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Research Article

A Region-based criterion weighting approach for the assessment of post-disaster shelters

Betül KAVAKLI*, Savaş EKİNCİ

Faculty of Architecture, Mimar Sinan Fine Arts University, İstanbul, Türkiye

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ABSTRACT

The need for shelter after disasters is a common issue, and its planning should occur during the risk management phase, not in the post-disaster process. Following the initial few weeks of emergency aid, the rehabilitation phase comes into play, encompassing the period spent in temporary housing units until a transition to permanent housing is achieved. Like the emergency aid phase, this phase cannot be sustained solely by emergency shelter tents due to its extended duration, which is shorter than the time required to construct permanent housing. Specific designs suited to the rehabilitation phase are necessary. However, many post-disaster temporary housing implementations have failed to meet the requirements. The study aims to establish a decision-making model for assessing temporary housing alternatives in the aftermath of a disaster. The experts must initially identify the criteria and assign their respective weights to build this model. They contend that the significance of criteria should differ depending on the particular attributes of diverse locales. To accomplish this, a methodology for determining criteria weights and an evaluation model is suggested, considering discrepancies in urban density, household size, urban accessibility, and climatic conditions based on regional dissimilarities.

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1. INTRODUCTION

Türkiye, due to its geological structure, is a country vulnerable to natural disasters. It has been hit by numerous major disasters throughout its history, with earthquakes being the most devastating, resulting in heavy casualties. Natural disasters are inevitable, and disaster management systems operate cyclically in our modern world [1].

In the modern disaster management framework, pre-disaster risk reduction efforts are of great importance, especially in mitigating post-earthquake damages, as they can help to reduce both human and material losses after disasters. Addressing the need for shelter that will arise after any disaster is a common issue, and planning for this should be done during the risk management stage, not in the post-disaster phase. In our era, considering factors such as the climate crisis, migration, unplanned settlements, and rapid industrialization, it is thought that all types of disasters will be more severe and frequent. Therefore, governments and, indirectly, architects should consider addressing the post-disaster housing crisis with more effective alternatives as their responsibility.

Although some experiences have been gained in Türkiye regarding post-disaster temporary housing strategies, there is still insufficient research. Additionally, the aftermath of previous earthquakes has yet to be consistently reported, resulting in different approaches after each earthquake. This leads to post-disaster temporary settlements being planned under crisis conditions [2].

***Corresponding author.**
*E-mail address: betulyigitkavakli@gmail.com

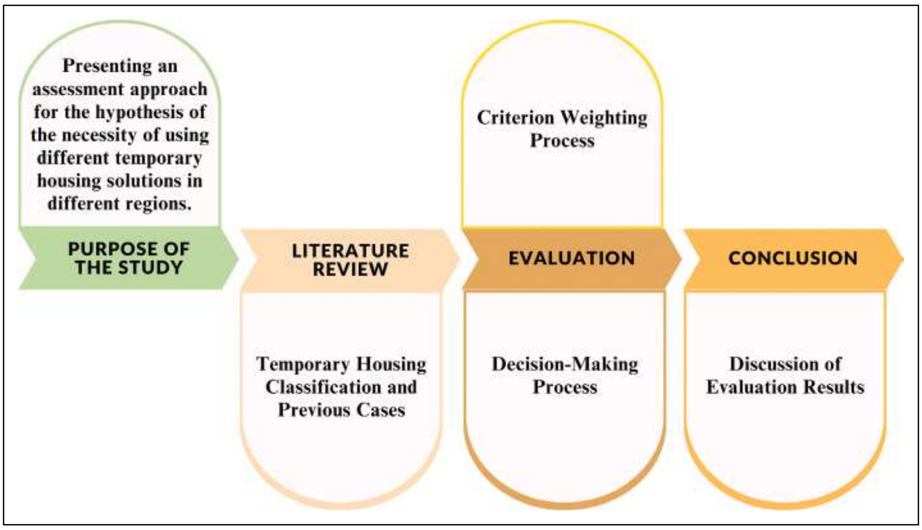

Figure 1. The study's general structure.

It is crucial to evaluate temporary housing properly to make the right system choices. Numerous literature studies have been conducted to achieve this goal, and various criteria have been established. These criteria primarily focus on providing a rapid response in disaster situations without adversely affecting the economy, contributing to permanent housing scenarios, and minimizing the suffering of disaster victims.

We must first understand the decision-making process's parameters to assess the situation appropriately. These parameters include the region's characteristics where temporary housing will be utilized. The study aims to provide decision support for evaluating quick housing systems that can be used after an earthquake and to select appropriate alternatives for different regions. The hypothesis suggests that the criteria weights may vary depending on the disaster region where the temporary housing is used during rehabilitation. With this in mind, the research presents an approach to evaluate post-earthquake quick housing systems applied in the various areas of Türkiye.

In line with this objective, temporary housing is first defined by its classification over time. Firstly, the literature's identified issues with temporary housing in various Turkish regions post-earthquake are presented. Next, the chosen methods for the study's assessment approach are explained while outlining the path from hypothesis testing. The subsequent steps of the assessment are then outlined. Once the evaluation is complete, the results are discussed. The study's general structure is illustrated in Figure 1.

2. MATERIALS AND METHODS

2.1. Classification of Temporary Housing and Problems Encountered in Previous Cases

When classifying temporary housing, it's essential to consider various factors. This is because no one-size-fits-all solution is available, and shelters that meet specific criteria, such as ease of assembly, disassembly, reusability, and ease of transportation, are often used as temporary housing [3].

After a disaster, temporary housing is classified based on post-disaster time frames, which are divided into three different periods in the disaster management system:

The following are the different types of temporary housing used in various phases of disaster management:

- Initial Relief Phase: Temporary housing used in this phase is expected to last about two weeks. It is used immediately after the disaster to shelter the affected people [4].
- Rehabilitation Phase: This phase begins after the initial relief phase and lasts until the construction of permanent housing is completed. The temporary housing used in this phase is expected to last between 6 months and one year [3].
- Reconstruction Phase: This phase is the transition phase that leads to the construction of permanent housing.

Different stages of temporary housing require other characteristics. For instance, tents and pneumatic systems used in the initial relief phase are meant for short-term use. They may lose their features if used beyond their intended period, making them uncomfortable for users. The length of this phase varies depending on the country's level of development. Once this stage is over, users transition to the shelter phase in the rehabilitation phase, which is relatively more comfortable. This transition stage is crucial for users' well-being.

During the second stage of the housing process, also called the rehabilitation or improvement phase, temporary housing units meet specific criteria until the transition to permanent housing is complete. This phase can be resolved in three different ways:

- Temporary housing in another region.
- Collective sheltering in the disaster-affected area in camp-like settings.
- Temporary housing in temporary shelters.

Based on the experiences of post-disaster sheltering so far, temporary housing in temporary shelters is considered the most suitable solution. Planning and evaluating all aspects of the temporary housing used during this phase is crucial to ensure the return to normal living conditions for users who have suffered heavy losses in life and property

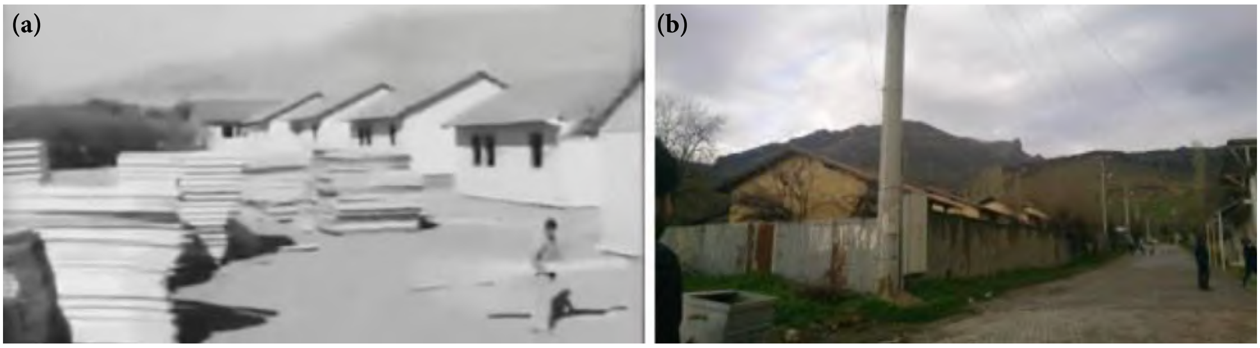

Figure 2. **(a)** The temporary housing units constructed by the Ministry of Construction and Housing [7]. **(b)** Their current conditions (photo taken by Hatice Doğan Keleş) [7].

due to a disaster. This study addresses the criteria and criterion weights for evaluating the different "temporary housing" alternatives to meet the housing needs in the rehabilitation phase [4].

The reconstruction phase marks the completion of permanent housing construction and users' transition to their new homes.

In addition to the classification, temporary housing can be classified based on construction systems. For instance, it can be categorized temporarily, like the "classification of temporary housing used in the rehabilitation phase based on construction systems."

Türkiye has experienced numerous destructive disasters throughout the years. Unfortunately, it has been observed that temporary housing has not always been used as intended in the aftermath of these disasters. To shed light on this issue, a comprehensive study conducted by Özata and Limoncu examined how temporary housing was utilized during the relief, rehabilitation, and reconstruction processes after major earthquakes over five centuries [5]. Additionally, this section will explore the problems that have arisen in the aftermath of disasters over the last fifty years.

Figure 3. Prefabricated concrete was used to construct temporary shelters [5].

Figure 4. Mevlana houses [42].

1975 Lice Earthquake Case

After the earthquake that hit Lice on September 6, 1975, 1,672 prefabricated temporary shelter units were built within 54 days. However, these houses faced various issues later on. It's worth noting that Oxfam's polyurethane igloos were used for the last time during this earthquake as they were not comfortable in adverse environmental conditions and were vulnerable to fire, leading to their discontinuation by Oxfam [6].

Initially, it was promised that permanent housing would be completed in five years. However, it has been 45 years since the earthquake, and the transition to permanent housing has yet to happen. The temporary housing units have deteriorated over time, as shown in Figure 2 [7]. Upon examination of the materials used in the temporary housing in Lice, it was found that there was a 1.5 cm thick athermic coating on the 5 cm wide external wall, and the interior was covered with wooden materials. Unfortunately, these materials are unsuitable for adapting to the region's environmental conditions. Repairs and modifications were carried out to these housing units over time due to the absence of permanent housing deliveries [7].

1999 Gölcük Earthquake Case

An earthquake, also known as the Marmara Earthquake, with a magnitude of 7.4, struck İzmit on August 17, 1999, causing numerous casualties and property damage across the region [8].

Figure 5. 2nd month report of the tent city on the Diyarbakır Silvan road [12].

After the earthquake, billions of Turkish Liras were spent on tent camps for relief and rehabilitation. However, the bases were unusable within 3–4 months [9].

Following the earthquake, the Ministry of Public Works and Settlement began constructing 44,107 temporary prefab housing units. Kocaeli received 16,314 units, Sakarya 11,707, Yalova 5,514, Bolu 3,903, and Düzce 6,669. The units were handed over to victims on November 30, 1999. Temporary prefab housing units were built for earthquake survivors in the Kocaeli, Yalova, Sakarya, Düzce, and Bolu regions. A total of 44,107 housing units were built, and around 150,000 people lived there for approximately 3.5 months. The infrastructure work for these units was completed in 45 days with an expenditure of 79 trillion 368 billion Turkish Lira [10]. Figure 3 shows the temporary shelters that were constructed using prefabricated concrete.

After examining the relief efforts, it was found that the tents used during the initial phase were used for around three and a half months. As of April 2002, approximately 16,000 temporary housing units were still in use in İzmit. Despite the introduction of permanent housing options, residents were expected to continue living in temporary housing due to housing shortages and high rent prices in the area [8].

2011 Van Erciş Earthquake Case

An earthquake of magnitude 7.2 hit Tabanlı village in Van on October 23, 2011. This is one of Türkiye's top ten strongest earthquakes in the last 110 years [11].

On November 9, 2011, a 5.7 magnitude earthquake hit the same region as the previous earthquake, causing casualties and damages. The second earthquake rendered many buildings unusable, including those undamaged by the first earthquake. 27 buildings collapsed during the second earthquake [11].

After the devastating earthquakes, one of the most urgent needs was shelter. Until permanent housing was built, survivors were provided personal tents, Mevlâna Houses, shared in Figure 4, containers, and tent camps in their neighborhoods [42].

February 6, 2023, Kahramanmaras Earthquake Case

An earthquake on February 6, 2023, resulted in many people facing housing issues. The Turkish Medical Association has reported that during the 2nd month after the disaster, over 3 million people are expected to experience housing problems in 10 provinces affected by the earthquake [12].

The tent settlement on Silvan Road, as shown in Figure 5, caused residents to evacuate in March due to flooding.

Figure 6. The construction of brick houses as temporary shelters in Islahiye [15].

The settlement was established in an unsuitable location by the banks of the Tigris River, with tents closely spaced and no drainage channels [12].

First aid tent spacing is a common issue. The narrow distance between tents can cause tripping and increase the risk of fire spread [12].

Measures were not taken despite observations. A fire caused injuries and damages in the third month after the earthquake. There are different practices in planning temporary housing units for the rehabilitation phase. Some of these practices need discussion to ensure the appropriateness of the temporary housing features.

The construction of 2,264 brick houses and container installations on a 190,000 square meter area in İslahiye, as shown in Figure 6, has been initiated [13]. Adıyaman is constructing temporary housing for 15,000 individuals using prefabricated materials and light steel following the earthquake, as confirmed by the Ministry of Environment and Urbanization [14].

Scientific studies on temporary housing practices after disasters in Türkiye have addressed the following issues:

- Due to its geographical location and unplanned urbanization, Türkiye is heavily impacted by economic crises and experiences significant destruction in its cities. Public buildings are often too damaged for use during first aid or rehabilitation, and there is a need for temporary housing in post-disaster settlement strategies as permanent housing options are inadequate. Public buildings are often too damaged for use during first aid or rehabilitation, and there is a need for temporary housing in post-disaster settlement strategies as permanent housing options are inadequate. Insufficient research has been conducted on post-disaster temporary housing strategies in Türkiye, and previous earthquakes have not been consistently reported, resulting in different experiences after each earthquake and crisis-driven post-disaster settlements [2].
- During the rehabilitation phase, the transition to temporary housing takes longer than necessary due to a lack of research and strategies on the locations and types of temporary housing.
- The transition from rehabilitation to permanent housing takes years for economic and social reasons. Temporary housing units have limited comfort and reusability over time [7].
- Temporary housing units with the same materials often fail to meet expected performance under varying climatic conditions, requiring user repairs over time [16].
- Insufficient pre-disaster planning can result in substantial economic losses [4].
- Temporary housing is not just for initial aid but also rehabilitation and should be planned separately [17].

Apart from the issues, there is an additional concern regarding the placement of temporary housing units. It is crucial to have pre-planned strategies to deal with the urgency and chaos that follows a disaster. Multiple location options should be considered for temporary housing, and the chosen alternatives must be implemented after the disaster, considering the specific characteristics of the affected area.

2.2. Evaluation Method

Post-disaster temporary housing requires a comprehensive approach. Various criteria need individual examination, and production and process aspects must be tackled separately [17].

Using temporary housing during rehabilitation is more complex than during the initial relief and reconstruction processes and involves different criteria. Temporary housing for initial relief is designed for short-term use and is evaluated on simple criteria. Tents are preferred as they provide optimal conditions. However, the reconstruction process is like constructing permanent housing [17].

To determine the most suitable temporary housing system, it is essential first to examine the characteristics of the production and construction processes involved in creating the system. Defining the goals and objectives of the temporary housing system is a crucial step in this process. A construction system has a unique identity that takes specific inputs through a process to produce specific outputs aligned with certain goals. This process consists of subsystems that create the structure, such as production and construction sub-processes.

An evaluation process is necessary to choose the best possible option. One of the stages in this process involves

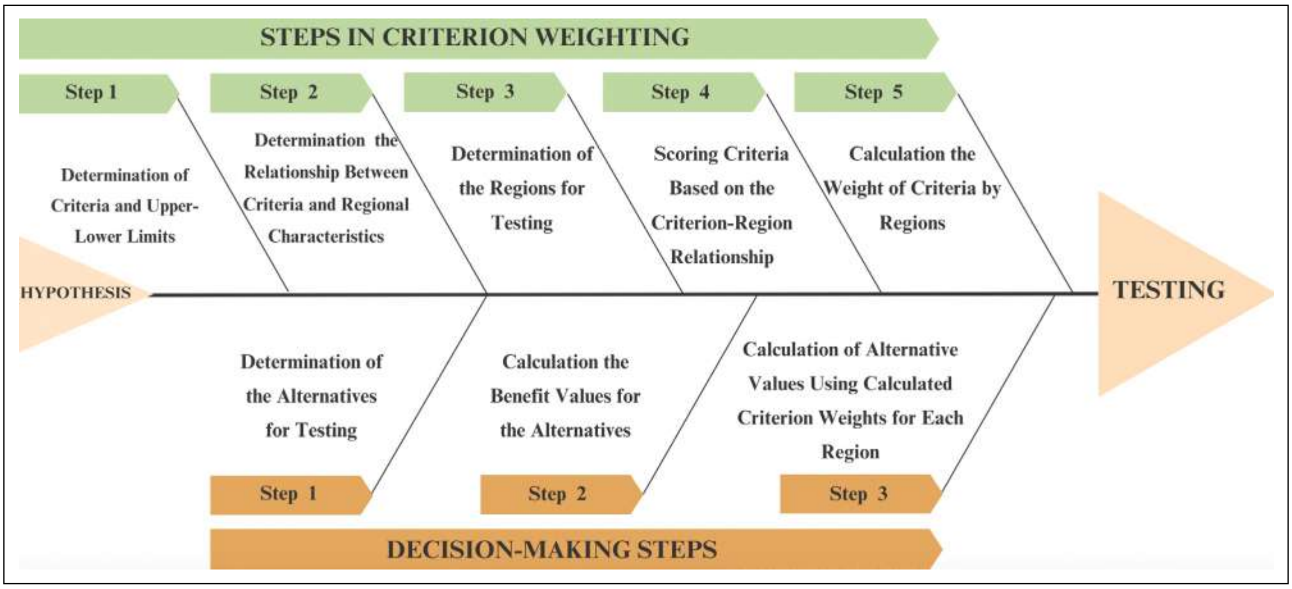

Figure 7. Diagram showing the evaluation steps.

Table 1. Commonly used criteria in the literature

	Criteria															
	SC	AC	AD	FR	CR	DAU	TI	FF	RWS	LUF	L (TC)	R	S	EV	VC	S
Mustafa K. Ervan (1995) [4]	x	x	x	x	x	x	x	x	x	x	x					
Demet Songür (2000) [21]	x		x	x					x	x	x	x	x	x		
Sibel Acerer (1999) [6]	x	x		x	x	x				x	x		x			
Belinda Torus, Sinan M. Şener (2015) [22]		x	x						x	x	x					x
Berna Baradan (2002) [3]	x	x	x			x	x				x	x		x		

SC: Storage convenience; AC: Assembly convenience; AD: Assembly duration; FR: Fire resistance; CR: Climate resilience; DAU: Durability against usage; TI: Thermal insulation; FF: Functional flexibility; RWS: Reproducibility with the same; LUF: Land use flexibility; L (TC): Lightness (transportation convenience); R: Reusability; S: Security; EV: Economic viability; VC: Visual comfort; S: Sustainability.

evaluating the alternatives based on specific criteria. The value of a choice is determined by its performance in achieving a particular goal [18].

When faced with multiple alternatives that need to be evaluated on various criteria, it is essential to determine the level of importance of each criterion. This is because each criterion can have a different significance level, and the selection of alternatives depends on how much weight is given to each criterion. Therefore, assigning weights to each criterion is crucial in decision-making methods involving multiple criteria. Several criterion weighting methods are available in the literature, such as AHP, SWARA, ENTROPY, etc. [19].

To ensure that an alternative meets the desired quality, it must satisfy the boundary values specified by the criteria. However, when evaluating multiple criteria, it is essential to consider certain factors. While some requirements can be quantified using measurable units, others rely on abstract values. Moreover, different systems use different units to describe the characteristics of criteria and alternatives. Furthermore, the difference in value between two alternatives that fulfill the same need may carry extra weight from a needs perspective. For instance, exceeding the threshold value for comfort against environmental conditions may be beneficial, while exceeding the desired lifespan for a building may not matter much [18].

The chosen evaluation method in this study is the benefit and value analysis. This method enables the consideration of both quantitative and qualitative evaluation criteria for alternative selection. Additionally, the evaluation process becomes variable as alternatives gain weight based on different characteristics. This method allows for obtaining further results through the same evaluation method when the consequences change [20].

In conclusion, the evaluation steps followed in this research are illustrated in Figure 7.

2.3. Steps in Criterion Weighting

Step 1: Determination of Criteria and Upper-Lower Limits

A building system is designed to achieve specific objectives by transforming inputs into outputs. This process involves various subsystems that include production and construction processes. The connection between environmental data and the objectives determines the building system's evaluation criteria [20].

In previous research on temporary housing, several evaluation criteria have been established. Table 1 shows

Table 2. Hierarchy of characteristics and criteria for suitability of temporary housing for rehabilitation phase

Overall objective	Lower level objectives	Criteria	Description
Suitability for the rehabilitation phase of temporary housing	Suitability of structural features	Variability of spatial organization	According to potential user diversity, the construction system of temporary housing should be capable of meeting users' different capacities, spatial organization preferences, and functional requirements. The construction system's ability to allow various spatial arrangements during the initial construction phase and to modify the spatial qualities of the dwelling to address changing user needs during the usage phase also signifies the adjustability and transformability of the housing's spatial characteristics.
		Variability of unit compositions	According to different conditions such as varying ground, land, urban settings, etc., the concept explains the ability of temporary housing to be multiplied by stacking them on top of each other or placing them side by side. It highlights the units' capacity to be interconnected, allowing for different placement patterns on the layout plan.
	Suitability of process features	Assembly convenience	The construction system of temporary housing signifies the ease of installation with minimal labor without requiring special equipment or expertise.
		Transportation convenience	It expresses the ease of transportation of temporary housing and components to the designated installation site.
		Storage convenience	It signifies the compactness of the elements and components constituting the temporary housing, their stackability, the ability to reduce their volume, and the fact that they do not require special protection conditions (against environmental factors) while stored.
	Suitability of environmental condition-related features	Providing comfort against Environmental conditions	It describes the protection of users and the structure against physical environmental conditions such as wind, solar effects, etc., by providing necessary values in terms of insulation against heat, water, sound, etc.

Table 3. Criteria's upper and lower limits

Evaluation criteria	Lower	and	Upper
A. Variability of spatial organization	Too little	–	Too much
B. Variability of mass compositions	Too little	–	Too much
C. Assembly convenience	10 days	–	5–6 hours
D. Transportation convenience	1 unit at a time	–	5–6 units at a time
E. Storage convenience	Storage in big modular units	–	Storage in small panels
F. Providing comfort against environmental conditions	Too weak	–	Very strong

the most prominent standards. However, to simplify the evaluation method, this study excludes cost-effectiveness, safety, and fire resistance, essential for temporary housing in any region. Instead, the evaluation model incorporates criteria related to the unique characteristic features of different areas.

We can classify the other criteria into three sub-objectives: structure, process, and environment. Table 2 shows the hierarchy of features and criteria for the main objective.

When assessing an alternative option, it is crucial to establish the upper and lower boundaries of the criteria. This is because the value of the alternative must meet the limits set by the criteria. To produce temporary housing units to be used in the rehabilitation phase, Table 3 provides the lower and upper limits for the evaluation criteria. These limits are determined based on the need for quick assembly and transportation during rehabilitation, the requirement to manufacture within a limited timeframe, the reusability factor, and the provision of options for various family sizes.

Step 2: Determination of the Relationship Between Criteria and Regional Characteristics

To test the research hypothesis about the appropriateness of temporary housing for the rehabilitation phase, it's essential to understand the factors that may impact the top-level criteria used for this purpose. This involves exploring the various characteristics of the regions where the housing will be installed before weighing the criteria based on their significance. This will help determine how these region-specific factors might affect temporary housing during rehabilitation.

This study explains the impact of regional characteristics on temporary housing in Table 3–7 after examining factors such as population density, household size, climate conditions, and urban accessibility in the regions.

Table 4. The effects of urban accessibility on the criteria

Transportation convenience	The vehicle choice depends on the transportation network's condition in disaster-affected areas. Efficiently delivering personnel to the region is crucial, and therefore, well-developed urban transportation performance is necessary. Transportation operations should be carried out using predetermined transportation network maps and vehicles based on these maps before the disaster occurs [4]. In areas with limited urban accessibility, it can be suggested that transport convenience holds a higher significance level.
Storage convenience	The selection of vehicles and organization of storage conditions should be planned based on the accessibility options to the city through roadways, railways, waterways, or airways for adequate post-disaster transportation. Each storage location should cover predetermined areas, and necessary facilities should be set up accordingly [4]. Therefore, accessibility to depots is essential for transportation, and it should be equally important for every region since it needs to be preplanned.
Assembly convenience	The condition of transportation networks is essential during the assembly phase to ensure the arrival of assembly personnel to the disaster-affected area. Specialized vehicles like cranes might be necessary to assemble modular systems [6]. In such cases, urban accessibility becomes significant for anchoring temporary housing units to the ground or other places.

Table 5. The effects of household size on the criteria

Variability of spatial organization	In addition to providing shelter, temporary housing units can serve as educational, healthcare, dining, and worship facilities. To accommodate these various functions, the units need to be spatially flexible [4]. Therefore, flexibility in household size is equally important in regions with varying household size averages as it relates to space usage.
Variability of unit compositions	Temporary housing units should be adaptable to varying user counts, especially for larger families, to function as sufficient shelter units for single families [6]. In regions where the average household size is larger, this criterion holds a relatively higher significance level.

Table 6. The effects of climate conditions on the criteria

Transportation convenience	During the transportation of temporary housing to disaster-stricken areas, various options such as air, land, and sea transportation can be [4]. In all scenarios, the region's climate conditions are a criterion that must be considered during the transportation phase. It could be argued that transportation convenience holds higher significance in areas with extremely cold climates than in other regions.
Storage convenience	Storage refers to the stage where temporary housing elements are stacked and kept in optimal condition until they are ready for use. When selecting a storage location, it is essential to consider the area's climate conditions to protect it from potential environmental damage—establishing adequate ventilation systems to prevent damage to the materials and ensure protection against disasters such as floods and landslides [4]. In regions that experience extreme cold or hot climates, the criterion of storage convenience may hold a relatively higher significance level than the other areas.
Providing comfort against environmental conditions	Temporary housing units must provide minimum living conditions, thermal insulation, and security while acting as a barrier against harmful plants and insects [21]. In areas with particularly low or high temperatures, ensuring comfort against environmental conditions may be deemed of higher importance than in other regions.

Urban Accessibility

Accessibility is crucial in disaster contexts for transportation networks to function continuously. It is necessary to meet people's needs and provide aid and services post-disaster [23]. The accessibility of a region affects transportation, storage, and assembly ease for temporary housing. A city's accessibility impacts these criteria and is correlated in Table 4.

Household Size

According to the Turkish Statistical Institute (TUIK), household size refers to the number of individuals residing together at the same address. This information is crucial in determining the appropriate number of people to accommodate in a single temporary housing unit and for varying spatial and mass compositions. In areas with larger households, temporary housing units with flexible designs are recommended [24]. The Table 5. correlates the potential impacts of household size on these criteria using the features of temporary housing described in the literature.

Climate Conditions

When considering climate conditions, Türkiye's climates are categorized into hot-dry, hot-humid, temperate-dry, temperate-humid, and cold. Varying structural requirements for temporary housing are expected in different regions to provide comfort against environmental conditions [25]. Table 6. correlates the potential impacts of climate conditions on these criteria using the features of temporary housing described in the literature.

Table 7. The effects of urban-population density on the criteria

Variability of spatial organization	In addition to providing shelter, temporary housing units can function as educational, healthcare, dining, or worship facilities, requiring flexible spatial qualities [4]. In densely populated areas, spatial functions may increase.
Variability of unit compositions	Temporary housing units should be adaptable to different user counts, including more prominent families, and flexible in their mass compositions to align with social life. Site planning should be completed before disasters, as a linear or rigid layout might not always be feasible in regions with different topographic features [27]. In areas with high urban density, it may be beneficial to consider giving more importance to the criterion related to the diversity of mass compositions compared to regions with low viscosity.
Assembly convenience	During the design phase, determine assembly details for the temporary housing unit. It should be able to be set up without special tools or equipment [4]. A ready-made modular system can provide easy assembly, but attaching units or toe ground might require cranes, which could be hindered by population and building density in the city after a disaster. Quick assembly is a critical essential aid phase due to the aim to move into a healthier environment during the rehabilitation stage [6]. Assembly convenience might be influenced by urban density proportional to the number of people affected by the disaster. In regions with high urban density, the importance of the assembly ease criterion can be considered higher than in areas with low density.
Transportation convenience	If pre-made modular systems are utilized, assembly is easy, but transportation and attachment to the ground may require heavy equipment, which can be hindered by post-disaster population density. Temporary housing elements should be designed to use existing vehicles [6]. However, transportation may also be considered more critical in densely populated cities. Therefore, the importance of the transportation ease criterion may be directly proportional to urban density.
Storage convenience	Warehouses should be established in safe locations, away from disaster zones like floods and landslides, and city density and transportation networks should be considered. During disasters, it's essential to plan for temporary housing based on the population and store appropriate stock quantities in the warehouses [4]. There may be a greater need for temporary housing units in densely populated areas, so the ease of storage could be considered more important and directly proportional to urban density. Packaging temporary housing elements for easy transport is also crucial, as transportation features can affect storage conditions [6].

Table 8. The characteristics of four regions in Türkiye

City name(s)	Urban-population density [26]	Transportation performance [28]	Average household size [24]	Climatic characteristics [25]
İstanbul	High-density urban	%80.1–100	3.18	Cool winters, hot summers, semi-arid
Muğla-Aydın	Medium-density urban	%20.1–40	2.77	Cool in winter, very hot in summer, dry-semi-humid
Muş-Bitlis-Van	Rural area- medium-density urban	%0.1–20	4.26	Cold in winter, warm in summer, humid-semi-humid
Sakarya-Kocaeli	Medium-density urban	%40.1–60	3.23	Cool in winter, hot in summer, semi-humid

Urban Population Density

Regarding population density, settlements are categorized as high-density urban, medium-density urban, and rural. High-density urban areas have at least 50% of their population living in cities, rural areas have at least 50% living in rural areas, and medium-density urban areas do not meet the criteria of high-density urban or rural settlements [26]. Urban population density impacts these criteria and is correlated in Table 7.

Considering this information, the diagram illustrating the relationship between the characteristics of regions and the evaluation criteria for temporary housing is shown in Figure 8.

Step 3: Determination of the Regions for Testing

When examining the effects of these factors on the criteria, selecting regions with diverse characteristics can provide a suitable assessment environment to discuss the necessity for temporary housing to have different structural requirements according to regions. The characteristics of four groups of cities located in the other areas of Türkiye at risk of disasters are presented in Table 8, along with their features.

Step 4: Scoring Criteria Based on the Criterion-Region Relationship

In the second step, the identified characteristics of the region and the criteria were evaluated based on the relationship scale. The relationship scale comprises five levels - extreme, strong, sufficient, weak, and very weak, ranging from 1 to 5. The scoring procedure is illustrated in Figure 9.

Step 5: Calculation the Weight of Criteria by Regions

The criterion weights were determined based on scores assigned using the relationship diagram in Figure 9, the relationship between region characteristics and criteria

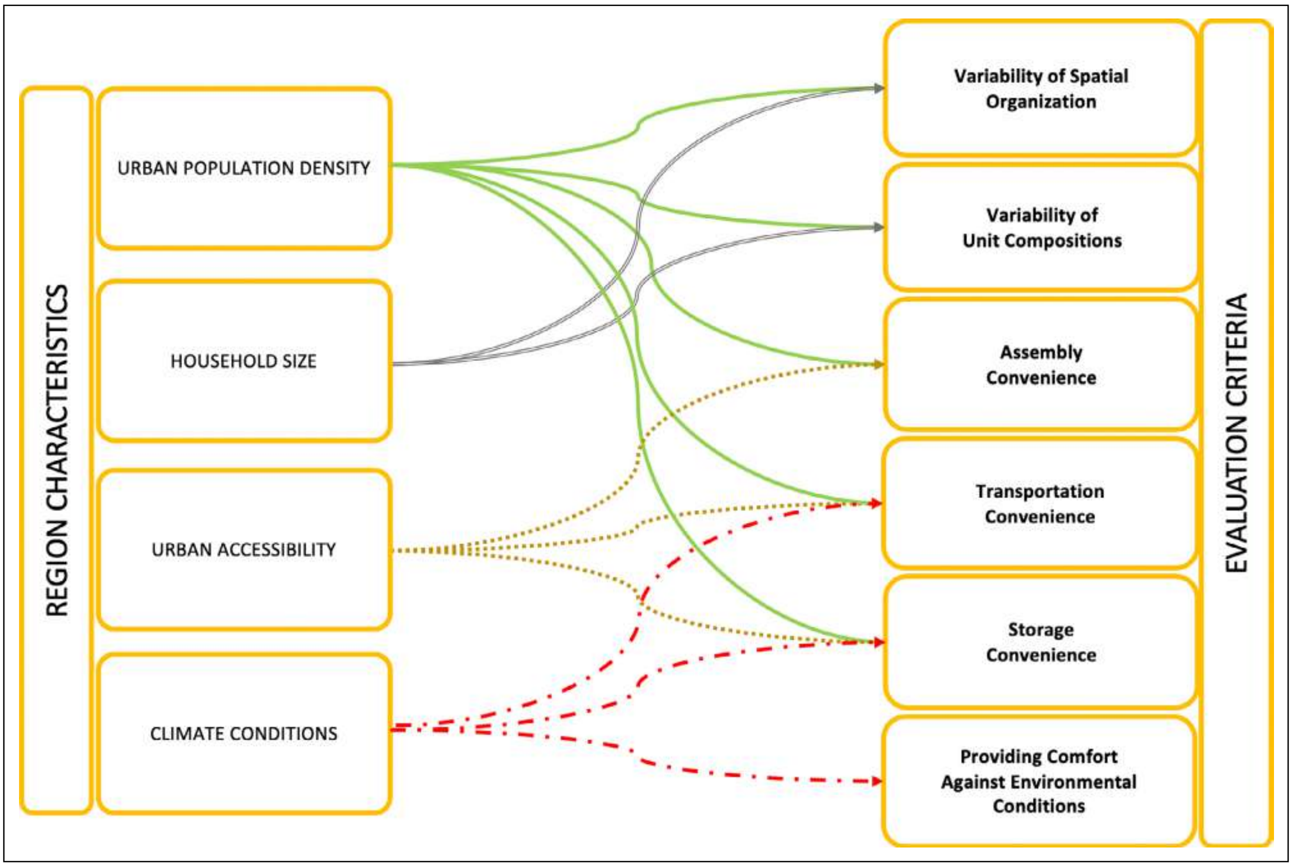

Figure 8. Diagram showing the relationships between region characteristics and temporary housing evaluation criteria.

Table 9. Weights of criteria importance in İstanbul region

İstanbul / Criteria	Urban density	Household size	Urban accessibility	Climate conditions	Relation total score (r_n)	Weight (W_n)
A. Variability of spatial organizations	5	3	0	0	**8**	**0,1667**
B. Variability of unit compositions	5	4	0	0	**9**	**0,1875**
C. Assembly convenience	5	0	1	0	**6**	**0,1250**
D. Transportation convenience	5	0	5	2	**12**	**0,2500**
E. Storage convenience	5	0	3	2	**10**	**0,2083**
F. Providing comfort against environmental conditions	0	0	0	3	**3**	**0,0625**
		Total value ($r_A+r_B+r_C+r_D+r_E+r_F$)=			**48**	

1: Very weak; 2: Weak; 3: Sufficient; 4: Strong; 5: Very strong relation.

established in Tables 3–7, and a literature review. The weights were normalized, transformed into standard values for four regions, and presented in Table 9, for İstanbul Region; Table 10, for Muğla-Aydın-Denizli; Table 11, for Muş-Bitlis-Van Region and Table 12 for Sakarya Region. The formula for calculating the criteria weights is shown in Equation 1 as follows [18].

W: Criterion Weight
r_n: Relation Total Score
r_A: Value of Criteria A
r_B: Value of Criteria B
r_F: Value of Criteria F

Equation 1 Calculating Criterion Weight: $(W_n: \frac{r_n}{r_A+r_B+r_C+r_D+r_E+r_F})$

According to this formula, the calculation of criterion weights for each region is as follows: Based on the relationship between the criteria and the part characteristics in Figure 4, the relationship scores for each measure are summed to find a separate Relation Total Score (r_n) for each criterion. Then, the Relation Total Scores for all requirements are added to find the Total value. Dividing each criterion's Relation Total Score (r_n) by the Total value gives the criterion weights for each region.

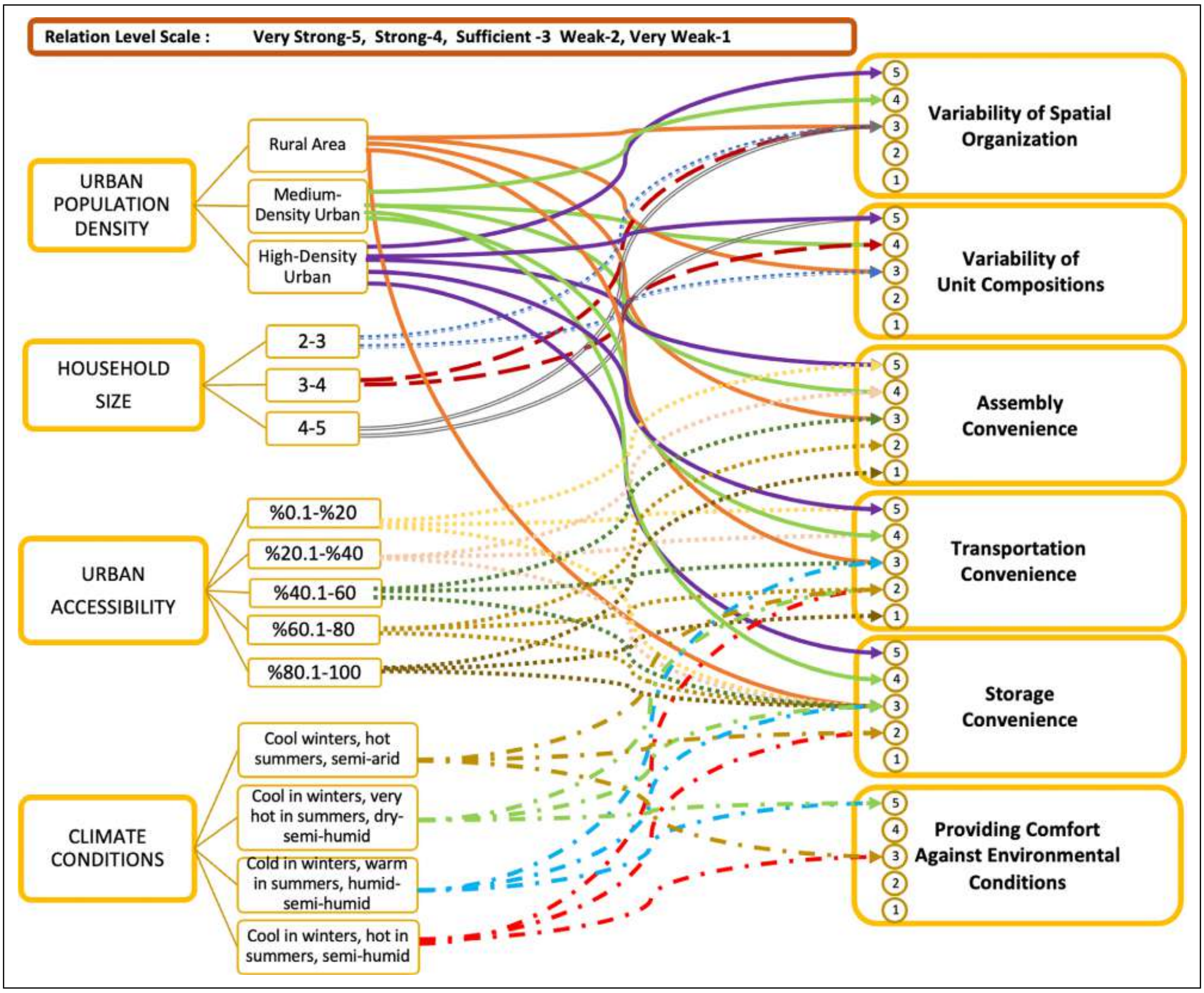

Figure 9. Diagram Illustrating the Relation Level Scale Between Region Characteristics and Criteria.

Table 10. Weights of criteria importance in Muğla-Aydın-Denizli region

Criteria \ Muğla-Aydın-Denizli	Urban density	Household size	Urban accessibility	Climate conditions	Relation total score (r_n)	Weight (W_n)
A. Variability of spatial organization	4	3	0	0	7	0,1489
B. Variability of unit compositions	4	3	0	0	7	0,1489
C. Assembly convenience	4	0	4	0	8	0,1702
D. Transportation convenience	4	0	4	2	10	0,2128
E. Storage convenience	4	0	3	3	10	0,2128
F. Providing comfort against environmental conditions	0	0	0	5	5	0,1064
		Total value ($r_A+r_B+r_C+r_D+r_E+r_F$)=			47	

1: Very Weak; 2: Weak; 3: Sufficient; 4: Strong; 5: Very strong relation.

2.4. Decision-Making Steps

Step 1: Determination of the Alternatives for Testing

Table 13 presents the characteristics and features of temporary housing solutions used worldwide, including prototype studies suggested for disaster areas. The table includes examples of temporary housing that have been previously used or are currently in use. Despite regional variations, all the examples are expected to meet the requirements, such as economic efficiency, fire safety, and sustainability.

Step 2: Calculation the Benefit Values for the Alternatives

The features of the alternatives and the differences in their displayed values can be determined using an interval scale. An interval scale allows the transformation of the features of options into other options, aiding in ag-

Table 11. Weights of criteria importance in Muş-Bitlis-Van region

Muş-Bitlis-Van / Criteria	Urban density	Household size	Urban accessibility	Climate conditions	Relation total score (r_n)	Weight (W_n)
A. Variability of spatial organization	**3**	**3**	**0**	**0**	**6**	**0,1277**
B. Variability of unit compositions	**3**	**5**	**0**	**0**	**8**	**0,1702**
C. Assembly convenience	**3**	**0**	**5**	**0**	**8**	**0,1702**
D. Transportation convenience	**3**	**0**	**5**	**3**	**11**	**0,2340**
E. Storage convenience	**3**	**0**	**3**	**3**	**9**	**0,1915**
F. Providing comfort against environmental conditions	**0**	**0**	**0**	**5**	**5**	**0,1064**
		Total value ($r_A+r_B+r_C+r_D+r_E+r_F$)=			**47**	

1: Very weak; 2: Weak; 3: Sufficient; 4: Strong; 5: Very strong relation.

Table 12. Weights of criteria importance in Sakarya region

Sakarya / Criteria	Urban density	Household size	Urban accessibility	Climate conditions	Relation total score (r_n)	Weight (W_n)
A. Variability of spatial organizations	4	3	0	0	**7**	**0,1591**
B. Variability of unit compositions	4	4	0	0	**8**	**0,1818**
C. Assembly convenience	4	0	3	0	**7**	**0,1591**
D. Transportation convenience	4	0	3	2	**9**	**0,1750**
E. Storage convenience	4	0	3	2	**9**	**0,1750**
F. Providing comfort against environmental conditions	0	0	0	4	**4**	**0,1000**
		Total value ($r_A+r_B+r_C+r_D+r_E+r_F$)=			**44**	

1: Very weak; 2: Weak; 3: Sufficient; 4: Strong; 5: Very strong relation.

gregating results measured in a single unit [18].Values have been considered benefit values, and the interval scales shown in Tables 14–19 have been used.

Step 3: Calculation of Alternative Values Using Calculated Criterion Weights for Each Region

After calculating the benefit values of each alternative based on the criteria, the total weights for each option are computed using Equation 2 [18]. The resulting values are shown in Tables 20–23.

W_n: Weight of Criteria**VB_n**: Value of Benefit of the Criteria **G**: Total Score of Alternative

Equation 2: ($G=W_n x VB_n$)

The total score for each alternative is calculated by multiplying the benefit values of the criteria with their corresponding weights and then summing these products. For example, the total score for the calculation of Alternative NO 1 is:

$G_1=((W_A x VB_A)+(W_B x VB_B)+ \ldots\ldots +(W_n x VB_n))$

For the Istanbul region, the total values received by the alternatives calculated with Equation 2 based on the criteria weights have been calculated and shown in Table 20. As a result of the calculation, Alternative NO 3 has received the highest score.

The total values received by the alternatives calculated with Equation 2 based on the criteria weights for the Muğla-Aydın-Denizli regions have been calculated and shown in Table 21. As a result of the calculation, Alternative NO 1 has received the highest score.

The total values received by the alternatives were calculated with Equation 2 based on the criteria weights for the Muş-Bitlis-Van regions, which have been calculated and shown in Table 22. As a result of the calculation, Alternative NO 1 has received the highest score.

The total values received by the alternatives calculated with Equation 2 based on the criteria weights for the Sakarya region have been calculated and shown in Table 23. As a result of the calculation, Alternative NO 1 has received the highest score.

3. RESULTS AND DISCUSSION

In a 'multi-criteria decision-making process for identifying (or evaluating) suitable temporary housing that can be used after a disaster, it is essential to differentiate the importance weights of criteria according to the different characteristics of the regions. In this context, a 'criteria weighting method' and an evaluation model that focuses on the effects of factors such as varying urban density, household size, urban accessibility, and climate conditions for regions are proposed in the study.

The importance weights of criteria for the four regions have been determined based on the degree of relationship between the factors defining the characteristics of the areas and evaluation criteria (Table 9–12). The findings related to the results are as follows:

Table 13. Temporary housing alternatives and their features

Alternative No. 1: Hex House [29]	 Manufacturer: Architects For Society	**Area:** 40 sqm **Flexibility:** Can be added side by side and multiplied **Structural System:** Panel walls support themselves. **Assembly Method and Time:** Simple tools are required, and assembly does not require expertise. **Transportation Method of the System:** Panels stacked flat are transported to the construction site with trailers. **Resistance to Environmental Conditions:** Conforms to LEED standards. **Flexibility:** Units can be arranged side by side in appropriate patterns or combined for better thermal insulation performance and shared walls.
Alternative No. 2: Onagawa Temporary Container Housing [30, 31]	 Manufacturer: Shigeru Ban Architects	**Area:** There are three mass compositions, each with an area of 19.86, 29.79, and 39.72 sqm, respectively. **Flexibility:** Containers can be stacked up to three levels, with open spaces between each unit. **Structural System:** Containers carry their weight. **Assembly Method and Time:** Containers are placed using cranes. **Primary Materials:** Repurposed shipping containers are used. **Transportation Method of the System:** Modules are transported to the site by truck and placed using a crane when needed. **Lifespan:** Housing units can be converted into permanent housing.
Alternative No. 3: AbleNook [32]	 Manufacturer: Sean Verdecia (Designer), AbleNook	**Area:** Each unit is approximately 25 sqm. **Flexibility:** Can be expanded for more extensive space requirements. **Structural System:** Aluminium frame **Assembly Method and Time:** Units can be assembled by unskilled individuals without using power tools. **Primary Materials:** Consists of flat-packed, on-site assembled kits made from SIPs (Structural Insulated Panels) and a sliding lightweight aluminum structural frame. **Transportation Method of the System:** Units are shipped as flat-packed. **Lifespan:** Can be used for 15 years or more. Reusable.
Alternative No. 4: NY House Prototype [33]	 Manufacturer: Garrison Architects Design	**Area:** Options range from 44 sqm to 75 sqm with additions. **Flexibility:** Plans include configurations with 1 and 3 bedrooms. Each unit features a living space, a bathroom, a fully equipped kitchen, and storage. **Structural System:** The prefab system carries its weight. **Assembly Method and Time:** Multi-story, multi-family units with various arrangements can be deployed in less than 15 hours. Units are stacked using cranes. **Primary Materials:** Made from recyclable materials. **Transportation Method of the System:** Modules are transported to the site by truck and placed using a crane when needed.
Alternative No. 5: Ex -container House [34]	 Manufacturer: Yasutaka Yoshimura Architects-Japan	**Area:** When placed side by side, two 20 ft containers create approximately 28 sqm of space (Bathroom with sink, bathtub, toilet / Kitchen / Living room). When stacked, two 20 ft containers provide around 26 sqm of space (Bathroom with sink, bathtub, toilet / Kitchen / Living room). Placing two vertically positioned old containers with a gap between them results in an approximate area of 50–60 sqm (Sink, bathtub, toilet / Kitchen / Living room, and bathroom). **Flexibility:** Units can be expanded by stacking them vertically or placing them side by side. **Structural System:** Containers carry their weight. **Assembly Method and Time:** Factory-produced units are transported to the site in their finished form and are stacked or placed side by side using a crane.

Table 13 (cont). Temporary housing alternatives and their features

		Primary Materials: The interior materials of the structure, made from ISO shipping containers, are applied on-site. **Transportation Method of the System:** Completed units are transported to the site via trailers and placed using a crane. One trailer can carry two housing units. **Lifespan:** Beyond the short term, the Ex-Container Project can be initially constructed as temporary housing and later transformed into a permanent architectural structure.
Alternative No. 6: IKEA Better shelter [35]	 Manufacturer: IKEA	**Area:** 17.5 sqm. It has a rectangular open plan. **Flexibility:** The lifespan of Better Shelter is strengthened through a progressive approach based on multiple shelter uses depending on local climate conditions and cultural characteristics. Existing units can be reinforced with local materials, reused over time, and recycled. **Structural System:** The metal frame can be wrapped in standard-sized tarpaulin for emergencies. Meanwhile, walls and roofs can be elevated using locally sourced building materials and attached to the frame using various techniques. The metal frame is fire-resistant. **Assembly Method and Time:** Assembled by a team of 4 people in 4–6 hours. **BaPrimary Materials:** Each package includes a lockable door, four windows, four vents, a semi-rigid opaque roof and wall panels, a steel frame assembled with floor anchors, a PV system, and a portable lamp. **Transportation Method of the System:** Stacked in packaged form. Each package is 1.07 m^3 and weighs 160 kg. **Lifespan:** Without maintenance, 1.5 years; with simple maintenance, three years of use.
Alternative No. 7: Uber Emergency Shelter [36, 37]	 Manufacturer: Rafael Smith	**Plan:** After a disaster, Uber is dispatched as a basic unit to meet the initial shelter needs. Over time, additional units are mounted onto the shelter units by sending a separate upgrade package (for light, compact stove, and refrigerator). **Flexibility:** Units can be added side by side or stacked. Structural System: Self-supporting. **Assembly Method and Time:** Easy assembly with minimal or even no tools. **Transportation Method of the System:** Panels are stacked flat. Stacked packages can be transported using trucks, transporting multiple units at once. **Lifespan:** Made from recyclable materials.
Alternative No. 8: Hush2 Shelter [38, 39]	 Manufacturer: Extremis Technology	**Area:** 12 sqm **Flexibility:** Cannot be added side by side or stacked. **Assembly Method and Time:** This can be easily set up in under two hours without requiring expertise or tools. Hush2 is a flat-packed structure made of marine plywood. **Primary Materials:** Made from plywood material. **Transportation Method of the System:** Panels are stacked flat. Stacked packages can be transported using trucks, transporting multiple units at once. **Lifespan:** Can be disassembled and reassembled up to 20 times.
Alternative No. 9: Cortex Shelter [40, 41]	 Manufacturer: Cutwork Studio	**Area:** 24 sqm **Flexibility:** Cannot be added side by side or stacked. **Assembly Method and Time:** Can be assembled within one day. **Primary Materials:** Concrete material rolled onto a steel framework. **Transportation Method of the System:** Panels are stacked flat. Stacked packages can be transported using trucks transporting multiple units at once. **Lifespan:** 30 years.

Table 14. Finding the benefit values of alternatives for criterion A using an interval scale

Value of benefit (VB)	1	2	3	4	5
	Too little	Little	Right amount	Much	Too much
A-variability of spatial organization	No. 4	No. 5	No. 1	No. 2	
	No. 7	No. 6		No. 3	
	No. 8	No. 9			

Table 15. Finding the benefit values of alternatives for criterion B using an interval scale

Value of benefit (VB)	1	2	3	4	5
	Too little	Little	Right amount	Much	Too much
B-variability of mass compositions		No. 6	No. 4	No. 1	
		No. 7	No. 5	No. 2	
		No. 8		No. 3	
		No. 9			

Table 16. Finding the benefit values of alternatives for criterion C using an interval scale

Value of benefit (VB)	1	2	3	4	5
	10 days	5–6 days	2–3 days	1 day	5–6 hours
C. Assembly convenience		No. 2	No. 3	No. 1	No. 6
		No. 4		No. 7	
		No. 5		No. 8	
				No. 9	

Table 17. Finding the benefit values of alternatives for criterion D using an interval scale

Value of benefit (VB)	1	2	3	4	5
	1 unit at a time	2 unitst at a time	Unitsit at a time	4 unitunitsa time	5–6 unitunits more
D. Transportation convenience	No. 2		No. 1	No. 3	No. 6
	No. 4		No. 8	No. 7	No. 9
	No. 5				

Table 18. Finding the benefit values of alternatives for criterion E using an interval scale

Value of benefit (VB)	1	2	3	4	5
	Storage in big modular units	Storage in small modular units	Hybrid system	Storage in big panels	storage in small panels
E. Storage convenience	No. 2		No. 1	No. 6	
	No. 4		No. 3	No. 7	
	No. 5			No. 8	
				No. 9	

For the İstanbul region, the 'Transportation Convenience' stands out with an importance weight of 0.2500 (25%). The criteria 'Storage Convenience' and 'Variability of mass composition' with importance weights of 0.2083 (21%) and 0.1875 (19%) are relatively secondary in importance compared to the 'Transportation Convenience' criterion. Relative to the other measures, the 'Providing Comfort Against Environmental Conditions" criterion' is less critical. The characteristics of Istanbul, especially urban density and accessibility, have influenced the results. Urban density restricts suitable areas for storage and installation of temporary housing units while posing a barrier to accessing these areas during a large-scale earthquake. Additionally, the appropriately limited regions due to density will necessitate stacking and densely placing teams on top of each other, making the criterion of variability in mass

Table 19. Finding the benefit values of alternatives for criterion F using an interval scale

Value of benefit (VB)	**1**	**2**	**3**	**4**	**5**
	Too weak	**Weak**	**Sufficient**	**Strong**	**Very strong**
F. Providing comfort against environmental conditions	No. 6 No. 7	No. 3 No. 8	No. 9	No. 2	No. 1 No. 4 No. 5

Table 20. The total value obtained by alternatives in the İstanbul region

Alternatives / Criteria	İstanbul									Weight of criteria (W_n)
	NO1	**NO2**	**NO3**	**NO4**	**NO5**	**NO6**	**NO7**	**NO8**	**NO9**	
A	3	4	4	1	2	2	1	1	2	0,1667
B	4	4	4	3	3	2	2	2	2	0,1875
C	4	2	3	2	2	5	4	4	4	0,1250
D	3	1	4	1	1	5	4	3	5	0,2500
E	3	1	3	1	1	4	4	4	4	0,2083
F	5	4	2	5	5	1	1	2	3	0,0625
Total score of alternative (G)	3,44	2,38	**3,54**	1,75	1,92	3,48	2,94	2,75	3,48	

Table 21. The total value obtained by alternatives in the Muğla-Aydın-Denizli regions

Alternatives / Criteria	Muğla-Aydın-Denizli									Weight of criteria (W_n)
	NO1	**NO2**	**NO3**	**NO4**	**NO5**	**NO6**	**NO7**	**NO8**	**NO9**	
A	3	4	4	1	2	2	1	1	2	0,1489
B	4	4	4	3	3	2	2	2	2	0,1489
C	4	2	3	2	2	5	4	4	4	0,1702
D	3	1	4	1	1	5	4	3	5	0,2128
E	3	1	3	1	1	4	4	4	4	0,2128
F	5	4	2	5	5	1	1	2	3	0,1064
Total score of alternative (G)	**3,53**	2,38	3,40	1,89	2,04	3,47	2,94	2,83	3,51	

Table 22. The total value obtained by alternatives in the Muş-Bitlis-Van regions

Alternatives / Criteria	Muş-Bitlis-Van									Weight of criteria (W_n)
	NO1	**NO2**	**NO3**	**NO4**	**NO5**	**NO6**	**NO7**	**NO8**	**NO9**	
A	3	4	4	1	2	2	1	1	2	0,1277
B	4	4	4	3	3	2	2	2	2	0,1702
C	4	2	3	2	2	5	4	4	4	0,1702
D	3	1	4	1	1	5	4	3	5	0,2340
E	3	1	3	1	1	4	4	4	4	0,1915
F	5	4	2	5	5	1	1	2	3	0,1064
Total score of alternative (G)	3,55	2,38	3,43	1,94	2,06	3,49	2,96	2,83	3,53	

composition another weighted measure for the Istanbul region. Climatic conditions are relatively less important for this region than other factors.

In the Muğla-Aydın-Denizli region, an importance weight of approximately 21% for the "Storage Convenience" criterion and the "Transportation Convenience " criterion can be associated with the region's access and transportation infrastructure status. Although relatively less dense than Istanbul, the area has a much weaker transportation network. Additionally, the "Installation Convenience" criterion, weighing 17%, is related to the effect of urban accessibility. Spatial diversity and the standard of mass composition have a medium level of importance, likely influenced by region-specific characteristics, such as the availability of suitable areas for installation and the smaller household size.

Table 23. The total value obtained by alternatives in the Sakarya region

Alternatives / Criteria	Sakarya									Weight of criteria (W_n)
	NO1	**NO2**	**NO3**	**NO4**	**NO5**	**NO6**	**NO7**	**NO8**	**NO9**	
A	3	4	4	1	2	2	1	1	2	0,1591
B	4	4	4	3	3	2	2	2	2	0,1818
C	4	2	3	2	2	5	4	4	4	0,1591
D	3	1	4	1	1	5	4	3	5	0,1750
E	3	1	3	1	1	4	4	4	4	0,1750
F	5	4	2	5	5	1	1	2	3	0,1000
Total score of alternative (G)	**3,39**	2,43	3,27	1,87	2,03	3,15	2,66	2,58	3,19	

In the Muş-Bitlis-Van region, the "Transportation Convenience " takes precedence with an importance weight of 23%. The harsh and challenging transportation network, coupled with the impact of climatic conditions, makes transportation ease a top priority. Similarly, the region's difficult transportation and harsh climate make storage requirements prominent, affecting the importance of the "Storage Convenience " criterion. Although the region has low urban density, a larger household size than other regions makes measuring spatial diversity more critical.

In the Sakarya region, all criteria have been calculated to have similar or equal weights except for the "Comfort Against Environmental Conditions" criterion, which weighs 10%. This is likely associated with the region's average values for urban density, accessibility, household size, and climate characteristics. The criterion of “Variability in Mass Composition” has a slightly higher weight of 18% compared to others. The mild and semi-humid climate leads to a relatively lower importance weight of 10% for the "Providing Comfort Against Environmental Conditions" criterion.

The multi-criteria decision-making method based on the weighting of criteria by region was tested on a selected group of temporary housing alternatives from the literature. As a result of the test:

For the İstanbul region, alternative NO 3 scored the highest points. The benefit values corresponding to all criteria for choice NO 3 are close to the average level, allowing the option to fulfill all requirements optimally.

In the Muğla region, alternative number 1 received a high score, influenced by the alternative's transportation and storage convenience. Additionally, choices NO 3, 6, and 9 follow closely, with high scores. All these three alternatives have optimal benefit values.

Alternative NO 1 is at the top for the Mus-Bitlis-Van region, and alternative option nine also scored highly. The benefit values for these three alternatives are generally close to the average level. However, considering the region's harsh winter conditions, alternative number 1's higher benefit value for providing comfort against environmental conditions influenced its top placement.

In the Sakarya region, while alternative NO 1 is in first place, choices NO 3, 6, and 9 are close in scores. With similar criteria weights in the Sakarya region, alternatives with generally average or above-average benefit values are favored as optimal choices.

When these findings are generalized, it can be concluded that the portability and storability of alternatives are generally emphasized. This is because of the strong influence of urban accessibility, urban density, and climatic factors, particularly portability. Increased urban density reduces the availability of suitable areas for storing and installing units. Urban density is also a significant factor in hindering post-disaster accessibility. Additionally, harsh climate conditions are another factor that restricts the portability and storability of units. This relationship and interaction between criteria and regional characteristics align with the findings obtained from the evaluation.

4. CONCLUSIONS

When determining the importance weights of criteria based on regional characteristics, decision-makers can consider additional factors representing site-specific attributes such as topography, terrain, orientation, and demographic details such as household diversity, user diversity, and city cosmopolitanism. The decision-makers can also include extra criteria specific to the region, such as sustainability, durability, land settlement flexibility, dismantling, reusability, cost, etc. As a result, the method and process can become more detailed, complex, straightforward, and general.

It is essential to understand that the "factors influencing criteria weights" and "criteria" are inputs and data used in the evaluation method. Any changes in these factors and criteria may affect the evaluation results, but they do not alter the methodology and process of the evaluation. In other words, even if different factors and standards specific to the region are used, the basic structure and method of the approach remain unchanged. Therefore, the study provides a systematic process for identifying and evaluating post-disaster housing systems and proposes a hypothetical approach.

ETHICS

There are no ethical issues with the publication of this manuscript.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

FINANCIAL DISCLOSURE

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PEER-REVIEW

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