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RESEARCH ARTICLE

Assessing the Post-Earthquake Temporary Accommodation Risks in Iran Using Fuzzy Delphi Method

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Abstract:

Background:

The process of temporary accommodation after an earthquake is one of the most important issues in crisis management.

Objective:

This research study attempts to identify and prioritize the key risks inherent with the post-earthquake temporary accommodation process in Sanandaj, Iran using the Fuzzy Delphi method.

Methods:

To achieve this goal, first, we examined the previous research on the issue of temporary accommodation after earthquakes and other disasters worldwide in order to determine the current important challenges. Then, the opinions of crisis management experts in 11 areas and 94 questions in the form of Fuzzy Delphi survey questionnaire with Five-point Likert measurement scale were used to rank these challenges. The Delphi panel participants, who responded to the Fuzzy Delphi questionnaire, consisted of 18 experts related to crisis management in executive organizations of Kurdistan province.

Result:

After performing the steps of the fuzzy Delphi method, a basket of important risks in the temporary accommodation process were identified qualitatively and quantitatively, and were prioritized in order of relevance and significance. The results showed that climatic challenges have the highest potential of post-earthquake temporary accommodation risk in the region among of the 11 major risk areas under examination.

Conclusion:

The study's findings and recommendations can serve as a policy instrument and consultative toolkit for relevant stakeholders.

Keywords: Accommodation, Risk assessment, Crisis management, Fuzzy Delphi Method, Lawshe method, SPSS software.

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1. INTRODUCTION

During the last decades, with the rapid development of infrastructure and urbanization worldwide, the role of crisis management and risk management in preventing irreversible losses in populated areas has become vital. A crisis, by a simple definition, is an unexpected event that threatens different levels of society, including human life, environment, and economy. Highly populated cities with dense infrastructure are the most vulnerable areas to such threats, which can be caused by natural disasters such as earthquakes, storms, and

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tsunamis [1]. The methods and techniques for dealing with such threats have been evolving in proportion to the severity and complexity of threats. Risk management is a powerful tool for minimizing and controlling the impact of unfortunate events to guarantee sustainable development [2]. Typically, crisis management consists of the identification, prioritization, and mitigation of potential risks. In this context, the risks with the greater impact and probability of occurrence are dealt with first, and this process continues for the less severe risks in descending order.

Every year, many buildings suffered significant damage due to natural disasters. In extreme cases, the buildings become inhabitable and unusable, which imposes a large economic burden on the government for managing the people who have lost their homes [3]. In such circumstances, governments use a housing restructuring policy, which consists of temporary and permanent accommodations. The former facilitates a fast recovery after a disaster, whereas the latter provides a safe place for victims to maintain their normal lives [4].

The preparation of families for the destructive consequences of an earthquake is profoundly influenced by their mindset. According to past research, people's experiences from previous earthquakes determine how they perceive such phenomena and take action to get back to their normal life as soon as possible [5]. Despite efforts to increase the resistance of buildings, building collapse still remains one of the most common consequences of earthquakes [6]. Temporary accommodation can be very helpful in mitigating these consequences since families who have lost their homes need a private and safe place to continue their daily routine [7]. One of the most important problems after natural disasters is the provision of temporary accommodation for survivors [8].

The establishment of temporary accommodations requires evaluating different types of planning variables to select the plan with the highest effectiveness and cost-efficiency. The selected planning variables should be re-evaluated after a disaster to examine their performance and modify them if necessary [9]. Iran has often suffered from large and destructive earthquakes and has experienced several major earthquakes in the last few decades. More than 70 percent of Iran's major cities are located near seismic faults, and in some cases, active faults cross the cities [10].

This study is conducted to identify and prioritize the risks of the temporary accommodation process in possible future earthquakes in Sanandaj (the capital of Kurdistan Province in Iran). The first step in achieving this goal is to identify the challenges posed by earthquakes around the world through a comprehensive and accurate review of the literature. The identified risks and challenges are then integrated and monitored with expert opinions. In the next step, using the fuzzy Delphi method, the importance of identified risks is determined based on the characteristics of the study area.

2. LITERATURE REVIEW

2.1. Project Risk Management

Risk management consists of identifying, analyzing, and prioritizing the risks to minimize the consequences and negative impact of unfortunate events [11, 12]. It involves the use of available resources to develop solutions for reducing the risks based on their priority [13]. The risks vary from one project to another; therefore, a risk checklist should be prepared in order to have a comprehensive identification [14]. According to previous studies, historical data, experience, and judgment are the main elements in risk identification [2]. The gathered data should be examined, and the data which is more crucial in the risk management process should be dealt with in more detail. The main objective in risk identification is to highlight the most critical components of a given project during design and construction.

The prioritization of risks should be carried out carefully to sort them from the most critical with the highest probability of occurrence to the less frequent with lower impact in descending order. Using this method can save a significant portion of resources, leading to effective management of the project. In risk management, uncertainties play an important role and can make huge differences in the prioritization of risks [13]. The methods used for the identification of risks and associated uncertainties generally rely on past experience from previous projects. However, in projects with a lack of previous experience, it is important to use the opinion of experts to make a decision on prioritization of risks.

In construction projects, the risk identification procedure becomes more complex since no specific guidelines or standard procedure is available for this purpose [15]. Therefore, the experience, knowledge, and judgment of experts are usually the reference for identifying and prioritizing risks in such projects. The key to successful risk management is the risk identification step. Typically, the potential risks are identified by three different groups [16]: *(i)* risk analysts, *(ii)* experts of the project team, and *(iii)* brainstorming meetings. The first group identifies risks exclusively based on his/her personal experience. In the second group, each expert is interviewed to give his/her opinion about the risks relevant to his/her area of expertise. In the third group, all interested parties are asked to attend meetings to brainstorm and share their ideas.

2.2. Challenges of Temporary Accommodation

Recently, post-earthquake risk evaluation has gained the attention of the construction industry and the government since it can mitigate the adverse effects of unfortunate events on human life and the economy. Previous studies were aimed at presenting a detailed post-earthquake evaluation of risks and prioritize them based on their contribution to the total loss [6, 17 - 19]. Félix *et al*. (2015) used the predefined role of local temporary accommodation locations to assess the importance of predicting temporary accommodation [6]. This study explores the essential role of temporary accommodation location during post-disaster reconstruction programs using a literature review. It also examines common and general solutions for post-disaster temporary accommodation and outlines the strengths and weaknesses of these solutions. Finally, it provides a framework for improving and developing architectural designs to overcome problems of post-disaster temporary accommodation. They show that one of the important strategies for dealing with the challenges of

temporary accommodation is to predict and equip places for this work before the earthquake. These sites can be used, depending on the main infrastructure as a default for public activities. If emergency conditions occur, they will change to the temporary accommodation quickly. These sites are then considered as a space for public use after the temporary accommodation process.

Johnson (2007) analyzed the strategic planning for post-disaster temporary accommodation. She evaluated the weaknesses and strengths of the temporary accommodation process after the earthquake in Marmara and Bloom, Turkey (1999), Armenia and Colombia (1999), Kobe Japan (1995), Greek Calmatoria (1986), Mexico City (1985), and Italy Friuli (1976). He stated that the existence of a systematic and preventive strategy is the guarantor of overcoming challenges [17].

In another research by Yüksel and Hasirci (2012), experts' opinions and those who experienced the "Kocaeli" earthquake have been collected using a 5-points Likert scale questionnaire. The study analyzed the physical and psychological expectations of earthquake victims from temporary shelters and provided suggestions for improving them, including the psychology and personal needs of victims [19].

Perrucci and Aktas (2016) draw on an extensive range of sources to assess the barriers of creating steady temporary accommodation after a natural disaster such as floods, hurricanes, tsunamis, earthquakes, *etc*. In their review of issues-particularly in developing countries such as Haiti, they mentioned that attention to the environmental issues and compilation of the preventive program is essential [18].

Bettemir (2016) examined the challenges of the temporary accommodation system in previous earthquakes and their costs. Two earthquakes on the 23rd of October 2011 and the 9th of November 2011 in Erciş and Van, respectively. He suggested efficient and effective management strategies about natural disasters for repairing damaged buildings and the solution for the post-earthquake housing problem. The basis of this proposal was reducing the cost, time, and environmental impacts of the event. The simulation of his proposed strategy on earthquakes shows that the existence of an appropriate strategy is essential for the immediate resolution of the housing problem [20].

After the 1995 Kobe earthquake in Japan, temporary accommodation units were ready for a maximum of one year. While many displaced people, most of whom were poor and elderly, stayed in shelters for about three years. These temporary homes were also not designed for people with disabilities. There were other problems such as being away from previous locations and necessary services such as hospitals, schools, and so on. Some analysts [21 - 23] have stated that separation of previous residences led to an increased percentage of suicide cases among survivors.

The number of houses damaged or destroyed after disasters is frequently large, and re-housing homeless people is one of the most important tasks of reconstruction programs. Reconstruction works often last for a long time, and during that time, it is essential to provide victims with the minimum conditions to live with dignity, privacy, and protection. Due to land leases, which must be returned to the original state, it can be said that temporary accommodations are also unstable economically and environmentally [6].

In a study investigating post-earthquake temporary complex safety management, Hui and Lv (2012) reported that the danger of fire is one of the important issues of the temporary accommodation process [24]. Creating a temporary accommodation is a necessary step in the reconstruction, and therefore, it is necessary to determine how to improve it [17].

Reviewing the literature shows that most of the previous research examines the conditions and challenges of temporary accommodation location after natural disasters occurred. However, this study tries to identify the challenges in possible future earthquakes in the study area by using past experiences and experts' opinions. This study also seeks to determine the significance of the identified risks. Therefore, the results of this study can be helpful in adopting the necessary strategies to reduce potential risks in crisis management prevention programs. In fact, the purpose of this study is to identify and evaluate the potential risks in the process of post-disaster temporary accommodation in the Kurdistan province in Iran. To achieve this, a number of risks and challenges in the process of temporary accommodation of Iran and the world were collected. The results are shown in Table **1**. Then, according to the opinion of experts and their experience, a number of other probable challenges were added to this list. Finally, a total number of 94 challenges were considered.

3. RESEARCH METHODOLOGY

In terms of data collection, this research is a descriptive survey. In terms of the method also, it is a mix-mode (qualitative and quantitative). Data in this study were collected using the fuzzy Delphi method [32, 33]. According to the rules of the Delphi method, one of the most important steps is to form a panel of experts. In this panel, the opinions and judgments of experts are extracted and analyzed [34]. In consensus methods, experts are those who have knowledge about the subject of study [35]. In this study, members of the Delphi panel included 18 experienced crisis management experts from 18 departments of Kurdistan province. In addition, the practical tool for collecting data using semi-structured fuzzy Delphi questionnaires included 94 challenges regarding temporary accommodation in 11 domains, and the data analysis was carried out using the fuzzy Delphi method (Fig. **1**).

Table 1. Post-earthquake temporary accommodation challenges based on literature review.

No.	Challenges	References
1	Displacements' psychological problems (irritability, fear of the future, worry, humiliation, *etc*.)	[19,21,23,25,26]
2	Outbreak of illness	[18,27,28]

(Table 1) contd.....

3	Being prolonged the period of temporary accommodation	[7,17,18,20,21,22,23]
4	Lack of correct estimation of the number of people affected in a short time	[17,20]
5	Incorrect evaluation and prioritization of the needs, according to the fast the need for attempts	[6,20]
6	The challenge of drinking water supply	[19,29]
7	Lack of equal availability to friendly human resources for residents of different sites	[22]
8	The lack of prediction of prefabricated structures and conex leads to the establishment of the accommodation site being prolonged	[20]
9	The reluctance of some of the victims to evacuates the temporary accommodation site due to the use of free facilities when the reconstruction is completed.	[20]
10	The problem of fire	[19,20,24]
11	Challenge of sewage disposal	[20,22]
12	The challenge of lighting and electricity	[19,20]
13	The insurance of the permanent buildings of the victims as a result of the prolongation of the reconstruction and the prolongation of the period of temporary accommodation	[20]
14	The problem of victims occupation	[6,25]
15	Shortage of infrastructure (water, drainage, electricity, road networks, *etc*.)	[6]
16	Lack of formal psychiatric health services	[27]
17	Medical facilities avoidance	[6,21,23]
18	Disrespect to cultural and local issues	[6]
19	Destruction of environmental signs	[6]
20	Destruction of vegetation	[6]
21	Soil degradation	[6]
22	Social isolation of victims occupant in temporary accommodation away from permanent accommodation	[6]
23	Occurrence of strongly floods and rains	[19,30]
24	Lack of formal mental health infrastructures	[21,23,27]
25	Ignoring the local context in the relief program	[27]
26	The fragmentation of health care among a large number of non-governmental organizations	[27]
27	Waste accumulation resulting from the Dismantlement of temporary accommodation infrastructure after the expiration of the period of residence on the rental lands	[6]
28	The cold and hot challenge	[19,20,25,30]
29	Change in social communication in society (social capital)	[31]
30	The problem of economic activity, education, and social health	[25]
31	The problem of health facilities (bathroom and toilet)	[19,25,30]
32	Challenge of facilities maintenance	[25,30]
33	Privacy challenge	[29,30]
34	Challenging the evacuation of the temporary accommodation site by tenants and new migrants after the expiration of the temporary accommodation	[17]
35	The problem of the shelter type selection	[18,19,22,24,25,30]
36	Lack of sense of belonging to the location on behalf of the injured, occupant on the site	[19]
37	Inadequacy of enough space in the selected shelter	[22,30]
38	The issue of the accurate distribution of shelter	[22]
39	People avoidance from going to camps as temporary accommodation	[22]
40	Challenges of the health environment	[29, 30]
41	The problem of waste disposal	[29]
42	The challenge of safety management in the food supply	[29]
43	The Challenge of Non-Native Immigrants	[28]
44	The fruition of secondary refugee to have more comfortable facilities than victims	[28]
45	The difference between women and men for availability to facilities and sense of security	[28]
46	The difference in the service between temporary accommodation sites, which leads to a high population density on sites with more facilities	[28]
47	The difference in services between urban and rural temporary accommodation sites will lead to an increase in demand for urban temporary accommodation sites	[28]
48	The challenge of change in the diet of the injured	[28]
49	The problem of coordination among service provider devices	[28]

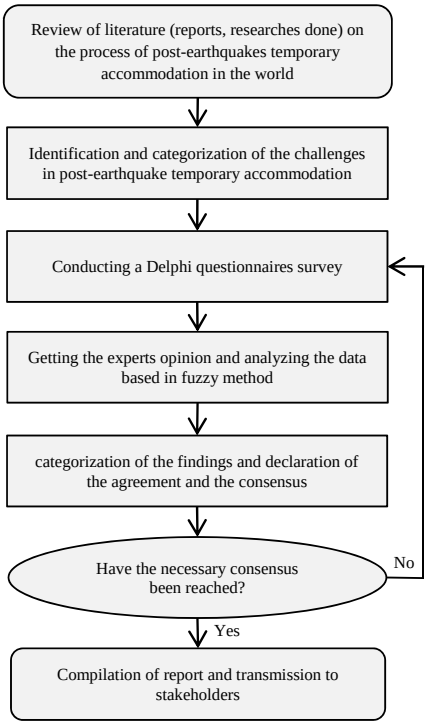


Fig. (1). Research steps of identifying the risks in the post-earthquake temporary accommodation process based on the Fuzzy Delphi technique.

The judgment of 17 experts in the area of crisis management was used to assess the validity of the questionnaire, and the Lawshe method was used to determine the content validity ratio (CVR) in each section [36]. To measure reliability, Cronbach's alpha was used in a questionnaire completed by 17 experts. Excel and SPSS software were used for data analysis.

3.1. Delphi Survey Technique

The Delphi survey technique is a communication structure whose purpose is to produce a detailed survey and discussion. Delphi studies are useful in creating regulation, standards, and predicting processes [37] and are a widespread and acceptable way for collecting information from respondents in their field of expertise. This technique was designed as a group communication process whose goal is to achieve the convergence of belief in a particular issue in the real world [38]. The Delphi technique is essentially a series of successive or periodic questionnaires combined with feedback which seeks to gain the most trusted opinion of an expert group [39].

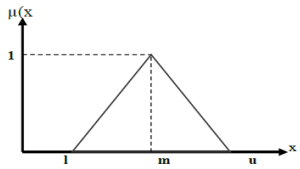
3.2. Fuzzy Delphi Technique

A fuzzy set is a continuous group of objects with a set of continuous scores under the membership title. Such a set is characterized by a membership function (characteristic) that specifies each object with a decimal membership degree between zero and one [40]. The Delphi method is based on respondents' views. In this method, verbal expressions are used to measure the viewpoints. Verbal terms have limitations in reflecting the subjective views of respondents. For example, the term “Tall or high” for person “A” has a meaning and a certain number, and another means and another number for person “B.” In other words, although the competence and mental capabilities of experts are used to make decisions, the quantification of experts’ opinions cannot fully reflect their thinking style. The use of fuzzy sets is consistent with linguistic and sometimes vague human descriptions, and it is better to use fuzzy numbers in real-world decision making [32, 41, 42].

A triangular fuzzy digit (TFN) is a fuzzy number represented by three real numbers (f = (l, m, u)). The upper limit for the fuzzy number is f and is indicated by u, and the lower limit is indicated by l. The mean of the fuzzy number is shown with m, which has the highest possible value. The membership function of a triangular fuzzy number is as follows [32]:

$$\mu_f(x) = \begin{cases} \frac{x-l}{m-l} & l < x < m \\ \frac{u-x}{u-m} & m < x < u \\ 0 & otherwise \end{cases} \quad \textbf{(1)}$$

The geometric image of the triangular fuzzy number (f = (l, m, u)) is displayed as follows:



The structure of fuzzy triangular numbers is very suitable for prediction by the Delphi method. In a method used to

predict the time, cost, and other quantitative values, experts are asked to make their predictions based on the minimum, maximum, and most probable values. Hence, it is no longer necessary to prepare a clear and absolute value [32].

Some mathematical operations for fuzzy numbers are as follows [32]:

$$F_1 = (l_1, m_1, u_1) \quad \textbf{(2)}$$

$$F_2 = (l_2, m_2, u_2) \quad \textbf{(3)}$$

$$F_1 \oplus F_2 = (l_1 \oplus l_2,\ m_1 \oplus m_2,\ u_1 \oplus u_2) \quad \textbf{(4)}$$

$$F_1 \otimes F_2 = (l_1 \otimes l_2,\ m_1 \otimes m_2,\ u_1 \otimes u_2) \quad \textbf{(5)}$$

$$\frac{F_1}{F_2} = \left(\frac{l_1}{u_2}, \frac{m_1}{m_2}, \frac{u_1}{l_2}\right) \quad \textbf{(6)}$$

$$F_1^{-1} = \left(\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1}\right) \quad \textbf{(7)}$$

$$K \otimes F = (K \otimes l,\ K \otimes m,\ K \otimes u) \quad \textbf{(8)}$$

The Fuzzy Delphi technique algorithm contains the following steps [32]: *(i)* Identification and selection of appropriate fuzzy spectrum for the fuzzification of respondents' linguistic expressions, *(ii)* Fuzzy aggregation of values that became fuzzy (experts' opinions should be gathered), *(iii)* Defuzzification of value, *(iv)* Selection of threshold and screening criteria. Table **2** shows the fuzzy triangular numbers for a five-point scale.

Table 2. Triangular fuzzy numbers for the five-point Likert scale of measurement [32].

Verbal Expressions	Fuzzy Numbers
Very Important	(0.75, 1.00, 1.00)
Important	(0.5, 0.75, 1.00)
Relatively Important	(0.25, 0.5, 0.75)
Unimportant	(0.00, 0.25, 0.5)
Very Unimportant	(0.00, 0.00, 0.25)

4. RESULTS AND DISCUSSION

4.1. Two Steps of Fuzzy Delphi Method

Fuzzy Delphi questionnaire, along with the summary of identified challenges of previous studies (Table **1**), was sent to all organizations and companies through the Kurdistan Crisis Management Office. The questionnaire included 11 areas and 94 questions, in which experts were asked to add comments to their questions in addition to answering these questions, if necessary. In the first step, the questionnaire completed by specialists and crisis management experts was sent to the crisis management directorate by 18 organizations, agencies, and companies.

In order to analyze the responses of the Fuzzy Delphi questionnaire, first, all of the answers in the 11 tables (the number of related domains) were collected in fuzzy numbers in Excel software. Then, the average total of 18 experts' answers for each question was extracted in fuzzy form. To further utilize the defuzzification method of fuzzy number, we use three different methods. The average of the defuzzification number of the three methods was determined as a defuzzification response according to Table **3** for each question.

Given that in the first step of the Fuzzy Delphi method, none of the responses were within a very small range, no questions among 94 questions were removed to continue the fuzzy Delphi process [43]. After carrying out the analysis and calculations in the first stage, again, the questionnaire, along with the results of the first step, was presented in person to the participating experts in the first stage. They were asked to compare their responses with the average of the total responses in the previous step, and offer revisions, if appropriate. The second stage questionnaire was then collected, and the results were extracted after the fuzzification and de-fuzzification, as described in Table **4**.

Given that the average difference of defuzzification number in the second and the first is less than 0.1 or lower threshold of defuzzification number in the Likert five-point spectrum, another stage is not considered for the poll [43]. In other words, convergence has been achieved among experts.

4.2. Prioritization of Post-earthquake Temporary Accommodation Risks and the Area

The Prioritization in this study is based on a comparison of the defuzzification number in the fuzzy Delphi final step of each question with the defuzzification number in the Likert five-point area. The results of this prioritization are presented in Table **5**, in order of priority. In addition, the total defuzzification average of all questions in each area is computed and presented in Table **6** and (Fig. **2**).

The results show that, among the 94 identified risks, the challenge of cold and hot weather and the challenge of sewage disposal with a score of 0.808 are the most important. The risk of disrespectful feeling to cultural and local issues, with a score of 0.327, has the least important issue in the process of temporary accommodation after possible future earthquakes in the study area. In addition, in cross-sectoral comparison, the risks of climatic scope were the most important, with an average score of 0.698.

Table 3. Fuzzy triangular numbers of verbal variables.

Verbal variables	Triangular fuzzy number	Defuzzification number based on Minkowski formula (1) X=(l+(u-m)/4)	Defuzzification number based on formula (2) X=(l+2m+u)/4	Defuzzification number based on formula (3) X=(l+m+u)/3	Defuzzification number based on average of three methods (1),(2),(3)
Very High	(0.75, 1.00, 1.00)	0.75	0.9375	0.9167	0.8681

(Table 3) contd.....

High	(0.5, 0.75, 1.00)	0.5625	0.75	0.75	0.6875
Medium	(0.25, 0.5, 0.75)	0.3125	0.5	0.5	0.4375
Low	(0.00, 0.25, 0.5)	0.0625	0.25	0.25	0.1875
Very low	(0.00, 0.00, 0.25)	0.0625	0.0625	0.0833	0.0694

Table 4. The average of experts' opinions after the second phase of the Fuzzy Delphi survey.

Scope of Risk	Risk No.	Risk Name	The triangular fuzzy mean of expert opinion in the second step of the Delphi method l m u	The average of experts defuzzification in first step of the Delphi method	The average of experts defuzzification in second step of the Delphi method	The average of experts defuzzification in first and second step of the Delphi method
Social and Cultural Scope	R_1	The unwillingness of people to reside on the sites of temporary accommodation outside the city	0.361 0.583 0.778	0.500	0.520	0.020
	R_2	Cultural differences between victims and relief experts	0.278 0.500 0.750	0.466	0.452	0.014
	R_3	The challenge of mutual trust between victims and reliefs	0.319 0.556 0.792	0.507	0.497	0.010
	R_4	The reluctance of some of the victims to evacuate the temporary accommodation site due to the use of free facilities when the reconstruction is completed.	0.292 0.528 0.750	0.475	0.465	0.010
	R_5	Disrespectful feeling to cultural and local issues	0.153 0.375 0.625	0.341	0.327	0.014
	R_6	Lack of victims participation in the site administration	0.194 0.431 0.681	0.361	0.375	0.014
	R_7	The challenge of rumors creation from unofficial sources	0.486 0.722 0.903	0.658	0.648	0.010
	R_8	Change in social communication in society (social capital)	0.292 0.528 0.778	0.459	0.459	0.014
	R_9	Sense of not belonging to the place from the victims residents on the site	0.403 0.639 0.833	0.568	0.568	0.000
	R_{10}	The challenges of ethnic and religious differences between the injured	0.292 0.528 0.778	0.459	0.459	0.014
	R_{11}	Problems of study continuation for the injured	0.389 0.639 0.861	0.569	0.569	0.000
	R_{12}	Non-sense of neighborhood among the injured	0.264 0.514 0.750	0.441	0.448	0.007
	R_{13}	Social isolation of victims, occupant in temporary accommodation far away from permanent accommodation	0.333 0.569 0.792	0.500	0.507	0.007
Security Scope	R_{14}	Challenge of privacy regard	0.486 0.736 0.917	0.650	0.654	0.004
	R_{15}	Entrance of non-victims and opportunists to the temporary accommodation site	0.528 0.764 0.889	0.684	0.674	0.010
	R_{16}	The challenge of non-native immigrants	0.444 0.694 0.889	0.627	0.617	0.010
	R_{17}	The difference between men and women in the sense of security	0.444 0.694 0.903	0.620	0.620	0.000
	R_{18}	Challenge of vehicles in unconventional hours and creation of noise pollution	0.347 0.583 0.806	0.530	0.520	0.010
	R_{19}	Creation of disturbance by site residents for neighbors or vice versa	0.375 0.625 0.847	0.569	0.555	0.014
	R_{20}	The conversion into these sites after the end of the temporary accommodation to crime society that operate outside the law, by new immigrants and people who do not qualify for provision of permanent accommodation.	0.375 0.611 0.903	0.574	0.568	0.006
	R_{21}	Conflict between people	0.361 0.611 0.847	0.555	0.545	0.010

(Table 4) contd.....

Climatic Scope	R_{22}	Challenge of cold and heat	0.667 0.917 1.000	0.784	0.808	0.024
	R_{23}	Challenge of wind and storm	0.667 0.819 0.944	0.708	0.722	0.014
	R_{24}	Challenge of flood	0.514 0.764 0.903	0.664	0.671	0.007
	R_{25}	Challenge of sand storm	0.472 0.722 0.917	0.654	0.644	0.010
	R_{26}	Challenge of snow and rain	0.639 0.889 1.000	0.774	0.788	0.014
	R_{27}	Paths obstruction due to snow and rain as a result of disorderliness in the offer of winter service	0.583 0.833 0.972	0.726	0.740	0.014
	R_{28}	Inappropriate selection of shelter type based on climatic conditions	0.472 0.722 0.889	0.623	0.637	0.014
	R_{29}	Inappropriate establishment of shelter based on sunrise and sunset location and dominant wind direction	0.403 0.653 0.847	0.547	0.575	0.028
	R_{30}	Challenge of the spread of infectious diseases	0.569 0.819 0.958	0.712	0.726	0.014
	R_{31}	Challenge of availability to medication and treatment	0.514 0.764 0.958	0.672	0.686	0.014
	R_{32}	Challenge of food corruption	0.514 0.764 0.944	0.692	0.682	0.010
	R_{33}	Challenge of sewage disposal	0.667 0.917 1.000	0.797	0.808	0.010
	R_{34}	Challenge of waste disposal	0.639 0.889 1.000	0.778	0.788	0.010
	R_{35}	Division of corrupt and unstable food products among the injured	0.514 0.750 0.903	0.654	0.668	0.014
	R_{36}	Challenges for the equipment and machinery provision for shipping of patient and outpatient emergency	0.486 0.726 0.917	0.627	0.654	0.028
	R_{37}	Challenge of changing the diet of the injured	0.486 0.722 0.917	0.642	0.652	0.010
	R_{38}	Psychological problems of the injured	0.625 0.875 0.972	0.756	0.770	0.014
	R_{39}	Lack of formalized pre-provided infrastructure for the mental health of the injured	0.500 0.750 0.944	0.682	0.672	0.010
	R_{40}	Lack of formal psychiatric health services	0.514 0.764 0.944	0.692	0.682	0.010
	R_{41}	The fragmentation of health care among a large number of non-governmental organizations	0.361 0.611 0.847	0.559	0.545	0.014
Support and Logistics Scope	R_{42}	The difference between men and women to availability the facilities	0.389 0.639 0.861	0.555	0.569	0.014
	R_{43}	Easier availability for secondary refugees to facilities than the main injuries	0.264 0.500 0.750	0.459	0.445	0.014
	R_{44}	High population density at sites with more facilities	0.403 0.639 0.875	0.566	0.580	0.014
	R_{45}	Increased demand in temporary urban accommodation sites compared to temporary accommodation and rural sites	0.528 0.778 0.944	0.678	0.692	0.014
	R_{46}	Ignoring of local backgrounds in the assisting program	0.389 0.625 0.847	0.548	0.562	0.014
	R_{47}	Weakness in the distribution of shelter (tent and conex)	0.542 0.792 0.944	0.688	0.702	0.014
	R_{48}	Differences in the type of shelter offered to people during the temporary accommodation, and the creation of a sense of discrimination	0.528 0.778 0.931	0.698	0.688	0.010
	R_{49}	Lack of coordination in the distribution of humanitarian assistance	0.542 0.792 0.958	0.716	0.706	0.010

(Table 4) contd.....

Infrastructure Scope	R_{50}	Challenge of supplying water requirements to drink and health issues	0.569 0.806 0.931	0.702	0.716	0.014
	R_{51}	Challenge of machine traffic on the paths leading to the site and their surrounding environment	0.444 0694 0.861	0.619	0.609	0.010
	R_{52}	Lack of adequate knowledge of local materials for creation of shelter and rising transportation costs	0.361 0.597 0.806	0.517	0.530	0.014
	R_{53}	Challenge of fuel supply	0.556 0.806 0.944	0.698	0.712	0.014
	R_{54}	Challenge of electricity and lighting	0.500 0.750 0.917	0.650	0.664	0.014
	R_{55}	Challenge of the inability to inventory temporary shelters for property taken out of the rubble	0.500 0.750 0.917	0.650	0.664	0.014
	R_{56}	Challenge of availability to entertainment and sports facilities according to age and gender of the injured	0.403 0.653 0.833	0.557	0.571	0.014
	R_{57}	The issue of availability to appropriate communication networks, such as the fixed telephone	0.403 0.653 0.861	0.572	0.579	0.007
	R_{58}	Challenge of riding person and pedestrian availability interference for the inside and around the site	0.375 0.625 0.819	0.533	0.547	0.014
	R_{59}	Lack of prediction of pre-event prefabricated structures and conex that prolong the launch phase of the site.	0.542 0.792 0.944	0.688	0.702	0.014
	R_{60}	Disproportionate type of shelter with accommodation duration	0.556 0.806 0.931	0.694	0.708	0.014
	R_{61}	Lack of adequate public and suitable services during temporary accommodation	0.431 0.667 0.889	0.590	0.604	0.014
	R_{62}	Lack of familiarity with the victims to maintenance of new shelters	0.389 0.625 0.861	0.566	0.566	0.000
	R_{63}	Lack of equal and optimal availability of temporary accommodation units to the welfare facilities available on the site	0.417 0.667 0.889	0.583	0.596	0.014
	R_{64}	Disproportion of the space within the temporary accommodation units with the number of households and the type of activity of the residents	0.431 0.681 0.889	0.593	0.606	0.014
	R_{65}	Non-separation of riding person and walking person availability into the temporary accommodation site	0.431 0.681 0.875	0.589	0.603	0.014
Economic Scope	R_{66}	Unemployed victims and closure of their businesses	0.625 0.875 0.972	0.742	0.770	0.028
	R_{67}	Priority of physical reconstruction on economic reconstruction	0.375 0.625 0.833	0.544	0.551	0.007
	R_{68}	The loss of young people's skills training in the creation of business during the temporary accommodation	0.347 0.597 0.806	0.509	0.523	0.014
	R_{69}	Challenge of maintaining income sources in some families during the temporary accommodation, such as livestock keeping	0.611 0.681 0.875	0.708	0.698	0.010
	R_{70}	Not having permanent insurance buildings of the victims which are not insured as a result of the prolongation of the reconstruction and the prolongation of the period of temporary accommodation	0.583 0.833 0.987	0.734	0.744	0.010
Environmental Scope	R_{71}	Destruction of environmental signs	0.444 0.681 0.903	0.604	0.618	0.014
	R_{72}	Destruction of vegetation	0.347 0.583 0.819	0.510	0.524	0.014
	R_{73}	Soil degradation	0.278 0.500 0.722	0.431	0.444	0.014
	R_{74}	Damaging forests and pastures	0.306 0.556 0.792	0.475	0.489	0.014
	R_{75}	Accumulation of waste and materials due to the destruction of the site after the end of temporary accommodation	0.403 0.639 0.847	0.582	0.572	0.010

(Table 4) contd.....

Scope of Ownership and Legal Issues	R_{76}	Installation of prefabricated units on private lands and in the vicinity of damaged homes. Creation of reconstruction problems and elimination debris	0.403 0.653 0.875	0.569	0.583	0.014
	R_{77}	Putting the conex on the land belonging to other people	0.403 0.653 0.875	0.544	0.551	0.007
	R_{78}	Arbitrary use of the victims' lands and private estates around the site as a warehouse, parking, and ...	0.375 0.625 0.833	0.630	0.644	0.014
Events Scope	R_{79}	Fire on the site	0.372 0.722 0.917	0.562	0.568	0.007
	R_{80}	electrocution	0.403 0.639 0.833	0.510	0.524	0.014
	R_{81}	Vehicle crash with people	0.361 0.583 0.792	0.362	0.348	0.014
	R_{82}	Damages resulting from animals and insects hart to people (snake, scorpion, *etc*.)	0.181 0.389 0.639	0.578	0.592	0.014
Management Scope	R_{83}	Lack of centralized management based on existing potential in the region and coordination between service providers	0.431 0.667 0.847	0.617	0.606	0.010
	R_{84}	Inappropriate placement of the temporary accommodation site and non-attention to the relevant criteria (Such as availability to services, avoidance of faults and streams, gas lines, and ...)	0.431 0.681 0.889	0.706	0.716	0.010
	R_{85}	The desire of some organizations to prioritization of their organization instead of integrated crisis management brief and agreements	0.556 0.806 0.958	0.599	0.589	0.010
	R_{86}	Lack of correctly estimate about the number of people who go to other cities after of earthquake.	0.417 0.667 0.861	0.586	0.576	0.010
	R_{87}	Evaluation and prioritization of the needs	0.403 0.639 0.861	0.606	0.596	0.010
	R_{88}	Lack of coordinating reconstruction of permanent buildings in pre-specified temporary accommodation	0.417 0.667 0.889	0.638	0.628	0.010
	R_{89}	Non conformity of the procedure unity and using different methods	0.444 0.694 0.931	0.603	0.693	0.010
	R_{90}	Lack of assessment of the post-earthquake local workforce, for the temporary accommodation period and permanent accommodation reconstruction	0.417 0.667 0.875	0.561	0.551	0.010
	R_{91}	Lack of same procedure in the assessment of earthquake effects	0.375 0.625 0.833	0.568	0.582	0.014
	R_{92}	The lack of a pre-codification evaluation plan for responsibility and accountability	0.417 0.653 0.847	0.586	0.590	0.004
	R_{93}	Lack of predicting the number of victims on preventive planning before the earthquake	0.431 0.653 0.847	0.613	0.627	0.014
	R_{94}	Challenge of coordination between service providers during temporary accommodation	0.458 0.708 0.889	0.640	0.630	0.010

Table 5. Prioritized of risks and their relevance in the post-earthquake temporary accommodation process based on the average of three methods of defuzzification in the Fuzzy Delphi technique.

Priority Risk No.	Risk rating	Risk level	Priority Risk No.	Risk rating	Risk level	Priority Risk No.	Risk rating	Risk level
R_{22}	0.808	Very High	$\mathbf{R_{7}}$	0.648	High	$\mathbf{R_{20}}$	0.568	High
R_{33}	0.808	Very High	$\mathbf{R_{25}}$	0.644	High	$\mathbf{R_{79}}$	0.568	High
R_{26}	0.788	Very High	$\mathbf{R_{78}}$	0.644	High	$\mathbf{R_{62}}$	0.566	High
R_{34}	0.788	Very High	$\mathbf{R_{28}}$	0.637	High	$\mathbf{R_{67}}$	0.562	High
R_{38}	0.770	Very High	$\mathbf{R_{94}}$	0.630	High	$\mathbf{R_{46}}$	0.555	High
R_{66}	0.770	Very High	$\mathbf{R_{88}}$	0.628	High	$\mathbf{R_{19}}$	0.551	High
R_{70}	0.744	High	$\mathbf{R_{93}}$	0.627	High	$\mathbf{R_{77}}$	0.551	High
R_{27}	0.740	High	$\mathbf{R_{17}}$	0.620	High	$\mathbf{R_{90}}$	0.551	High
R_{30}	0.726	High	$\mathbf{R_{71}}$	0.618	High	$\mathbf{R_{58}}$	0.547	High
R_{23}	0.722	High	$\mathbf{R_{16}}$	0.617	High	$\mathbf{R_{21}}$	0.545	High
R_{50}	0.716	High	$\mathbf{R_{51}}$	0.609	High	$\mathbf{R_{41}}$	0.545	High

(Table 5) contd.....

R_{84}	0.716	High	$\mathbf{R_{64}}$	0.606	High	$\mathbf{R_{52}}$	0.530	High
R_{53}	0.712	High	$\mathbf{R_{83}}$	0.606	High	$\mathbf{R_{72}}$	0.524	High
R_{60}	0.708	High	$\mathbf{R_{61}}$	0.604	High	$\mathbf{R_{80}}$	0.524	High
R_{49}	0.706	High	$\mathbf{R_{65}}$	0.603	High	$\mathbf{R_{68}}$	0.523	High
R_{47}	0.702	High	$\mathbf{R_{63}}$	0.596	High	$\mathbf{R_{1}}$	0.520	High
R_{59}	0.702	High	$\mathbf{R_{87}}$	0.596	High	$\mathbf{R_{18}}$	0.520	High
R_{69}	0.698	High	$\mathbf{R_{89}}$	0.593	High	$\mathbf{R_{13}}$	0.507	High
R_{45}	0.692	High	$\mathbf{R_{82}}$	0.592	High	$\mathbf{R_{3}}$	0.497	High
R_{48}	0.688	High	$\mathbf{R_{92}}$	0.590	High	$\mathbf{R_{74}}$	0.489	High
R_{31}	0.686	High	$\mathbf{R_{85}}$	0.589	High	$\mathbf{R_{8}}$	0.473	High
R_{32}	0.682	High	$\mathbf{R_{76}}$	0.583	High	$\mathbf{R_{10}}$	0.473	High
R_{40}	0.682	High	$\mathbf{R_{91}}$	0.582	High	$\mathbf{R_{4}}$	0.465	High
R_{15}	0.674	High	$\mathbf{R_{44}}$	0.580	High	$\mathbf{R_{2}}$	0.452	High
R_{39}	0.672	High	$\mathbf{R_{57}}$	0.579	High	$\mathbf{R_{12}}$	0.448	High
R_{24}	0.671	High	$\mathbf{R_{86}}$	0.576	High	$\mathbf{R_{43}}$	0.445	High
R_{35}	0.668	High	$\mathbf{R_{29}}$	0.575	High	$\mathbf{R_{73}}$	0.444	High
R_{54}	0.664	High	$\mathbf{R_{75}}$	0.572	High	$\mathbf{R_{6}}$	0.375	Medium
R_{55}	0.664	High	$\mathbf{R_{56}}$	0.571	High	$\mathbf{R_{81}}$	0.348	Medium
R_{14}	0.654	High	$\mathbf{R_{11}}$	0.569	High			
R_{36}	0.654	High	$\mathbf{R_{42}}$	0.569	High	$\mathbf{R_{5}}$	0.327	Medium
R_{37}	0.652	High	$\mathbf{R_{9}}$	0.568	High			

Table 6. Prioritization of different risk areas in the post-earthquake temporary accommodation process based on the defuzzification average of experts' opinions.

Priority No.	Scope Name	Defuzzification average of experts' opinions
1	Climatic Scope	0.698
2	Healthcare Scope	0.694
3	Economics Scope	0.657
4	Infrastructure Scope	0.624
5	Procurement and Support Scope	0.618
6	Management Scope	0.607
7	Security Scope	0.594
8	Scope of Ownership and Legal Issues	0.593
9	Environmental Scope	0.530
10	Scope of Events	0.508
11	Social and cultural Scope	0.486

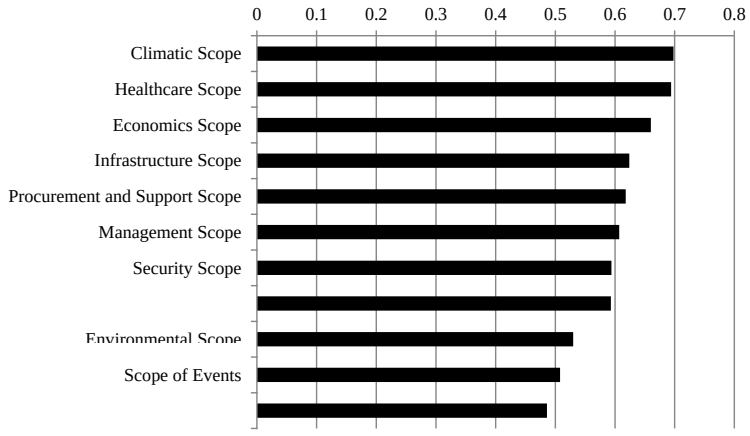


Fig. (2). Defuzzification average diagram opinion of experts for various risk areas in the post-earthquake temporary accommodation process.

CONCLUSION

This research was carried out to answer the two following questions: *(i)* What are the risks in the post-earthquake temporary accommodation process? and *(ii)* What is the priority of the risks in the post-earthquake temporary accommodation process? To this end, first, the theoretical basis of the temporary accommodation process after natural and unnatural disasters was studied. Then, challenges of the temporary accommodation process were collected through previous reports and research on temporary accommodation, and experienced experts' opinions gathered through interviews. Finally, 94 challenges were collected. The Delphi method was used to evaluate the identified risks. The consensus among experts to determine the significance of each risk was reached after two rounds of fuzzy Delphi. The results of the Delphi method were analyzed using fuzzy triangular numbers. Finally, the risks were ranked according to their importance. The study results show that all 94 identified risks are of medium and high importance in the post-earthquake temporary accommodation process. In this study, the risks were identified and evaluated based on the characteristics of the study area. Therefore, it is suggested that areas with different characteristics should be studied for future studies. Identifying the risks of the temporary post-earthquake resettlement process can help develop a disaster prevention plan. It can also help promote various aspects of sustainable development, including social, environmental, and economic aspects.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

The data used to support the findings of this study are included in the article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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