23.183-193

Brauers, W.K.M., & Zavadskas, E.K., (2009). Robustness of the multiobjective MOORA method with a test for the facilities sector, *Technological and Economic Development of Economy*, 15(2), 352–375. doi. 10.3846/1392-8619.2009.15.352-375

Brauers, W.K.M., & Zavadskas, E.K., (2010). Project management by MULTIMOOORA as an instrument for transition economies, *Technological and Economic Development of Economy*, 16(1), 5-24. doi. 10.3846/tede.2010.01

Brauers, W.K.M., Ginevičius, R., & Podvezko, V. (2010). Regional development in Lithuania considering multiple objectives by the MOORA method, *Technological and Economic Development of Economy*, 16(4), 613–640. doi. 10.3846/tede.2010.38

Brauers, W.K.M., & Zavadskas, E.K., (2011). MULTIMOORA optimization used to decide on a bank loan to buy property, *Technological and Economic Development of Economy*, 17(1), 174–88. doi. 10.3846/13928619.2011.560632

Chakraborty, S., (2011). Applications of the MOORA method for decision making in manufacturing environment, *The International Journal of Advanced Manufacturing Technology*, 54(9), 1155–1166. doi. 10.1007/s00170-010-2972-0

Ersöz, F., & Atav, A. (2011). Çok kriterli karar verme problemlerinde MOORA yöntemi, KHO Savunma Bilimleri Enstitüsü Harekat Araştırması.

Es, H.A., Hamzaçebi C., & Oktay Fırat S.Ü., (2014). İllerin lojistik faaliyetlere göre kümelenmesi: Türkiye örneği, *3. Ulusal Lojistik ve Tedarik Zinciri Kongresi*, Trabzon, Turkey.

Gadakh., V.S. (2011). Application of MOORA method for parametric optimization of milling process, *International Journal of Applied Engineering Research*, 1(4), 743-758.

Georgijevic, M., Bojic, S., & Brcanov, D., (2013). The location of public logistic centers: an expanded capacity-limited fixed cost location-allocation modelling approach, *Transportation Planning and Technology*, 36(2), 218-229. doi. 10.1080/03081060.2013.770945

Hamzaçebi, C., & İmamoğlu, G., (2014). TR90 bölgesi lojistik merkezi yer seçimi için hedef programlama tekniği uygulaması, *Gümüşhane Üniversitesi Sosyal Bilimler Elektronik Dergisi*, 11, 154-170.

Ji, Y., Yang H., Zhang, Y., & Zhong, W., (2013). Location optimization model of regional express distribution center, *Procedia Social and Behavioral Sciences*, 96, 1008-1013. doi. 10.1016/j.sbspro.2013.08.115

Ka, B., (2011). Application of fuzzy AHP and ELECTRE to China dry port location selection, *The Asian Journal of Shipping and Logistics*, 27(2), 331-354. doi. 10.1016/S2092-5212(11)80015-5

Kampf, R., Prusa, P., & Savage, C., (2011). Systematic location of the public logistic centres in Czech Republic. *Transport*, 26(4), 425-432. doi. 10.3846/16484142.2011.635424

Karande, P. & Chakraborty, S. (2012). Application of multi-objective optimization on the basis of ratio analysis (MOORA) method for materials selection, *Materials and Design*, 37, 317–324. doi. 10.1016/j.matdes.2012.01.013

Kayikci, Y. (2010). A conceptual model for intermodal freight logistics centre location decisions, *Procedia Social and Behavioral Sciences*, 2(3), 6297-6311. doi. 10.1016/j.sbspro.2010.04.039

Li, Y., Liu, X., & Chen Y., (2011). Selection of logistics center location using axiomatic fuzzy set and TOPSIS methodology in logistics management. *Expert Systems with Applications*, 38(6), 7901-7908. doi. 10.1016/j.eswa.2010.12.161

Markovic, G., Gasie, M., Kolarevic, M., Savkovic, M. & Marinkovic, Z., (2013). Application of the MODIPROM method to the final solution of logistics centre location, *Transport*, 28(4), 341- 351. doi. 10.3846/16484142.2013.864328

Önay, O., & Çetin, E. (2012). Turistik yerlerin popülaritesinin belirlenmesi: İstanbul örneği, Haziran. Özçelik, G., & Atmaca H.E. (2014). Satın alma süreci için MOORA metodu ile tedarikçi seçimi problemi, *3.Ulusal Lojistik ve Tedarik Zinciri Kongresi*, Trabzon, Türkiye.

Regmi, M.B., & Hanaoka S., (2013). Location analysis of logistics centres in Laos, *International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management*, 16(3), 227-242. doi. 10.1080/13675567.2013.812194

Stanujkic, D., Magdalinovic, N., Stojanovic, S., & Jovanovic, R. (2012). Extension of ratio system part of MOORA method for solving decision-making problems with interval data, *Informatica*, 23(1), 141-154.

URL 1: Webster Dictionary İnternet Sitesi, http://www.merriam-webster.com/dictionary/logistics, Erişim Tarihi:31.12.2015.

URL 2:TÜİK İnternet Sitesi, http://tuikapp.tuik.gov.tr/

URL 3:TÜİK İnternet Sitesi, http://www.tuik.gov.tr/

URL 4: T.C. Devlet Demiryolları İnternet Sitesi, http://www.tcdd.gov.tr/

Yang, L., Ji X., Gao Z., & Li K., (2007). Logistics distribution centers location problem and algorithm under fuzzy environment, *Journal of Computational and Applied Mathematics*, 208(2), 303-315. doi. 10.1016/j.cam.2006.09.015

Yıldırım, B. F., & Önay, O. (2013). Bulut teknolojisi firmalarının bulanık AHP-MOORA yöntemi kullanılarak sıralanması, *İ.Ü. İşletme Fakültesi İşletme İktisadı Enstitüsü Yönetim Dergisi*, 24(75), 59-81.