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Research Article

Selection of Humanitarian Supply Chain Warehouse Location: A Case Study Based on the MCDM Methodology

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Abstract

"Disaster" is a general name given to events that cause physical, economic, and social losses for people that will disrupt the functioning of a community or society. Disasters that occur largely or completely beyond the control of people cause a mass loss of life and property. Turkey is in one of the most effective earthquake zones which is the Mediterranean-Alpine-Himalayan belt. Almost, every 5 years, one big earthquake is happened and causes loss of life and property. Disaster management requires complex logistic activities and it is an unpredictable marketplace, they must be managed appropriately to achieve faster and more efficient results. In this study, evaluation of the factors which is affecting the location selection of the humanitarian supply chain warehouses (HSCW) at the local and regional levels is done with multi-criteria decision making (MCDM) based methods. Main and subcriteria weights are Main criteria and subcriteria were calculated with AHP. The ranking of criteria and alternatives was carried out with the TOPSIS method. In this study, AHP-TOPSIS integrated criteria assessment is conducted for the HSCW selection problem. This study intends to explore the humanitarian supply chain warehouse selection problem and evaluate criteria to improve humanitarian supply chain management and location selection implementation.

Keywords: Humanitarian Logistics, Multi-criteria decision making, AHP, TOPSIS.

İnsani Yardım Tedarik Zinciri Depo Yer Seçimi: ÇKKV Metodolojisi Temelli Bir Örnek Olay İncelemesi

Öz

"Afet", bir topluluğun veya toplumun işleyişini bozacak kişiler için fiziksel, ekonomik ve sosyal kayıplara neden olan olaylara verilen genel bir addır. Büyük ölçüde veya tamamen insanların kontrolü dışında meydana gelen afetler, kitlesel can ve mal kaybına neden olur. Türkiye, Akdeniz-Alp-Himalaya kuşağı olan en etkili deprem bölgelerinden biridir. Neredeyse her 5 yılda bir büyük bir deprem meydana gelir ve can ve mal kaybına neden olur. Afet yönetimi, karmaşık lojistik faaliyetler gerektirir ve öngörülemeyen bir pazardır, daha hızlı ve daha verimli sonuçlar elde etmek için uygun şekilde yönetilmeleri gerekir. Bu çalışmada, insani yardım tedarik zinciri depolarının (HSCW) yerel ve bölgesel düzeydeki lokasyon seçimini etkileyen faktörlerin değerlendirilmesi, çok kriterli karar verme (MCDM) tabanlı yöntemlerle yapılmıştır. Temel ve alt kriter ağırlıkları Ana kriterler olup, alt kriterler AHP ile hesaplanmıştır. Kriter ve alternatiflerin sıralaması TOPSIS yöntemi ile yapıldı.

Anahtar Kelimeler: İnsani Yardım Lojistiği, Çok kriterli karar verme, AHP, TOPSIS.

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1. Introduction

"Disaster" is a general name given to events that cause physical, economic, and social losses for people that will disrupt the functioning of a community or society. Disasters that occur largely or completely beyond the control of people cause a mass loss of life and property [1].

According to a Statista report, 7344 natural disasters have been recorded between 2000 and 2019 in the world [2]. Centre for Research on the Epidemiology of Disasters (EM-DAT) observed that natural disasters kill on average 60.000 people per year. Additionally, the United Nations Development Programme (UNDP) states that 75% of the world's population still lives in disaster-prone areas.

Turkey is in one of the most effective earthquake zones which is the Mediterranean-Alpine-Himalayan belt. Almost, every 5 years, one big earthquake is happened and causes loss of life and property. In Turkey, at least 210 earthquakes happened, 86 thousand 802 people died and 597 thousand 865 housing was heavily damaged between 1900 to 2017 [4].

Depending on the devastation of the natural disaster experienced, the size of aid and rescue resources (relief supplies, money, and manpower) varies. Since disaster management requires complex logistic activities and it is an unpredictable marketplace, they must be managed appropriately to achieve faster and more efficient results. These activities are often called humanitarian supply chain management. The success or failure of an aid operation depends on the humanitarian supply chain management activities carried out. Additionally, making decisions about where to locate the relief organization's warehouses are very important because the operational effectiveness is related to location. For example, in the 2001 Gujarat earthquake, the relief aid was failed because of poor fracture, and in the 2004 Asian Tsunami, the relief effort was failed because of poor logistics [3]. Therefore, to identify factors that can enhance the performance of the humanitarian supply chain planning is needed.

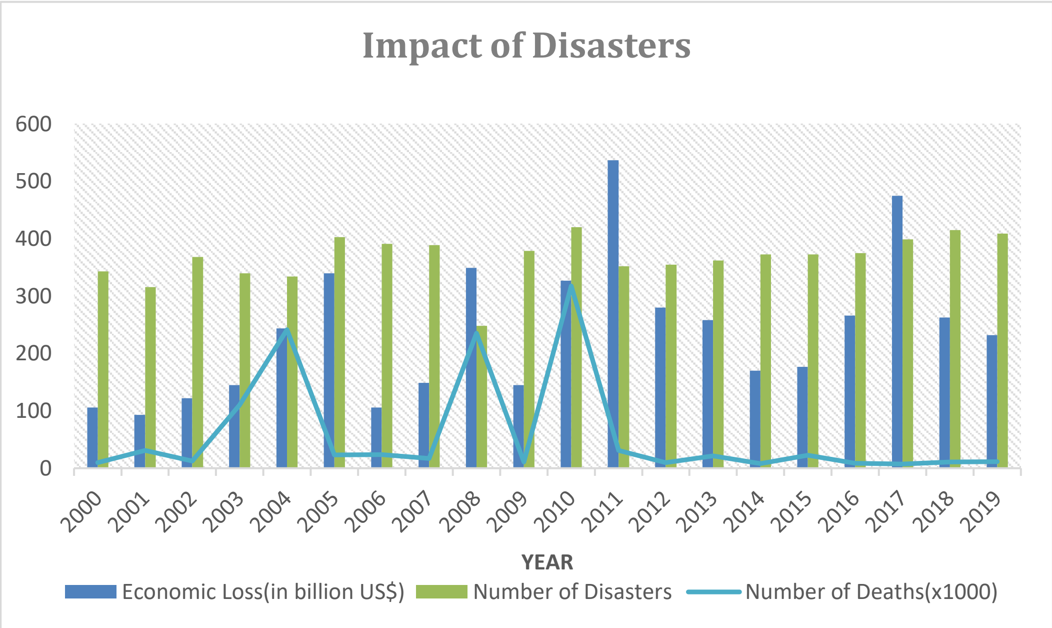
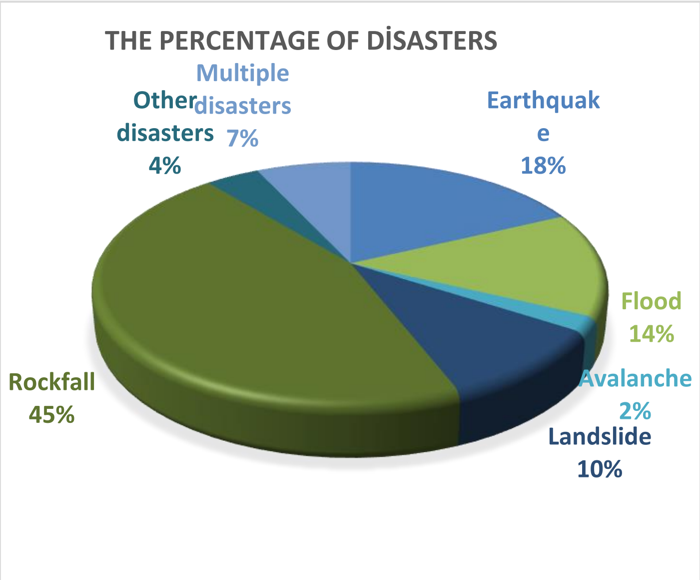


Fig.1 Number of disasters, their economic impact and number of deaths in the world with respect to year period between 2000-2019

As seen in Figure 1, the 7.0 Mw earthquake in Haiti in 2010 was the year in which the most casualties were experienced. According to the United Nations report on the earthquake, it is stated that more than 222 thousand people lost their lives. Also following year, in 2011, the biggest economic loss occurred, due to the 9.0 Mw earthquake in Japan and the tsunami that followed the earthquake.

Approximately 16,000 people lost their lives in these disasters that swallowed residential units, streets, and train tracks



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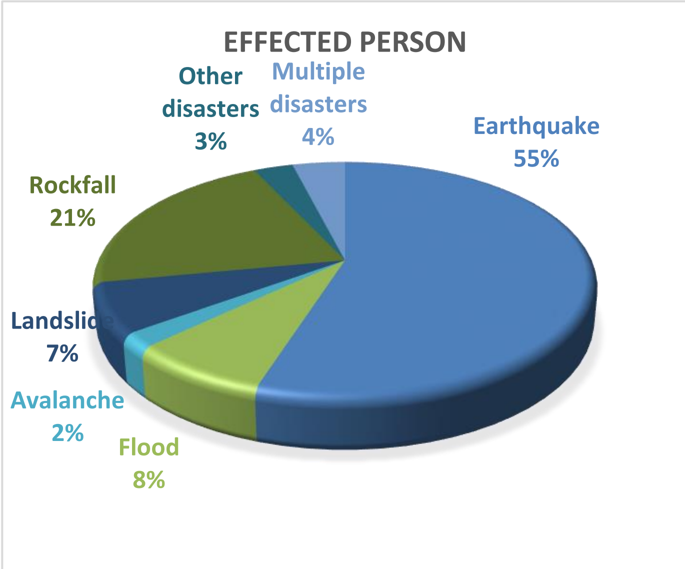

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Fig.2.(a)Percentage of disasters that occurred in Turkey ,(b) Disasters in terms of the number of people affected

Rockfall is the most common natural disaster in Turkey with an incidence of 45%. However, when we look at the impact on human life, it is seen that the earthquake is 55% and its negative effect is more than other natural disasters. The largest earthquake that occurred in Turkey, Erzincan earthquake with a magnitude of 7.9 Mw. In the Erzincan Earthquake that took place on December 27 in 1939, approximately 33 thousand people died, 100 thousand people were injured, and around 116 thousand buildings were destroyed. At the same time, the Erzincan earthquake is considered one of the biggest earthquakes in the world.

The purpose of this research is to evaluate the factors affecting the location selection of the humanitarian supply chain warehouses (HSCW) at the local and regional levels. Therefore, in this study, firstly, it is planned to examine the factors affecting the pre- location selection of humanitarian aid warehouses [HAW] in Turkey, for reducing effects of natural disaster on human beings. Then, based on the impact levels of these factors, choosing the most suitable place as a warehouse among the provinces of Istanbul, Izmir, Hatay, Van, and Bursa, which are risky regions in terms of natural disasters. Observations and researches revealed that the pre-positioning of humanitarian aid depots is affected by many factors. In this reason, multi-criteria decision making (MCDM) techniques were used to evaluate all factors.

2. Literature Review

Tuzkaya and Yilmazer[5] presented a methodology to determine the best location for the Emergency Logistics Centers (ELCs) and its application for Turkey. In their study, Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Network Process (ANP) methods are integrated to determine the convenient locations considering the relations between criteria and alternative locations. They determined disaster-prone cities based on the frequency of occurrence of natural disasters such as the intensity of an earthquake, rate of the landslide, based on the data of the Republic of Turkey Prime Ministry Disaster & Emergency Management Presidency (AFAD) in Turkey. They ranked the significant criteria for weighting ELC alternatives, based on expert opinions. Then, considering the overall disaster risk values, they selected 10 alternative locations, which included İstanbul, Ankara, İzmir, Bursa respectively. After using MCDM methods, they determined the Istanbul (13.6%) is the most convenient location to locate an ELC, and the second is İzmir (12.5%). Roh, Beresford, Pettit, and Harris[6] developed a system to determine a capacitated location model for International Humanitarian Organisation A(Case Study A) and humanitarian relief organizations in Dubai(Case Study B) for the selection of the warehouse location. The objective of case study A is to determine the regional attributes affecting the warehouse location decision-making process for the International Humanitarian Organisation A. For both studies, they determined criteria according to the literature review and a survey. Yadav, Barve[3] analyzed the critical success factors of the humanitarian supply chain. According to their literature review, they obtained that there are 12 critical success factors. They used Interpretive Structural Modeling (ISM) and MICMAC to evaluate chosen factors. They realized that Government policies and Organizational structure are the most dominating factors. Balcik, Beamon, Krejci, Muramatsu, and Ramirez[7] evaluated practices, challenges, and opportunities in the humanitarian chain. Their primary focus is on sudden natural disasters. Boonmee, Arimura, and Asada[8] focused on the facility location optimization model for emergency humanitarian logistics. This article aims to examine the facility location, distribution center, and medical problems experienced before and after the disaster by organizing a questionnaire. Richardsoni, Leeuw, and Dullaert [9]examined the factors affecting global inventory pre-positioning in humanitarian aid organizations using the Delphi method. Maharjan and Hanaoka [1] conducted a case study in Nepal to determine a humanitarian distribution location. As a result of the calculations, several alternative solutions have been reached. The decision-maker is given the freedom to choose the one that will meet demands.

Different researches and applications have been made for the selection of humanitarian aid stores. In many studies, AHP, ANP, TOPSIS, and VIKOR methods, which are among the multi-criteria decision-making techniques, were used separately. In the literature reviews, it was observed that AHP and ANP methods were generally used as a case study for Turkey. In addition, although there are many factors affecting the selection of humanitarian aid warehouses, it has been observed that only the cost factors was considered in previous studies[22-26].

The aim of our study is to make a case study for Turkey, to choose the most appropriate location for HAW by evaluating all the factors. And using the AHP, TOPSIS, and VIKOR for choosing the most suitable place between specified risk provinces (Istanbul, Izmir, Bursa, Van, and Bursa).First, the analytical hierarchy (AHP) method was used to determine the importance weights of the factors affecting the HAW selection. Then, TOPSIS and VIKOR methods were used to rank the alternative cities by using these weights.

The organization of the remaining sections of this study is as follows Part 2 briefly reviews the literature to identify factors influencing the selection (HSCW). In part 3, the AHP, VIKOR, and TOPSIS methods used are presented. Then applied the specified methods to evaluate the main factors and alternatives for the local and regional perspectives. Finally, the result is given in the last section of this article.

3. Material and Method

After determining the evaluation criteria of affecting factors will benefit from multi-criteria decision-making methods to ranking factors and determine the priority of them.

3.1-AHP (Analytical Hierarchy Process) Method

AHP was developed by Thomas L. Saaty in a university in Pansivanya in the early 1970s. AHP is an MCDM technique that enables decision-makers to make an active contribution to the process and to choose among the alternatives in their problems. The ability of AHP is that it allows for binary comparison under a specially designed questionnaire. Determining and arranging subjective or objective criteria according to a hierarchy carries a special value. The hierarchy includes goals, main and subcriteria, and alternatives. Most of the surveys adopted the five-point Likert scale. However, AHP's questionnaire is 1 to 9.

The step-by-step algorithm used in this paper is shown below:

Step 1. Define the problem and set the goal.

Step 2. A hierarchical structure is established by determining relative priorities for the main criteria and their subcriteria.

Step 3. The main and subcriteria and alternatives are subjected to binary comparisons using the scale given in Table

Table 1. AHP Binary Comparison Scale

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgement slightly favour one activity over another
5	Essential importance	Experience and judgement strongly favour one activity over another
7	Very strong importance	An activity is favoured very strongly over another;
		its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is
		of the highest possible order of affirmation
2,4,6,8	Intermediate values	When compromise is needed between two.

To create pairwise comparisons concerning the determined main and subcriteria, the result of the pairwise comparison of the i element to the j element, bringing the aji format in the figure below, and A matrix is formed in turn.

$$A=\begin{bmatrix} a11 & a12 & \dots & a1n \\ a21 & a22 & \dots & a2n \\ . & \cdots & . & . \\ \vdots & \dots & \vdots & . \\ an1 & an2 \cdots & \dots & anm \end{bmatrix}$$

Step 4. Add the columns of the comparison matrix and divide the terms in the column by the individual column sum to convert the normalized matrix.

Step 5. The relative priorities matrix is obtained by taking the arithmetic mean of the rows of the normalized matrix. The main - subcriteria and alternatives are ranked into importance.

Step 6. The weighted total matrix is created by multiplying the values in the relative priority matrix by all the values in the column of the binary comparison matrix.

Step 7. λmax value is calculated.

Step 8. Consistency Indicator (CI) is calculated.

$$CI = \frac{\lambda max - n}{n-1} \tag{1}$$

Step 9. Consistency Ratio (CR) is calculated using Table 2 and Equation (2) corresponding to n..

$$CR = \frac{CI}{RI} \tag{2}$$

where RI: Random CI and n=size of matrix

Table 2 Values of the Random Index (RI)

n	1	3	5	7	9	11	13	15
Received Value	0	0,58	1,12	1,32	1,45	1,51	1,56	1,59

3.2- TOPSIS (The Technique for Order of Preference by Similarity to Ideal Solution)

The weighting of the alternative factors was achieved by the AHP application. First of all, we create a decision matrix and then follow the steps which are given below.

Step 1. Creating the Normalized Decision Matrix (R) calculated using the elements of matrix A and using equation 3. At the end of the normalization process, the R matrix shown in figure 2 is obtained.

$$r_{ij} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^{n} y_{ij}^2}} \qquad (3)$$

$$i = 1,2,\dots\dots,n \ \ , j = 1,2,\dots\dots,k$$

$$R=\begin{bmatrix} r11 & r12 & \dots & r1k \\ r21 & r22 & \dots & r2n \\ . & \cdots & . & . \\ \vdots & \dots & \vdots & . \\ rn1 & rn2 \cdots & \dots & rnk \end{bmatrix}$$

Step 2. In this study, the weight values obtained in the AHP method are used in the creation of the decision matrix. Then, these weights are multiplied by the value of the relevant criterion in the standard decision matrix to obtain the weighted standard decision matrix(V).

$$V=\begin{bmatrix} V11 & V12 & \dots & V1k \\ V21 & V22 & \dots & V2n \\ . & \cdots & . & . \\ \vdots & \dots & \vdots & . \\ Vn1 & Vn2 \cdots & \dots & Vnk \end{bmatrix}$$

Step 3. In the weighted standard decision matrix, the maximum and minimum values are determined.

Ideal (A *)= $\left\{\max_i v_{ij} \middle| j \in I), (\min_i v_{ij} | j \in J\right\} \ R^*$

Negative Ideal (A-) = $\left\{\min_i v_{ij} \middle| j \in I), (\max_i v_{ij} | j \in J\right\} \ R^*$

In both formulas, I denotes the benefit (maximization) and J is the cost (minimization) value.

Step 4. The distances of the criterion values of each decision point in the matrix to the ideal and negative ideal solution are calculated using the equations (4) and (5).

$$S_{i*}= \sqrt{\sum_{j=1}^{n}(vij - vj^*)^2}\ , for\ i = 1,2,\dots\dots m \qquad (4)$$

$$S_i - = \sqrt{\sum_{j=1}^{n}(vij - vj^-)^2}\ \ , for\ i = 1,2,\dots m \qquad (5)$$

Step 5. Calculation of Relative Proximity to Ideal Solution (PIS) : Using separation criteria, the relative proximity to the ideal solution is calculated with the help of the equation (6).

$$C_i{*}=\frac{Si^-}{Si^*+Si^-} \qquad (6)$$

$C_i{*} \in [0;1]$ and i=1 ,2 , ….m.

Here, the share of the negative ideal discrimination criterion within the total discrimination criteria is calculated. If C_i * is close to 1, it indicates that alternative A_i is closer to PIS.

4. Results and Discussion

Determination of alternatives; As stated in the introduction part, an earthquake is a natural disaster that caused the most casualties in Turkey. Therefore, Bursa, Hatay, Istanbul, Izmir, and Van provinces were chosen as alternatives for HSCW because they are the provinces with the highest earthquake risk and the population density. Figure 3 indicates the alternative locations for problem.

Figure 3. Alternative locations for warehouse selection

Determination of criteria; While selecting the factors affecting the selection of the warehouse at local and regional levels, literature reviews were used. As a result, 5 main criteria and 17 subcriteria that affect the selection of humanitarian supply warehouses were determined.

Table 3 Selected factors for this study

Main Criteria	Subcriteria
C1-Geographical Characteristics	C11-Labor availability
	C12-Disaster free location
	C13-Proximity to disaster prone area
	C14-Closeness to other support services
C2-Transportation Characteristics	C21-Transportation mode opportunities (seaport, airport, road, and railway)
	C22-Route flexibility
	C23-Transport vehicle reachability
C3- Socio-political	C31-Government and Political Stability
	C32-Cultural and Social Stability
C4-Cost	C41-Labor Cost
	C42-Land Cost
	C43-Replenishment Cost
	C44-Storage Cost
	C45-Logistics Cost
	C46-Investment Cost
C5-Cooperation	C51-Cooperation with logistics agents (Local and Int'T NGO's)
	C52-IT/Communication

- C11-Labor availability; Humanitarian warehouses have a complex layout. Qualified workforce working in coordination with each other in case of natural disasters is needed. We assume that the qualified workforce is different for each selected province. To evaluate these subcriteria based on selected provinces, it is The data published by the Ministry of Interior 'Number of Employees in Associations by City' was used [10].

- C12-Disaster free location; The probability of experiencing natural disasters in the area where the warehouse is planned to be established should be less in terms of the safety of the warehouse. For this criterion, the numerical data of overall disaster risk for each city specified in the article were used [5].

- C13- Proximity to the disaster-prone area; To provide fast service after a disaster, the installed warehouse must be close to the disaster area. The surface area of five provinces determined for this criterion was examined. The province with a small area is more likely to be close to the disaster area [11].

- C14-Closeness to other support services; There is a possibility that the existing warehouse may not be able to meet the humanitarian aid demand after a major disaster, so the selected warehouse location should be close to other support services. While assessing this criterion, 'Geographical Accessibility Index Results' was taken into account on a provincial basis[12].

- C21-Transportation mode opportunities; There should be more than one transportation mode to deliver the necessary humanitarian aid to the disaster area in a timely and agile manner. While evaluating this criterion, the modes of transportation (railway, airline, sea route) of the selected provinces were taken into consideration. The province, which has a wide variety of transportation modes, has been selected as the most advantageous province in terms of transportation.

- C22-Route flexibility; While providing humanitarian aid to disaster areas, the highways used should be suitable to avoid any problems during transportation. While evaluating this criterion, the rate of freight traffic on the highways of the specified provinces has been taken into account. The province with the least freight traffic has more road flexibility[13].

- C23-Transport vehicle reachability; Appropriate vehicles must be found to deliver aid from the warehouse to the disaster area. While evaluating this criterion, the total number of trucks registered on a provincial basis was taken into account. The province with the largest amount of pickup trucks is more likely to have access to suitable means of transport [14].

- C31-Government and Political Stability; Local and general government policies should be consistent so that the assistance provided to the disaster area before and after the disaster is not interrupted. This is because policies that will allow or restrict any foreign aid during aid are expected to be consistent within the framework of the decisions taken. This criterion is assumed to be the same for all provinces shown as alternatives.

- C32-Cultural and Social Stability; The place chosen for the storage area must have cultural and social stability to have harmonious communication with the citizens. When evaluating this criterion, the total crime rates based on the province were taken into consideration. The province with the lowest crime rate has more cultural and social stability[15].

- C41-Labor Cost-C42-Land Cost-C43-Replenishment Cost-C44-Storage Cost-C45-Logistics Cost-C46-Investment Cost; Activities such as the flow and storage of materials cause a certain amount of cost. Therefore, it has an important place in humanitarian logistics as in other organizations. When choosing a new warehouse location, it should be analyzed whether the organization's budget will meet the finances. While evaluating these criteria given under the cost main criterion, the purchasing parity of the cities was taken into consideration. The city with the lowest cost of living has been determined as the most cost-effective city.

- C51-Cooperation with logistics agents (Local and Int'T NGO's); If the region selected as a warehouse does not meet the request for aid, it is required to communicate with other local and international organizations. While evaluating this criterion, the number of humanitarian aid associations registered to the Ministry of Interior of the provinces was taken into account. The province with the highest number of associations has stronger communication with aid organizations[16].

- C52-IT/Communication; It is important to have a reliable communication infrastructure during and after disasters to carry out an efficient process. While evaluating this criterion, the number of fixed broadband fiber internet subscribers by province was taken into consideration. The province with the most internet subscribers has a better infrastructure in terms of communication [17].

The selection of a suitable expert team is very important for an appropriate weights of each critera in HSCW problem. Similarly, it enables to support in determination of the criteria sets. In this case, four experienced experts were finally chosen to participate in HSCW: three engineers and civil defense staff are selected from different disciplines who are all well-experienced in humanitarian logistics and its management. The experts' profile is presented in Table 4.

Table 4. Description of experts participating in the evaluation

#	Title	Educational Stage
Expert-1	Industrial Engineer	Master of Science
Expert-2	Mechanical Engineer	PhD
Expert-3	Civil Defence Staff	Bachelor Degree
Expert-4	Geological Engineer	PhD

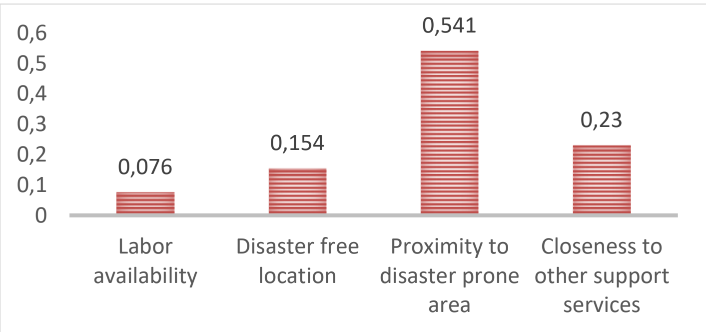
After pairwise comparisons and finishing each steps each criteria weights are found in Table 4. Cooperation has the highest weight and geographical characteristics, transportation characteristics, cost, are sorted orderly.

Table 5. Subjective Weights Of Criteria

Criteria	Normalized Weights
Geographical Characteristics	0.304
Transportation Characteristics	0.151
Socio-political	0.048
Cost	0.108
Cooperation	0.389

According to the AHP application, evaluations of the experts in 9 scale matrixes are used to evaluate the relative weights of each group by pairwise comparisons. After determining the weights of the five main criteria and its subcriteria by AHP, the evaluations of each selected metropolitan city (Bursa, Hatay, İstanbul, İzmir, and Van) TOPSIS method is applied [18],[19].

Figure 3a-3e indicates the priority weights of the five main criteria and their subcriteria by AHP. In Figure 3a C13 subcriteria has the highest weight in Geographical Characteristics main criteria set. C14 and C12 are sorted orderly.



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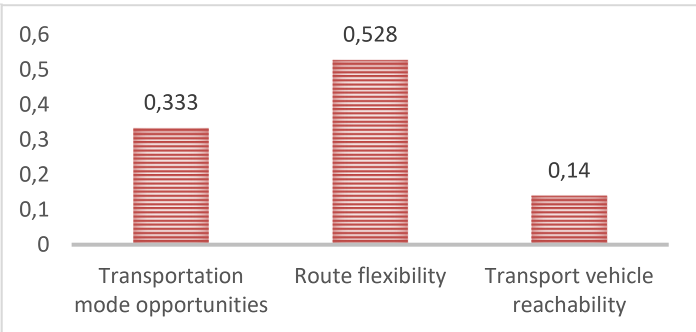

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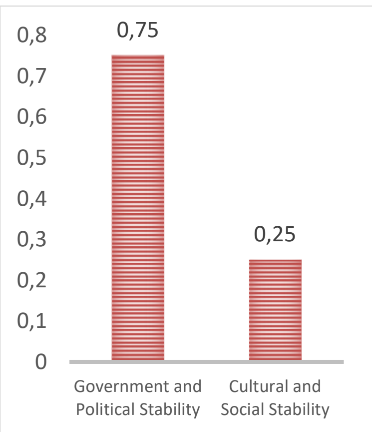

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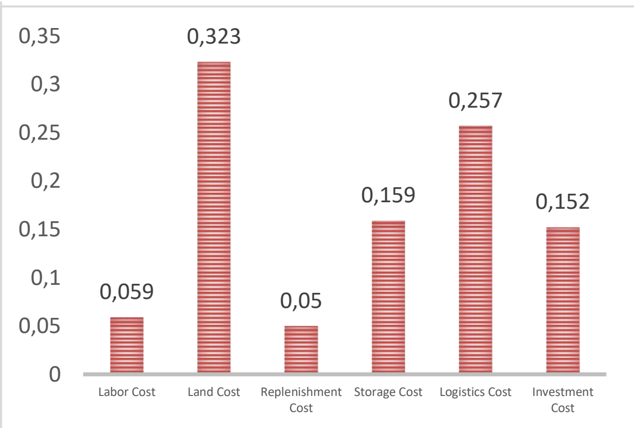

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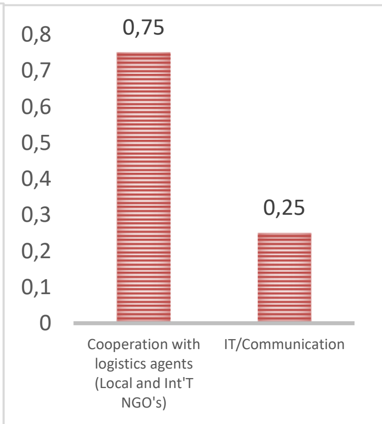

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Figure 3a-3e. Priority weights of five main criteria and its subcriteria by AHP

In Figure 3b C_{22} subcriteria has the highest weight in Transportation Characteristics main criteria set. C_{21} and C_{23} are sorted orderly. In Figure 3c C_{31} subcriteria has significantly higher weight compared with C_{32} in Socio-political main criteria set. In Figure 3d C_{42} subcriteria has the highest weight in Cost main criteria set. C_{45},C_{44}, C_{46}, C_{44}, and C_{41} are sorted orderly. In Figure 3e C_{51} subcriteria has significantly higher weight compared with C_{52} in Cooperation main criteria set.

In Table 6 subjective weights of each subcriteria are conducted using the TOPSIS method to rank the alternatives.

Table 6. Subjective Weights Of Criteria

	C11	C12	C13	C14	C21	C22	C23	C31	C32	C41	C42	C43	C44	C45	C46	C51	C52
Bursa	0.031	0.067	0.107	0.150	0.104	0.193	0.046	0.335	0.136	0.026	0.143	0.022	0.071	0.114	0.067	0.191	0.078
Hatay	0.026	0.086	0.321	0.120	0.146	0.289	0.023	0.335	0.045	0.035	0.191	0.030	0.094	0.152	0.090	0.318	0.058
Istanbul	0.052	0.019	0.357	0.075	0.209	0.064	0.116	0.335	0.091	0.013	0.072	0.011	0.035	0.057	0.034	0.636	0.195
Izmir	0.037	0.048	0.071	0.090	0.167	0.225	0.058	0.335	0.182	0.022	0.119	0.018	0.059	0.095	0.056	0.127	0.117
Van	0.005	0.096	0.214	0.045	0.084	0.321	0.012	0.335	0.023	0.031	0.167	0.026	0.082	0.133	0.079	0.064	0.039
V*	0.052	0.096	0.357	0.150	0.209	0.321	0.116	0.335	0.182	0.035	0.191	0.030	0.094	0.152	0.090	0.636	0.195
V-	0.005	0.019	0.071	0.045	0.084	0.064	0.012	0.335	0.023	0.013	0.072	0.011	0.035	0.057	0.034	0.064	0.039

Table 7 indicates the ranking of metropolitan city's suitability for the HSCW criteria set. The Pi values of TOPSIS indicates that the most suitable city is İstanbul. Hatay, Van, İzmir, and Bursa are sorted orderly.

Table 7. Ranking of Alternatives Weights Of Criteria

	Si+	**Si-**	**Pi**	
Bursa	0.561061353	0.538712	0.48983	5th alternative
Hatay	0.351931069	0.756408	0.68247	2nd alternative
Istanbul	0.189028572	0.915584	0.82887	**1st alternative**
Izmir	0.560657284	0.55629	0.49804	4th alternative
Van	0.567879826	0.625503	0.52414	3rd alternative

4. Conclusions and Recommendations

As mentioned in the literature review some studies conducted to explore and prioritize the coordination barriers in HSCM [20], in the local environment to improve the performance of operations. Selection of warehouses at strategic locations becomes a crutial topic for humanitarian relief organizations [21]. Warehouse location selection in HSCM is a challenging issue and process due to inapproiate decisions may come up with extra problems during rescue activities [22]. The features that differentiate the study from other studies are the criteria and sub-criteria set selected and the local based approaches and evaluations of the experts [23].

In this study, AHP-TOPSIS integrated criteria assessment is conducted for the HSCW selection problem. This study intends to explore the humanitarian supply chain warehouse selection problem and evaluate criteria to improve humanitarian supply chain management and location selection implementation. This study aims to evaluate the alternatives and criteria using two-stage MCDM integration as a weight assessment of main and subcriteria with AHP and ranking of alternatives using the TOPSIS method. Obtained results indicate that the most important alternatives for location are İstanbul and Hatay while Cooperation and Geographical Characteristics are the most crucial parameters according to the expert's opinion.

TOPSIS method is based on real data set which could be improved in future studies with more alternatives and relatively more criteria set. TOPSIS method is based on real data set which could be improved in the future studies with more alternatives and relatively more criteria set.

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