Logistic Location Selection with Critic-Ahp and Vikor Integrated Approach

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***Abstract*— Transportation costs' directly affecting national economies; increase in transportation costs depending on energy resources have directed the countries to develop combined transportation strategies to reduce transportation costs. In this study, it is aimed to provide suggestions for the location selection of the logistics centers where wil be determined the strategies for the most economic, rapid and safe transportation with the integration of the transportation types which will contribute to the reduction of the transportation costs. The Aegean Region and The Central Anatolia Region were chosen as the pilot regions in the selection of the optimum location of the logistics centers required to develop combined transportation. The information required to select location in these two regions was obtained through a questionnaire survey and the CRITIC-AHP-VIKOR integrated method was used for the optimum location selection. While the criteria weights were determined by the CRITIC-AHP method, alternative location was chosen by VIKOR method.**

***Keywords*: CRITIC, VIKOR, logistic location selection**

I. INTRODUCTION

Transportation and logistics are one of the biggest parameters affecting the economy of countries in today's world. It is very important to reduce the transportation costs, to reduce the dependency on the transportation sector and to develop the logistics sector for to interact with the energy sector and the transportation sector. Therefore, the fact that transportation costs in the world have a direct impact on the economies of the countries and transportation costs increase due to energy resources has led the countries to develop combined transportation strategies that will reduce the transportation costs.

In the literature, all functional activities from the point of production of a commercial product to the point of final consumption are defined as the supply chain. Logistics supply is defined as the necessity of delivering this product safely to the final point. Considering the logistics supply as a whole; Applicability in both field and theory is very important. The most important reflection of the logistics sector in the field is the strengthening of transportation activities.

Turkey has increased its development in the logistics industry in recent years, both public and private sector institutions and local governments have intensified their efforts regarding logistics and transportation field.

In this study, Aegean and Central Anatolia Regions were selected as pilot regions for optimum location selection of the logistics centers needed to develop combined transport. The information required in the selection of the locations in these two regions was obtained through the survey study and the CRITIC-AHP-VIKOR integrated method was used for optimum location selection.

As a result of this study, a model suggestion was made for the determination of structural and legal analysis as well as the establishment of logistics areas. However, Turkey's national strategies and investments intended to give an idea to conduct a study will be provided.

II. LITERATURE RESEARCH

In the literature, there are many different approaches to the problem of choice of warehouse or logistics location. Within these approaches, it is seen that multi-criteria decision-making and integrated approaches come to the fore.

Canel and Khumawala [1] conducted a survey of 8 potential plant locations in the US, South America, Europe, and the Far East to search for solutions to the growing demand of a chemical company serving customers in the US. Chen [2] used the center of gravity and AHP methods in the selection of storage locations. In this study, sales volume in the region, ease of transportation, status of land, political and social faculties are discussed. Birsel and Cerit [3] examined the impact of the land factor in the location of the location of the logistics enterprises and the storage location selection problem was considered as a subheading. In the study, the importance of land factor in place selection is emphasized. Demirel et al. [4], the problem, cost, business characteristics, infrastructure, market and environment with the main criteria and related sub-criteria in the evaluation of 4 different alternative places as a multi-criteria decision making process and a fuzzy integral method Choquet Integral using. Özcan et al. [5] conducted a comparative analysis on the use of multi-criteria decision-making methods in storage location selection problems. Zhang et al. [6] conducted a site selection survey for facilities that could have become unavailable due to possible natural disasters or other events that could have minimum cost and maximum demand / coverage. Srivastava et al. [7]

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examined the decision of a dynamic single plant location and displacement problem in a company's existing plant / customer cluster that aims to improve cost and service performance. Ghadge et al. [8] attempted to optimize the single and double center distribution center position with case study. In this study, site selection problems were examined in a wider range

III. METHODOLOGY

A. Analytical Hierarchy Process (AHP) Method

Analytical Hierarchy Process (AHP), developed by L. Thomas Saaty [9] in 1965, is widely used in the literature. AHP is a decision-making technique that measures objective and subjective criteria by comparing them in a double comparison and determines their importance (weight) by determining the priorities of each of these criteria. The 5 basic steps of AHP are as follows:

Step 1. The problem is put forward and the target to be placed at the top of the hierarchy is determined.

Step 2. A hierarchy of goals, criteria, sub-criteria and alternatives is created.

Step 3. A dual comparison matrix is created.

Step 4. Weight vector is found.

Step 5. The consistency ratio is calculated. In case of consistency, it is decided. In the absence of consistency, the binary comparisons are reviewed and the process is repeated.

B. CRITIC Method

Diakoulaki et al. [10] developed the CRITICAL method based on Standard Deviation (SD), Average Weights (MW) and Correlation in order to weight the three evaluation criteria used in the study in which they measure the performance of firms. In the CRITICAL method, the decision matrix is examined analytically and it is aimed to extract the information in the evaluation criteria. The algorithm of the CRITICAL Method is as follows:

1.Normalization of Decision Matrix

2.Creating of Correlation Coefficient Matrix

3. Calculating the total information for the problem of contrast intensity and conflicts in the evaluation criteria.

4.Calculation of criteria weights

C. VIKOR Method

The VIKOR method, which was first proposed by Serafim Opricovic, was used in 2004 by Opricovic and Tzeng in order to solve multiple criteria decision problems. The basis of the method is the identification of a solution in the light of alternatives and within the scope of the evaluation criteria. This far-reaching solution is the closest solution to the ideal solution[11].

By the term solution, it is understood that by making a multi-criteria ranking index for the alternatives, the closest decision is made to the ideal solution under certain conditions. Under the assumption that each alternative is evaluated on the basis of decision making criteria, the closest values are reached by comparing the proximity values to the ideal alternative. VIKOR method consists of 5 steps [11]:

1.For all criteria, the best and worst values that the alternatives take are determined.

2. For each alternative the benchmark weights are calculated using the average and worst scores values.

3.Calculate the maximum group benefit for each alternative or evaluation unit.

4. The obtained mean, worst score and maximum group benefit values are sorted from small to large. Here, the alternative with the smallest group benefit value is the best alternative.

5. Acceptable advantages and acceptable sets of stability are determined for decision makers according to the order in Step 4.

IV. APPLICATION

In the determination of the model developed for the logistics location selection, survey study, load modeling and statistical analyzes were conducted as preliminary studies. For the survey study, a field study was carried out in 663 companies in the industry sector and 161 companies in the logistics sector in 8 provinces in the Central Anatolia and Aegean regions. As a result of this study, 12 alternative regions were determined for the logistics location selection. The geometric means of the responses to the criteria evaluations were entered into the AHP-CRITIC method. The hierarchical structure of the logistics location selection is given in figure-1.

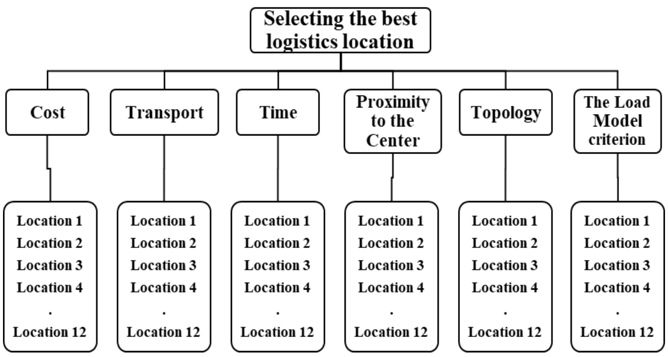

Figure 1. The hierarchical structure of the logistics location selection

For the evaluation of the alternatives, the weighting of the criteria determined by the expert group (weighting), which will be considered together with the load model criterion, was done by AHP-CRITIC method. The criteria and definitions of the expert team are as follows:

Cost: The average transportation cost of loads from one region to another.

Transport: The ratio of the average transport to the average transport distance. It is the transport density in terms of distance.

Time: The average delivery times of loads from one region to another.

Proximity to the Center: The distance from the city center to which the alternative corridor is connected.

Topology: The distance from the nearest corridor to the nearest train station.

The Load Model criterion is the total load values for the results of Production/Shooting Balancing.

The criteria weights were determined by AHP method as follows: 663 companies surveyed were asked to make two comparisons for each criterion according to 1/9 (Very minor) -1 (Equal) -9 (Very important) scale. Then, AHP weights were obtained by applying AHP method steps to the geometric means of the binary comparison values obtained from these firms.

CRITIC weights were determined as follows: CRITIC weights were obtained by applying CRITIC method steps to the values in the decision matrix.

AHP-CRITIC weights were created to multiply and normalize the criteria weights obtained from these two methods.

The priority values of the AHP-CRITIC integrated method were determined as in Table I.

After the weighting of the criteria to evaluate the alternative regions obtained by geographic information system (GIS) and load model, 12 alternative and 6 criteria decision matrix which will be taken into consideration in selecting the optimal alternative location by VIKOR method is given in the Table II. VIKOR application was carried out following the process steps proposed by Opricovic and Tzeng [11] and the EXCEL program was used for the solution.

After criterion analysis and decision matrix are formed, the maximum group benefit values are given in Table III sequentially as a result of the VIKOR method process steps. Accordingly, the best alternative location is Eskişehir OSB.

TABLE I. CRITERIA WEIGHTS

THE CRITERIA	AHP	CRITIC	AHP-CRITIC
Cost	0,21	0,16	0,21
Transport	0,11	0,25	0,17
Time	0,12	0,16	0,12
Proximity to the Center	0,04	0,14	0,04
Topology	0,02	0,15	0,02
The Load Model criterion	0,5	0,14	0,44
Consistency = 0.05 < 1			Total = 1.00

TABLE II. DECISION MATRIX

CRITERIA →	Cost	Transport	Time	Proximity to the Center	Topology(km)	The Load Model criterion
Criteria Weights	0.21	0.17	0.12	0.04	0.02	0.44
ALTERNATIVES↓						
Afyonkarahisar OSB	727467,288	1,13436223	34938,44	7,5	1,4	756,1
Ankara 1. OSB	1098289,568	0,8855178	52353,064	28,3	29,4	1193,7
Ankara Anadolu OSB	804928,12	1,18794556	38094,072	41,4	51,7	905,8
Ankara Başkent OSB	938924,464	0,74388753	44805,688	42,7	53,9	1037,6
Denizli OSB	688161,968	0,57090069	33003,76	29,8	17	710,4
Eskişehir OSB	945762,664	2,51283452	45583,472	9	2,9	994,3
İzmir Atatürk OSB	1551914,696	2,88721439	73784,88	21,2	28,2	604,5
İzmir Kemalpaşa OSB	1517507,904	2,03617021	72299,456	26,9	31,7	385,4
Kayseri OSB	1502693,96	2,81227695	72521,104	15,6	12,2	175,1
Konya 1. OSB	616528,264	0,68235294	29225,96	6,8	8,7	661,8
Konya OSB	1159337,992	2,65586725	55653,024	17,9	19,9	1241,9
Manisa OSB	774011,784	1,24421053	37098,984	93,4	8,6	804,5

TABLE III. AVERAGE, WORST SCORE AND MAXIMUM GROUP BENEFIT VALUES OF REGIONS

Order	**ALTERNATIVES↓**	S(j)	R(j)	Q(j)
7	Afyonkarahisar OSB	0,37	0,200367454	0,280147881
4	Ankara 1. OSB	0,358	0,146909471	0,190254498
3	Ankara Anadolu OSB	0,365	0,138623922	0,184238075
5	Ankara Başkent OSB	0,392	0,157304067	0,237314953
8	Denizli OSB	0,432	0,219216348	0,365085789
1	Eskişehir OSB	0,249	0,102122235	0,024647129
10	İzmir Atatürk OSB	0,61	0,262894638	0,592157554
11	İzmir Kemalpaşa OSB	0,755	0,353262092	0,858480682
12	Kayseri OSB	0,769	0,44	1
9	Konya 1. OSB	0,404	0,239261342	0,368995345
2	Konya OSB	0,222	0,121864118	0,029214535
6	Manisa OSB	0,4	0,180404949	0,278633284

V. CONCLUSIONS

In this study, alternative corridors were determined by expert team for the transportation of cargo transportation and a survey was conducted in the logistics area in each region. As a result of the survey study, load modeling was performed and a decision matrix was formed according to the data obtained from both the survey study and the load modeling in order to determine the most appropriate logistics location. The VIKOR method, which is one of the Multi Criteria Decision Making techniques, was used in the determination of the optimal alternative region. The reason why this method is preferred is that the criteria include the closest proximity feature**.**

According to the results obtained from VIKOR method, if a new logistics center is decided to be established, Eskişehir, Konya, and Ankara Anadolu OSB will be the best options respectively. This situation shows us that in the logistics sector, using only the transportation model in the selection of logistics areas can reduce the sensitivity, and it is difficult to implement data in terms of difficulty in collecting data. The model constructed using multi criteria criteria as a logistic model can be misleading by the intuitive methods without revealing the current potential load charts of the sector.

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