

EVALUATION OF LOCATION SELECTION CRITERIA FOR COORDINATION MANAGEMENT CENTERS AND LOGISTIC SUPPORT UNITS IN DISASTER AREAS WITH AHP METHOD



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Abstract

In recent years, human beings and our planet have suffered great losses in the frequent disasters. Effective and timely intervention is of utmost importance in all large-scale disasters, whether natural or man-made. In this article, a study has been conducted on a model in which the location selection criteria of the management and support centers, where the coordination works as well as the management and administration are carried out in disaster areas, are evaluated by the Multi-Criteria Decision Making (MCDM) method. For this, an in-depth literature analysis was carried out at the first stage, and then all the findings obtained as a result of the literature research were presented to the professionals related to the subject, and expert opinion was sought. In the light of expert opinion, the location selection criteria for the coordination management center and logistic support units in disaster areas were determined, and a model proposal was made, in which the importance values were weighted by using one of the MCDM methods, The Analytic Hierarchy Process (AHP), which is widely used.

1. Introduction

Incidents that disrupt the normal course of life in a society, exceed the capacity to respond and adapt, cause great loss of property and life, or result in disabilities are called “disasters” (Gögen, 2004). Reducing life, material and natural losses and accelerating the recovery process as much as possible are among the objectives of disaster management, which covers the management of before, during and after the occurrence of the disaster. The basis of effective aid operations is the delivery of essential supplies and equipment to the requesting regions within the shortest time and under the most suitable conditions possible. Logistics activities have an important role in emergency events and disaster management processes (Köseoğlu & Yıldırım, 2015). Being prepared for the mentioned disasters or large-scale emergencies and preventing possible losses can only be possible through a planned and coordinated administrative organization (Çiçekdağı & Kırış, 2012).

When the studies in the field of disaster management are evaluated; communication, transportation, shelter, water sanitation, security, psychological support and food and health modules are seen to be the main points in the emergency action plans that need to be implemented. In an effective disaster management organization, these modules should be within communication with each other effectively and uninterruptedly (Işık, et al., 2012).

Reduction of the negative situations experienced by people exposed to disasters depends on the effective and efficient execution of humanitarian aid operations. Approximately 80% of disaster-related operations are related to logistics activities. For this reason, it is vital to perform logistics management and supply chain management effectively in terms of humanitarian aid (Cozzolino, 2012).

Disaster logistics can be defined as the planning, implementation, and control of activities for the efficient flow of both products and

materials as well as the necessary information about them from the point of supply to the last point of need in order to meet the needs of people in need, particularly, on time and on site (Thomas & Kopczak, 2005).

Since the type, severity and effects of disasters can vary, the logistics must also be case-based, dynamic and flexible. One of the most important issues in a disaster case is the supply of basic need supplies and their transportation to the needed points, which are the responsibility of the logistics units. Therefore, disaster logistics has an important position in the disaster management system in terms of distributing agile and ready-to-use materials to the victims and working teams (Gülhan & Esmer, 2017).

One of the most important issues to be considered in disaster logistics is the determination of the location of the logistics support units or coordination centers. Following a disaster occurrence, the location selection and placement of logistics centers constitute an important task in terms of delivering aid equipment and basic need supplies to the affected communities and individuals, and providing support (Peker, Korucuk, Ulutaş, Sayın-Okatan, & Yaşar, 2016). Determining the location selection for these facilities is important in order to help the disaster victims in need more easily before, during and after the disaster.

Although academic studies on humanitarian logistics activities and related supply chain management activities have increased in recent years, it cannot be said that sufficient number of studies have been accumulated in this field. For example, studies on the location selection of the coordination management centers and logistics support units in disaster areas in Turkey are limited. Some of the examples of studies that can be given in this area are Çiçekdağı and Kırış (2012); Kılıç, Kara and Bozkaya, (2015); Peker et al., 2016; Aydın, Ayvaz and Küçükbaşçı, (2017); Cavdur, Sebatli-Sağlam and Kose-Kucuk (2020).

The aim of this study is to determine the establishment location selection criteria for the coordination management centers and logistic support units in disaster areas. The location selection problem is a problem structure in which the most suitable place is selected among the alternatives by using more than one criterion. Therefore, the site selection problem can be considered as a multi-criteria decision making (MCDM) problem, and also the method used in this study is the Analytical Hierarchy Process (AHP) method, which is one of the MCDM methods.

2. Literature Review

In this study, the “*Systematic Literature Review*” method (Tranfield, Denyer, & Palminder, 2003) was used in the

examination and classification of the studies on the location selection for the establishment of the coordination management centers and logistics support units in disaster areas. As a result of the application of the aforementioned method in the study, access to all relevant resources in the literature in the field of location selection in disaster areas was gained; and, by selecting those related to the research topic, a systematic review was made.

A comprehensive study for the period between 2001 and 2021 was conducted for the literature analysis, and Scopus, Science Citation Index, ScienceDirect, Social Sciences Citation Index, IEEE Xplore Digital Library, Arts & Humanities Citation Index, British Library EThOS, Emerald Insight, Springer Nature. eBooks databases were selected for this.

To be able to choose a large-scale and unbiased literature; “*Afet Yönetimi*”, “*Afet Lojistiği*”, “*Büyük Ölçekli Acil Durum*”, “*Acil Müdahale*”, “*Yer Tahsisi*”, “*Yer Seçimi*”, “*ÇKKV*”, “*MCDA*”, “*MCDM*”, “*AHP*”, “*Disaster Management*”, “*Disaster Logistics*”, “*Large-Scale Emergency*”, “*Emergency Response*”, “*Location Allocation*”, “*Site Selection*” keywords are used. Below are the number of articles that were gained through the searches made according to the constraints determined by the keywords and the time intervals in the databases by using the EBSCOhost system infrastructure. Keywords were searched in the “*Title/Başlık*”, “*Abstract/Özet*” and “*Keywords/Anahtar Kelime*” sections of the articles.

2.1. Literature Findings

When the keywords determined to be used in the literature study “*Afet Yönetimi*”, “*Afet Lojistiği*”, “*Büyük Ölçekli Acil Durum*”, “*Acil Müdahale*”, “*Yer Tahsisi*”, “*Yer Seçimi*”, “*ÇKKV*”, “*MCDA*”, “*MCDM*”, “*AHP*”, “*Disaster Management*”, “*Disaster Logistics*”, “*Large-Scale Emergency*”, “*Emergency Response*”, “*Location Allocation*”, “*Site Selection*” were used, the number of articles that were reached was 55. As a result of an in-depth review of the literature, 18 studies that were found to be directly related to the research topic were evaluated and summarized below.

Lu, Hou, and Qiang (2010) use a fuzzy theory to develop a location allocation model, called the fuzzy queuing maximal covering location-allocation model, to determine facility locations for large-scale emergencies. The model aims to maximize population coverage ability. All demand areas, considering the need to identify suitable plant sites for the proper allocation of resources and also to categorize potential demand areas; different characteristics such as population density, economic importance, geographical features, weather conditions, as well as whether the facilities have easy access to more than one

main road/highway and are not affected by the damages that may occur in emergencies were taken into account (Lu, Hou, & Qiang, 2010).

Çiçekdağı and Kırış (2012) handle the problem of location selection for disaster stations, and thus determining the collecting center of people. In an environment where alternatives are plentiful, it is a difficult decision for managers to determine the location of most suitable accommodation area. In the study, using clustering analysis, the units were grouped according to the coordinates they had and, by taking their numbers into account, the most suitable location for disaster station was determined for each group using the center of gravity method (Çiçekdağı & Kırış, 2012).

Mirzapour, Wong, and Govindan (2013) aim to find suitable places for the evacuation of people to a safe place to mitigate the possible consequences of floods. In the research, a p-center location problem was handled to determine the distribution of aid centers in the city. The proposed model aims to minimize the expected maximum weighted distance for demand zones to reduce the evacuation time from affected areas before flood occurs (Mirzapour, Wong, & Govindan, 2013).

Omidvar, Baradaran-Shoraka, and Nojavan (2013) propose a model for appropriate and systematic site selection for pre-earthquake temporary shelters using a geographic information system based on earthquake damage assessment and multi-attribute decision making. After determining the effective criteria for the site selection of temporary shelters, the geographical layers of these criteria were prepared for a region in Tehran (Omidvar, Baradaran-Shoraka, & Nojavan, 2013).

Barzinpour and Esmaili (2014) develop a new multi-objective mixed integer linear programming model for the preparation planning phase of disaster management. The model they propose is inspired by a real case study of an urban area in Iran that takes both humanitarian and cost-based objectives into account (Barzinpour & Esmaili, 2014).

Fan (2014) proposes a hybrid analytical method for the location selection of emergency response centers and defines the relationships between emergency locations and surrounding objects. He proposes a spatial data association mining method to determine the correlation rules including emergency information and geographical factors, and developed a simulated annealing algorithm with the method of adding weights to find the most suitable regions for emergency centers (Fan, 2014).

Kılıcı, Kara, and Bozkaya (2015) discuss the problem of choosing a shelter area. They formulated a mixed integer linear program to solve the problem and made a sensitivity analysis to validate the model (Kılıcı, Kara, & Bozkaya, 2015).

Gama, Santos and Scaparra's study presents a multi-period location allocation approach that determines where and when a predetermined number of shelters will be opened, when evacuation orders will be sent, and how evacuees will be assigned to shelters over time. The aim is to minimize the overall network distances that evacuees have to travel to reach the shelters (Gama, Santos, & Scaparra, 2016).

Peker, Korucuk, Ulutaş, Sayın-Okatan, and Yaşar (2016) created a two-stage model for disaster logistics. In the first stage of the model; the criteria to be used in site selection for the distribution center were weighted with AHP method, and in the second stage, the most suitable establishment location was determined by the VIKOR method (Peker, Korucuk, Ulutaş, Sayın-Okatan, & Yaşar, 2016).

Fereiduni and Shahanaghi (2017) developed a network design model for humanitarian logistics that can assist in location allocation decisions during disaster periods. To deal with the uncertainty, dynamic nature and consequences of disasters, the proposed model takes the values of critical input data in a number of scenarios into account. To generate related random numbers and different scenarios due to possible disruption in the distribution infrastructure, Monte Carlo simulation was used in the study. Sensitivity analysis experiments have been proposed to investigate the effects of various problem parameters (Fereiduni & Shahanaghi, 2017).

Aydın, Ayvaz and Küçükaşçı (2017) handle the problem of location selection for disaster logistics warehouses, which ensure the delivery of emergency aid materials to the points of need as soon as possible within the scope of disaster logistics. In the first stage, a cluster coverage model that determines the minimum number of alternative locations for a given coverage area was developed, and in the second stage, the p-median problem for demand-weighted distance minimization was presented (Aydın, Ayvaz, & Küçükaşçı, 2017).

Trivedi and Singh (2017) developed a hybrid group decision support approach for the emergency shelter location selection problem. In the study, factors related to finding potential areas were identified through consultation with a panel of disaster management experts. Fuzzy analytic hierarchy process theory and technique were used to prioritize defined criteria and evaluate

potential locations for displacement sites (Trivedi & Singh, 2017).

Xu et al. (2018) developed a group-targeted multi-objective mathematical model with particle swarm optimization algorithm to solve the location allocation problem for an earthquake shelter. The model they propose includes identifying shelters and how the population will be allocated to them. Then, the objective groups and solutions of the model are given and compared with the example of Chaoyang region of Beijing city of China using the security, capacity, and investment evaluation index. Regarding the government's preferences and future urban planning, an optimal model solution has been proposed to decide where it is appropriate to build shelters and how the population will be allocated to them (Xu, et al., 2018).

Zhao, Coates, and Xu (2019) developed a multi-objective hierarchical mathematical model by combining particle swarm optimization algorithm and genetic algorithm (MPSO-GA) to solve the earthquake shelter location allocation problem. While the model determines which of several candidate shelters will be emergency resettlement sites and which should be used for long-term use, it also optimizes the allocation of the population to these locations. In the model, in which the number of evacuees and the shelter capacity as well as the damage to the evacuation routes are taken into account, the targets in terms of emergency and long-term sheltering phases are minimizing the total weighted evacuation time and the total shelter area used (Zhao, Coates, & Xu, 2019).

Rizeei, Pradhan, and Saharkhiz (2019) evaluate the current situation of emergency response centers in terms of points prone to excessive flooding. In the study, flood-prone urban areas were determined using a multi-layered perceptron machine learning model, and then a Taguchi method was used to calibrate the MLP variables (Rizeei, Pradhan, & Saharkhiz, 2019).

In the study of Cavdur, Sebatli-Saglam and Kose-Kucuk (2020), a electronic spreadsheet-based decision support tool is presented for allocating temporary disaster response facilities with the aim of distributing relief supplies. The developed decision support tool consists of three main components: database, decision engine and user interface. Each component was developed using appropriate platforms and these components were integrated into the spreadsheet environment. In the study, a sample case which shows the decision support tool and where various scenarios are defined and the relevant facility allocations are made is presented (Cavdur, Sebatli-Saglam, & Kose-Kucuk, 2020).

Wu, Ren, and Xu (2020) developed a decision-making method under uncertainty that validly handles site selection for earthquake shelters to reduce damage caused by earthquakes. Criteria are scale and location, disaster risk, rescue facilities, feasibility, building direction (Wu, Ren, & Xu, 2020).

Ramirez-Nafarrate, Araz, and Fowler (2021) formulated the problem of location allocation in disasters with capacity and time constraints and with the aim of minimizing service time for individuals in an affected area. Due to the complexity of solving the problem for large-scale scenarios, the presented algorithm simultaneously relaxes capacity and time constraints and offers flexibility to evaluate trade-offs. A modified NSGA-II algorithm was used to benefit from the sources (Ramirez-Nafarrate, Araz, & Fowler, 2021).

In the examined studies, it was seen that the type of problem studied related to disasters and location selection was the preference of temporary shelters and emergency evacuation. Most of the applied methods include heuristic methods and the evaluated criteria have been determined to be; *Location, Infrastructure, Cooperation, Transportation of relief supplies, Provision of relief supplies, Health facilities, Topography of land, Land type, Land inclination, Electrical infrastructure, Plumbing, Flora of land, Ownership, Availability of land, Electrical infrastructure, Hygiene and sanitation system, Community infrastructure, Safety and security, and Carrying capacity.*

3. Multi-Criteria Decision Making (MCDM)

Individuals or officials in the relevant units of institutional organizations have to face the necessity of making continuous decisions, both subjective and objective, at every stage throughout their lives. The problems encountered can be very simple, but they also have the potential to be extremely complex issues affected by many factors.

In decision making problems affected by a single criterion, the alternative that corresponds to the best value in this single criterion is simply selected. However, in cases where the number of criteria is more than one, determining the best alternative becomes more complex; Factors including weighting of criteria, determination of dependencies and contradictions between criteria can come into play. The steps of the process in decision making problems can be listed as follows (Tzeng & Huang, 2011):

- Defining the problem: The aim desired to achieve by this first step is to determine the criteria to be used for decision making.

- Establishing priorities: Not all criteria are equally important. At this stage, criteria are weighted (prioritized) by using knowledge and experience.
- Evaluating the alternatives: By using the weights of the criteria, the probability values between the alternatives are analyzed to reach the goal.
- Choosing the best alternative: Among the analyzed alternatives, the best one is determined.

3.1. Analytic Hierarchy Process (AHP)

AHP is an analysis method, the foundation of which Thomas L. Saaty laid in the 1970s. AHP is a powerful and easy-to-understand method enabling to combine quantitative and qualitative factors in decision-making processes (Bertolini & Bevilacqua, 2006).

In the AHP method, it is made possible for decision makers to evaluate both countable and uncountable data over pairwise comparison matrices. In the analysis process, a matrix is created to compare the criteria placed in the model by the decision makers using the concepts of importance or superiority through a scale (Saaty Scale, 1-9), numerically or over verbal values (Pan, 2018).

Table 1. Pairwise Comparisons Scale (Saaty, 1990)

Importance Values	Value Definitions
1	Equal Importance
3	Moderately More Important (Slight Superiority)
5	Strongly Important (Heavy Superiority)
7	Very Strongly Important (Overwhelming Superiority)
9	Extremely Important (Definite Superiority)
2, 4, 6, and 8	Intermediate Values (Combine Values)

This matrix is normalized and the relative priorities of the elements of the pairwise comparison matrix are calculated. At this stage, the matrix A, which is called the comparison matrices, and the eigenvector λ_{max} , which provides the $A \times w = \lambda_{max} \times w$ equality, should be obtained. While A represents the comparison matrix created by experts, w indicates the criteria weights. Consistency ratio (CR) is calculated with the help of equations (1) and (2) below. CI stands for consistency index and RI stands for randomness indicator. The randomness indicator consists of fixed RI values that take different values according to the alternative amount of the matrix.

$$CI = (\lambda_{max} - n)/(n - 1) \quad (1)$$

$$CR = CI/RI \quad (2)$$

Table 2. Randomness Indicator (Saaty, 2008)

n	1	2	3	4	5	6	7	8
RI	0,00	0,00	0,58	0,90	1,12	1,24	1,32	1,41

Existence of the expression $CR < 0.1$ in the AHP indicates that the comparison matrix is consistent.

At this stage, the sum of the multiplication products of the weight value of each criterion and the importance of the alternatives according to the criteria will give the priority value of each alternative separately.

3.2. Multi-Criteria Decision Making and Location Selection Criteria in Disaster Management

The criteria obtained from the studies in the literature regarding the decision for location selection during a disaster are as follows;

- Main criteria of Location, Infrastructure and Cooperation were used. Sub-criteria for location are; proximity to disaster victims, distance to settlement, distance to highway, airport, railway, cost

of land, warehouses, and distance to demand points. The sub-criteria of the infrastructure are; the ground of the land, disaster-proneness, the diversity of the workforce, the distance to the fault lines, whether the land belongs to the private or the public. The sub-criteria of the main criterion of cooperation are listed as the number of companies providing logistics services that can be cooperated with, the cooperation of the government, the cooperation of national and non-governmental organizations, and the cooperation of the university (Peker, Korucuk, Ulutaş, Sayın-Okatan, & Yaşar, 2016).

- Transportation of aid materials, supply of aid materials, healthcare establishments, topography of the land, land type, slope of the land, electrical infrastructure, sanitary installation, flora of the land and ownership (Kılıcı, Kara, & Bozkaya, 2015).
- The main criteria of land availability, electrical infrastructure, hygiene and sanitation system, community infrastructure, safety

and security, carrying capacity were used (Trivedi & Singh, 2017).

3.3. Application Establishing a Hierarchical Model for the Selection of Disaster Coordination Location

Selected articles were analyzed and examined meticulously, and publications containing the criteria and methods used in the selection of establishment location in disaster areas were determined. The main and sub-criteria in the hierarchical table in Figure 1 were determined upon taking the opinion of a group of 3 experts for the criteria to be used in the aforementioned area.

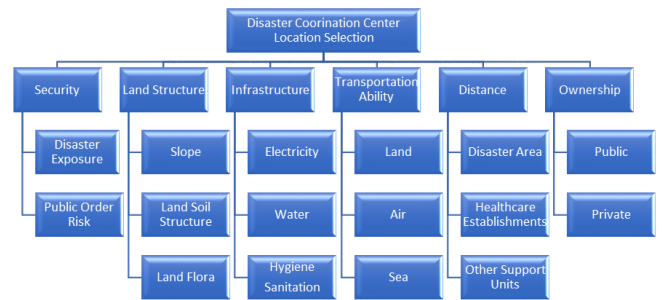
Two of the evaluators, who were selected for the pool of experts and whose knowledge was consulted, are professionals with Bachelor's Degree in geological engineering and surveying engineering, who have been on active field duty for more than 10 years in the Disaster and Emergency Management Presidency (AFAD) of Turkey. These two professionals are AFAD engineers who worked personally in the establishment of the Coordination Management Center in Disaster Areas and Logistics Support Units in disasters that occurred in various regions of Turkey. Therefore, they have experience in the decision of location selection during disasters in different regions of Turkey. The third expert is an academicians who has been working on logistics sector for more than 15 years and has a doctorate degree in logistics.

Upon the evaluation done by the expert group over the location selection criteria, obtained from the literature, for establishment in disaster areas; the main criteria of Security, Land structure, Infrastructure, Transportation Ability, Distance and Ownership are included in the hierarchical table.

3.4. AHP Application for the Selection of Disaster Coordination Location

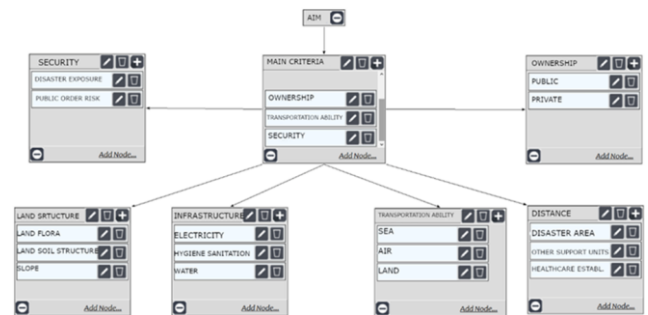
The degree of importance of the criteria, which is accepted as a measure of its effect on the evaluation of alternatives in decision problem types, has been determined by the expert group according to the business objectives. The importance levels of the criteria were calculated by utilizing the AHP method through the data provided from the questionnaires prepared according to the pairwise comparison of the criteria. The aforementioned questionnaire forms were automatically determined by the system as a result of the data entered into the SuperDecision program and presented to the evaluator expert team. The outputs related to the steps in the progress regarding the SuperDecision program are shown below.

Figure 1. Location Selection Criteria for Disaster Coordination Center



As can be seen in Figure 2, in the hierarchical structure of AHP there are 6 main criteria: Security, Land structure, Infrastructure, Transportation Ability, Distance and Ownership. There are a total of 16 sub-criteria consisting of 2 sub-criteria for each of the main criteria titles of Property and Security; and 3 sub-criteria for each of all other main criteria.

Figure 2. SuperDecision Program - AHP Relationship among Criteria



To apply the AHP method, a pairwise comparison matrix should firstly be created by the enterprise, which shows the importance levels of the main criteria. While creating the pairwise comparison matrix, Saaty's scale given as "1-9" range in Table 1 was used.

Questions in the questionnaire formed to make pairwise comparisons through the SuperDecision program by using pairwise comparison expressions were directed to the experts. After the pairwise comparison results are entered into the SuperDecision program, the program calculates the inconsistency rate values of the entered values. For the comparison values that the program warns as inconsistent, again considering the intervals given as the ideal values by the program, the experts were contacted and asked to re-score these sections. Necessary results were obtained by rearranging the inconsistency rate to be less than 0.10 in all criteria comparisons. All the values of each pairwise comparison form the supermatrix in the program.

Unweighted supermatrix, weighted supermatrix and limit supermatrix values were reached with the SuperDecision program.

Table 3. Table of AHP Criteria Weights

Location Selection for Disaster Coord															
Security 0.45560		Land Structure 0.05088			Infrastructure 0.07647			Transportation Ability 0.26572			Distance 0.12904			Ownership 0.02230	
Disaster Exposure	Public Order Risk	Slope	Land Soil Structure	Land Flora	Electricity	Water	Hygiene Sanitation	Land	Air	Sea	Disaster Area	Healthcare Estab.	Other Support Units	Public	Private
0,87500	0,12500	0,64911	0,27896	0,07193	0,42857	0,42857	0,14286	0,70853	0,23115	0,06033	0,75141	0,17818	0,07041	0,75002	0,24998

On Table 3, the weight values taken from the SuperDecision program can be seen. When Table 3 is examined carefully; it can be observed that the sum of the values of the main criteria of security, land structure, infrastructure, transportation ability, distance and ownership is 1. Again, it is possible to see that each sum of the sub-criteria under each main criterion reaches the number 1 in its own set. When the weight results are examined, it is seen that the Security main criterion is the main criterion with the highest value of 0.45560. The sub-criterion of disaster exposure, which is under this main criterion, appears as the main criterion with the highest weight in this set. The main criteria of security were followed by transportation ability and distance to other centers, respectively. The main criterion of ownership emerged as the main criterion with the lowest weight value of 0.02230.

5. Conclusions and Recommendations

This study aims to select the criteria to be used for the solution of my establishment location selection problem on disaster areas and to determine their importance. The criteria used for the selection of establishment location in disaster areas and encountered in different studies in the literature review were determined and presented to expert opinions for evaluation. As a result of the group decision taken by experts who have experience in the field of study; the main criteria of Security, Land structure, Infrastructure, Transportation ability, Distance and Ownership and sub-criteria that form the hierarchical structure are included in the study.

While selecting the establishment locations for Disaster Coordination Centers and Logistics Support Units, which are of vital importance in disaster areas and are seen as the center of the response phase, the main criterion of safety comes to the fore as the most important criterion to be considered and evaluated. As a result of the consensus of experts and experiences from past emergencies, disaster areas have a much higher risk of experiencing similar or related disasters in a short time period when compared to other regions (aftershocks that occur following earthquakes; or, tsunami or volcanic origin disasters that are

likely to trigger such tectonic movements). For this reason, the importance of the safety criterion comes to the fore during location selection.

In addition, the fact that activities related to transportation such as transportation ability and distance to other centers have emerged as the second and third main criteria is also significant. This situation shows that the factors related to transportation have an important place in disaster logistics. In other words, it is important to minimize the distance of the selected location to transportation facilities and other centers. In future studies, the selected location can be optimized both in terms of safety and the mentioned distances.

One of the limitations of this study is that the study was carried out with a limited number of experts. In future studies, the criteria obtained from the literature analysis part of this study can be evaluated with a larger pool of experts. Therefore, both the literature analysis and the AHP analysis results of this study can be used by future studies.

Another limitation of the study is that the relationships between the criteria (as per the opinions of the experts, it is said that there is no relationship) are ignored. If the existence of these relationships is claimed by different experts for different regions in future studies, the models can be developed through such methods as the ANP.

Both the literature analysis and the application part of the study were carried out considering all disasters in order to generalize the results. Based on this study, different models can be developed for special disaster types in future studies. Studying the importance levels for each criterion according to the disaster type in detail will help to draw clearer and more consistent results.

As included in the Presidency of the Republic of Turkey's 2019-2023 development plan, it has been stated that studies and projects on risk maps of settlements can be carried out through the "Geographical Information System". In order to enable

practical application in the future, alternative location proposal applications for all regions with a population above a certain density limit should be carried out according to the hazard types, and relevant partners should be invited to cooperation.

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