Shipping Containers as Temporary Shelters in Post-Disaster Scenarios: Flying Factories

Semih G. Yıldırım*, İlke Ciritci**, Meryem Müzeyyen Fındıkgil***, Hilay Atalay****

* Corresponding Author, Assist. Prof., Department of Architecture, Istanbul Gelisim University, Cihangir Mah. Petrol Ofisi Cad. No.5, 34310, Avcılar, Istanbul, Türkiye. E-mail: sgyildirim@gelisim.edu.tr ORCID: 0000-0002-7832-6575

** Assoc. Prof., Department of Architecture, Istanbul Gelisim University, Cihangir Mah. Petrol Ofisi Cad. No.5, 34310, Avcılar, Istanbul, Türkiye. E-mail: iciritci@gelisim.edu.tr ORCID: 0000-0002-1492-0727

*** Assist. Prof., Department of Architecture, Istanbul Gelisim University, Cihangir Mah. Petrol Ofisi Cad. No.5, 34310, Avcılar, Istanbul, Türkiye. E-mail: mmfindikgil@gelisim.edu.tr ORCID: 0009-0004-9810-0962

**** Assist. Prof., Department of Architecture, Istanbul Gelisim University, Cihangir Mah. Petrol Ofisi Cad. No.5, 34310, Avcılar, Istanbul, Türkiye. E-mail: hatalay@gelisim.edu.tr ORCID: 0000-0001-7976-2240

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Abstract: After the recent earthquakes in Turkey, there has been a significant demand for temporary shelter. Issues such as the availability of emergency shelters, designated emergency assembly areas, and the lack of social networks have come to the forefront. Due to the construction industry's inability to produce the necessary quantity of prefabricated temporary housing, the Ministry of Trade imposed a three-month ban on the export of prefabricated structures in 2023. The limited availability of emergency assembly areas renders low-density temporary settlements unfeasible. For disaster victims, leaving their homes does not provide a solution to overcoming the trauma they have experienced; in fact, it can exacerbate other economic, social, and security issues. Reusable shipping containers can partially address the problem of temporary shelter by utilizing the concept of flying factories. This research proposes a model that encompasses both technical and social phases, including the creation of technical documentation prior to a disaster and aiming for a participatory production model in the aftermath. The establishment of temporary logistics and production facilities is crucial and should be driven by volunteer participation under the guidance of professionals. Additionally, this model includes training and coordination activities before a disaster as part of the execution plan. Through this study, which incorporates both physical and social dimensions, an integrated solution is proposed based on the identification of challenges faced after recent disasters.

Keywords: Shipping container, temporary shelter, emergency assembly area, flying factory, social networking

1. Introduction

Addressing the temporary shelter needs of disaster victims is a crucial component of disaster management planning. Temporary settlements provide essential support and shelter for individuals who have been displaced from their homes due to damage or destruction, until they can transition to permanent housing. The demand for such temporary housing remains significant worldwide, particularly following natural disasters such as earthquakes, floods, and wildfires. This need arises in situations where communities are impacted by flooding due to the failure to implement urban planning decisions or due to poor planning practices, as well as from wildfires that encroach upon urban areas and threaten the built environment. Additionally, earthquakes often result from inadequate construction practices that do not adhere to zoning regulations, building codes, or the existing geological conditions of the area. When evaluating damaged and unusable building stock following disasters, it becomes evident that temporary housing is primarily needed after earthquakes. In light of the experiences following the Kahramanmaraş earthquakes on February 6, 2023 (7.8 Mw magnitude in the Pazarcık district and 7.5 Mw magnitude in the Ekinözü district) and the Hatay earthquakes on February 20, 2023 (6.3 Mw magnitude in the Defne district and 5.5 Mw magnitude in the Samandağ district), it is clear that the issue of temporary shelter after earthquakes remains a significant challenge in Turkey.

2. Literature Review

Shipping containers, known for their modularity and resistance to harsh weather conditions, are increasingly being repurposed as housing. This approach represents a more environmentally friendly and sustainable construction method, as it reduces construction time, waste, and the overall workload on-site [1]. Numerous studies have been conducted globally on the use of shipping containers for social housing

[2][3]. Furthermore, the sustainability of recycling shipping containers for living spaces has been extensively researched [4][5][6]. Within the framework of the skeleton and infill construction system, shipping containers can be regarded as the primary structural element of a building, with additional components serving as infill within this cellular system [7].

Certain standards for the design of temporary settlements have been established to address the needs of disaster victims, and definitions for temporary shelter design criteria have been formulated based on previous experiences with prefabricated buildings [8][9]. In terms of construction methodology, it has been observed that structural systems utilizing shipping containers exhibit adequate seismic response to earthquake loads [1]. A review of the literature indicates that various studies have been conducted on the use of shipping containers as emergency shelters and temporary housing following disasters, leading to the proposal of numerous prototypes and designs [10][11][12][13][14][15][16][17]. For instance, Akar (2012) developed a database model for container use in producing temporary housing, while Atamer (2010) focused on optimal pricing and production decisions in reusable container systems. Additionally, Avlar et al. (2023) introduced the CLT E-BOX as a post-earthquake temporary housing unit, and Beyatlı (2010) proposed a model for an emergency state container as a shelter. Kumaş (2022) explored the use of containers for temporary housing and the development of spatial solutions in Turkey. Furthermore, a variety of sustainable temporary housing proposals have been developed as shelters [18][19][20].

Analyses have demonstrated that social sustainability is equally important as technological sustainability [21][22]. The architectural adaptation of shipping containers for housing has been investigated for domestically displaced individuals in Nigeria. Two significant social and environmental issues were addressed: mass displacement leading to homelessness and the increasing number of empty shipping containers abandoned at ports [23]. Similarly, the housing challenges faced by Syrian refugees have been tackled through the use of shipping containers [24]. Based on experiences with temporary housing following major disasters worldwide, several critical social factors have been identified. These factors include issues related to ownership, reuse, resettlement arrangements, and pre-disaster planning by authorities, which depend on the characteristics of various types of disasters. Furthermore, it is essential to explore whether these social factors are equally applicable to all post-disaster scenarios [25].

Post-disaster reconstruction is evaluated from a comprehensive and interdisciplinary perspective, encompassing both technical and managerial aspects, and is treated as an integrated system. The coordinated operation of these two subsystems is crucial in the chaotic environment that typically follows a disaster. The managerial subsystem delineates roles and responsibilities in the post-disaster process [26]. Within the framework of disaster management and post-disaster preparedness, it has become increasingly important to establish guidelines for temporary shelters and define coordination strategies in advance to mitigate potential financial and time losses [27]. Disaster operations occur in a chaotic environment characterized by uncertainty and time constraints. Consequently, there is a pressing need to leverage information and communication technologies in decision-making processes [27][28]. In addition, it is believed that the participatory design method, which is typically applied in permanent housing, can also be utilized in temporary housing to positively influence the recovery period of victims. The primary objective should be to engage the end-users [29]. It is anticipated that involving those affected by the disaster as stakeholders in the procurement, design, and construction of temporary housing can foster a sense of social interaction following the disaster [27]. Furthermore, a decision support system has been developed to prioritize assistance among disaster victims during the post-disaster recovery phase [30]. Participatory design should be favored in the production of post-disaster housing. Given the nature of participation, post-disaster traumas can be addressed in a more manageable and controlled manner. Society must address post-disaster trauma through solidarity and unity. Effective participation can be achieved by fostering solidarity, communication, cooperation, trust, and a sense of belonging. Participatory design offers a viable solution to this pressing issue following a disaster [31]. Research has shown that temporary settlement areas, which do not align with the characteristics of the region in which they are established and are designed uniformly, fail to aid the recovery of disaster victims; instead, they create additional challenges for those affected [32]. The process of partially or completely abandoning the disaster-stricken area and relocating to a new, safer environment also presents significant challenges regarding individuals' adaptation to their new surroundings [33][34]. For instance, following the 2011 Christchurch earthquake, studies were conducted on the transformation of urban spaces and post-disaster reconstruction, examining how these efforts could enhance a city's resilience [35].

In the selection and identification of temporary settlement areas within urban centers, specific methods were employed to establish criteria [36]. The criteria for selecting temporary settlement areas can be summarized under the following categories: proximity to existing urban areas, access to water resources, connectivity to city infrastructure, area size, ownership status, topography, transportation accessibility, distance from disaster risk zones, classification as agricultural land, and the presence of surface obstacles, among others [8]. Studies conducted by various institutions over the years aimed at determining the location and size of post-disaster housing and emergency assembly areas in Izmir have been compiled. A related study examined whether the emergency assembly points and the areas designated for tent shelters in the Karşıyaka district met the necessary quality and size requirements. Additionally, their compliance with national and international standards was assessed [37]. In a study conducted in Istanbul, the shortest routes for citizens traveling from temporary emergency assembly point to temporary shelter areas using vehicles were analyzed. This analysis revealed districts that face challenges and require strengthening [38]. Post-disaster risk maps were created for the districts of Istanbul, identifying areas that need improvement [39]. Additionally, geographical surveys of temporary settlements designated by civil defense and local municipalities in eighteen districts on the European side of Istanbul were conducted for use following a potential disaster. The minimum standards for temporary settlements should be clearly defined by the International Red Cross, the Red Crescent Society, and

Non-Governmental Organizations (NGOs). This study examined these standards in detail. Data obtained from field surveys, digital topographical maps, geological maps, and the established minimum standards for temporary settlements were evaluated using Geographic Information System (GIS) methods [40]. Potential vacant spaces for temporary emergency assembly areas were analyzed through various case studies, including Kastamonu, Denizli, Malatya, and Çankırı, leading to specific recommendations. As a result of the risk analysis, suitable locations within built-up environments were investigated [41][42][43][44]. Through these studies, appropriate locations for temporary emergency assembly areas will be identified prior to an earthquake, enabling local authorities to enhance and rehabilitate these areas effectively [45].

3. Categorization of Emerging Problems in Dense-Urban Regions

When evaluating the post-disaster process in light of the experiences gained from recent disasters in Turkey, the emerging challenges can be categorized into three main areas. This study identifies these issues as follows: difficulties encountered in emergency assembly areas, a lack of social networks, and ineffective use of temporary shelters. After identifying these problems, the question arises: how can we contribute to addressing the issues of temporary housing and social assistance following a disaster? Depending on the definition of the problem, the solution emphasizes the post-disaster period, urban environments with high population density, temporary settlement and shelter design, and contributions to social life. Accordingly, the hypothesis of this study is articulated as follows: a partial contribution will be made to addressing the problem by developing a high-density, on-site temporary settlement and social network model following a disaster. Issues related to the hypothesis are presented in this section under the topics of temporary shelter, social networking, and emergency assembly areas (see Figure 1).

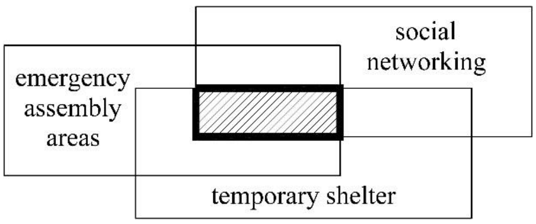

Figure 1: Problem definition

3.1 Temporary shelter

The need for post-disaster shelter is defined at various levels, with tents classified as "emergency shelters. The accommodations where disaster victims reside until they transition to permanent housing are referred to as "temporary shelters. Temporary shelters are typically established using prefabricated units and are expected to be constructed starting from the fifteenth day after the disaster and continuing until the second month. It can be stated that permanent housing is generally provided to disaster victims within twelve months following the event. Temporary shelter refers to the settlements where disaster victims reside from the second month following an earthquake until the twelfth month. Generally, prefabricated building technology is the predominant method used during this period. However, considering the impact area of the Kahramanmaraş earthquakes in 2023, it appears unlikely that prefabricated temporary shelters capable of meeting all needs can be established within the specified timeframe, even when accounting for all available resources in the country. Following the aforementioned earthquakes, the demand for prefabricated housing in earthquake-affected regions surged. Consequently, the Ministry of Trade issued a decision on February 15, 2023, to ban the export of prefabricated structures for three months [46]. Similarly, in the risk analysis of a potential Marmara earthquake, it is anticipated that a substantial population will require temporary shelter. It is evident that the needs of all individuals affected by the earthquake cannot be met simultaneously with prefabricated houses. In the context of emergency management, diversifying the range of solutions is deemed highly beneficial. Therefore, various alternatives should be proposed in addition to the production of prefabricated buildings for the establishment of temporary settlements.

At this stage, standard prefabrication production techniques are insufficient for rapid and on-site production, leading to the emergence of the innovative concept of the flying factory. Skanska defines modern flying factories as a strategy for off-site manufacturing and the industrialization of construction projects, which utilizes temporary and flexible factories while implementing lean principles in the manufacturing process [47][48]. The modern flying factory (MFF) involves the production of specific components or modules at temporary off-site or near-site locations, employing relatively simple technologies and processes that can be quickly set up and dismantled [49][50][51].

3.2 Social networking

It is often not immediately possible for disaster victims to leave their living environment for various reasons. Even if their building has become uninhabitable, disaster victims may not be able to leave the area due to physical, economic, and sociological factors. For instance, after an earthquake, live search and rescue operations can last up to fourteen days, while debris removal may take anywhere from two to six months. Consequently, disaster victims may be unable to leave the affected areas immediately, and first-degree relatives who come to the site during this time may also remain in the region for an extended period. In addition, first responders in charge of search and rescue operations also face challenges related to emergency shelter. The lack of a social network within the neighborhood following a disaster further complicates search, rescue, and support efforts. Therefore, there is a pressing need for a pre-established social network at the neighborhood level in the aftermath of a disaster. Evacuating the region or relocating disaster victims to large-scale temporary settlements outside the city center is often not a viable solution. Involving disaster survivors in recovery activities not only aids regional recovery but also significantly helps victims cope with the trauma they have experienced [52] [53] [54] [55]. At the neighborhood level, there is a need for volunteers to support on-site solutions.

3.3 Temporary settlements in emergency assembly areas

In Turkey, the medium to high density of urban development, zoning plans that do not align with soil geology, construction activities that fail to adhere to regulations, and the presence of construction defects—even when regulations are met—render the built environment particularly susceptible to earthquakes. The large number of people affected by earthquakes presents a significant challenge that must be addressed, both by learning from past earthquake experiences and by conducting future risk analyses in the context of disaster management. It is highly probable that we will encounter a phenomenon similar to the population density affected by the Kahramanmaraş earthquakes in future seismic events. In this context, various public institutions and universities have conducted risk analyses regarding the anticipated impact of the Marmara earthquake on Turkey's largest city. The population density that will be affected has been frequently discussed. In the case of Istanbul, it is evident that temporary settlements following a disaster cannot be dispersed over a large area due to the limited open spaces in the city center, which has a high population density. In addition, post-disaster emergency transportation routes and evacuation corridors are being developed in collaboration with various public institutions as part of disaster management efforts. However, ensuring self-sufficiency and coordination in disaster-affected areas in the event of potential transportation restrictions is also a critical concern. Temporary settlements established after a disaster should be designed to utilize existing small open spaces within urban areas. Furthermore, previous earthquake experiences have shown that relocating earthquake victims from their neighborhoods can have detrimental socio-psychological effects [56][57][58][59]. When the prefabricated temporary settlements constructed outside the city center were dismantled, it became evident that the concrete used for ground leveling had resulted in significant environmental issues. Furthermore, based on the risk analyses conducted for Istanbul, transferring such a large number of people outside the city and establishing extensive temporary accommodation areas does not appear to be a feasible solution. The establishment of large-scale prefabricated settlements outside the city center may also lead to additional economic and environmental challenges.

4. Aim and Scope of the Study

The proposed model can be tested as a prototype for Istanbul. Solutions are sought at the neighborhood level due to the dense urban pattern, the limitations of large emergency assembly areas following an earthquake, and the relatively small size of existing open spaces. Emergency assembly areas are determined by local municipalities and the state emergency management agency (AFAD). Within the scope of this proposed project, suitable locations among these emergency assembly areas will be selected as case studies, and temporary settlements will be defined for these sites.

Table 1: The extensive impact of the proposed model

Category	Impact
Social / Cultural	>Finding solutions to post-disaster shelter needs >The utilization of existing materials, such as shipping containers, through conversion. >Supporting local production >Increasing the social awareness through volunteering activities >Contributing to on-site solutions for post-disaster social issues
Academic	>The potential for prototype production following the successful completion of the project >Providing public training to volunteers who will respond to disasters through public institutions and NGOs >Determining production bases by selecting pilot regions within organized industrial zones and testing the system
Economic	>It is essential not to rely solely on the manufacturing facilities and capacities of prefabricated building manufacturers for the production of temporary housing following a disaster. >The ability of different companies to produce kitchen, bathroom, door, window, etc. independently from one another. >Corporatization of temporary manufacturing facilities following a disaster: contributions to the local economy and employment
Homeland Security	>Preventing migration from regions experiencing economic recession following disasters and discouraging the evacuation of these areas. >Retaining skilled labor in the region >Addressing social issues directly within communities and mitigating the potential rise in crime rates through the establishment of neighborhood social networks

The number of individuals affected in the disaster risk analyses for the anticipated Marmara earthquake is significant enough to complicate search and rescue operations. Therefore, the application of a participatory production model for post-disaster temporary shelters aims to enhance social life during the recovery period. Upon the successful completion of a case study, the proposed model can be implemented in different provinces.

The aim of this study is to develop a research model for "post-disaster temporary shelter in high-density settlements utilizing the concept of a flying factory. Sufficient number of temporary shelter that aligns with the existing urban density like in Istanbul is not feasible. If it were designed to match the same density, this project would either evolve into a permanent housing initiative or be classified as an earthquake-prioritized urban regeneration project. In this context, the term temporary settlement non-single-storey, compact spaces within the city center that are intended to be utilized to their maximum capacity. The anticipated impacts of the project, if successfully implemented, are categorized as social/cultural, academic, economic, and homeland security [60]. Based on these impact categories, the extensive effects of the proposed model are illustrated in Table 1.

The scope of the model proposal can be summarized as follows: preparation of temporary settlement alternatives, creation of a structural design and assembly guide for shelters, definition of a temporary manufacturing facility, and development of a social network and volunteer management program. Following the preparation of the temporary settlement alternatives, the technical and organizational phases of the proposed model are illustrated in Figure 2.

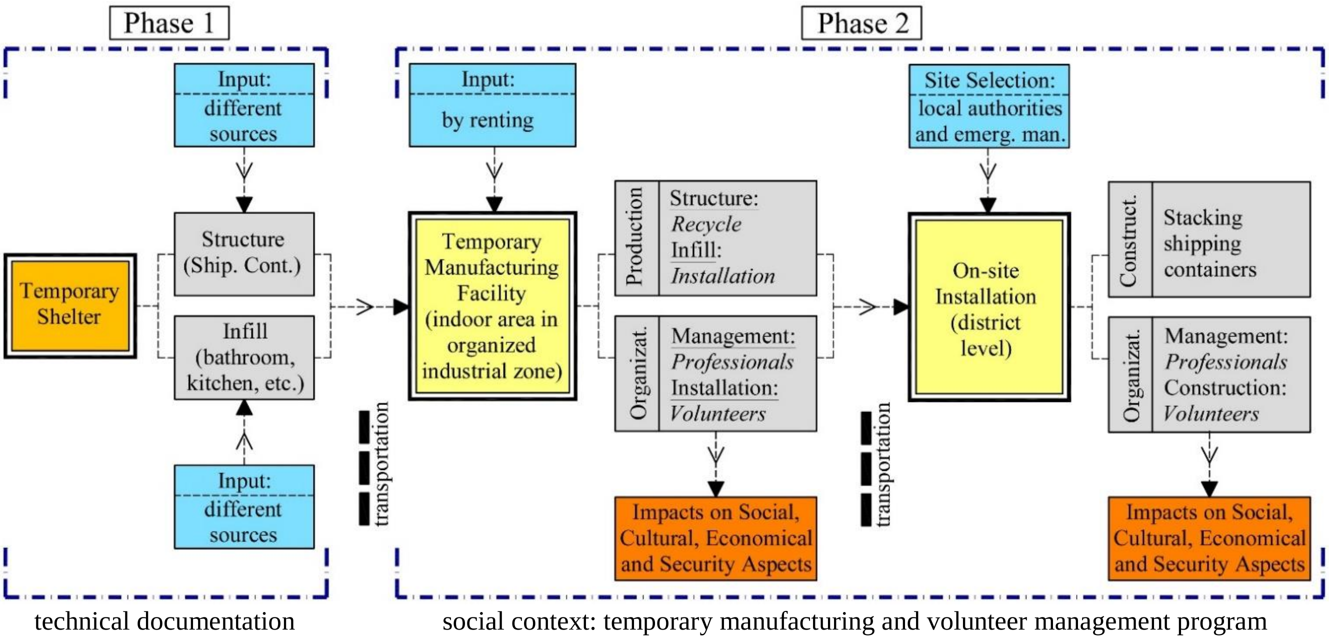

Figure 2: Technical and organizational phases of the proposed model

4.1 Temporary settlement and the structure

An existing shipping container will be converted into a shelter, with the dimensions of temporary shelters adhering to modular multiples of the container's specifications. Interior components, including doors, windows, bathrooms, and kitchens, will be manufactured separately. These components can be sourced from various suppliers in accordance with the established project procurement plan. Interior units can be assembled independently in a cellular form that fits inside a shipping container. This approach results in an assembly-intensive construction process on-site, rather than starting production from scratch. Individuals or organizations wishing to donate or support the production of temporary shelters can produce or procure these units, which have predefined dimensions and technical standards, and send them to on-site production centers, functioning as a flying factory. For instance, a kitchen unit or bathroom unit could be that rather than constructing a new structure, the focus is on rapidly transforming existing shipping containers by utilizing a production kit that follows a predefined work schedule.

It is anticipated that the proposed temporary settlement will be situated in high-density residential areas, with a structure manufactured in other production facilities and shipped to the designated regional manufacturing center.

This study targets the establishment of a temporary manufacturing facility at the local or regional level as a production model. It is proposed to create an appropriately sized indoor space within an organized industrial zone near the disaster area. In this temporary facility, local and regional manufacturing will take place, with professional and volunteer teams assembling the temporary shelters. In the following sections, these production facilities will be referred to as "temporary local manufacturing facilities”. A limited example of this production model was implemented after the Kahramanmaraş and Hatay earthquakes at the TÜYAP fair and exhibition hall in Beylikdüzü, Istanbul (see Table 2). Unlike the aforementioned example, this proposal suggests locating the manufacturing facility closer to the disaster area, with the expectation that it will enhance social life through volunteer involvement [61] [62] [63]. Additionally, a key distinction is comprising two or three stories due to the limited size of the emergency assembly areas. Consequently, the population of 30 units is expected to accommodate between 90 and 120 people. Based on this example, settlement alternatives will be developed according to increasing numbers in multiples. Examples of design features are presented in Table 3.

Table 2: Temporary manufacturing facility at TÜYAP fair and exhibition hall, Beylikdüzü, İstanbul [61] [62] [63]

Temporary Off-Site Manufacturing Phases for Core / Shell (Support) as Prefabrication			
a. structural frame (HSS hollow section) 	b. member connection 	c. exterior sheathing (OSB) 	d. interior finishing works 

Table 3: Samples of design features [64] [65] [66] [67] [68] [69] [70] [71] [72] [73]

Design features	
a. Urban context; - stacked structure - intricate design - different storey numbers	Housing / Dormitory / Commercial   
b. Building design; - small units like student dorm - optimum access to each unit by staircase	Housing / Dormitory    
c. Infill design; - modular kitchen pod - modular bathroom pod - doors & windows - MEP systems	Kitchen Pod / Bathroom Pod / Cabinets    

Although these samples pertain to permanent settlements, the design and construction management strategies outlined in this study provide methods for utilizing shipping containers as temporary shelters. Regarding infrastructure connections, the proposed project model will be integrated into the city's existing infrastructure network. Additionally, post-disaster infrastructure risk analyses previously conducted by the public sector will also be reviewed. Following this review, if deemed necessary, a study should be undertaken to assess self-sufficiency in an off-the-grid context.

Shipping containers are constructed from corten steel, which is highly resistant to weathering and corrosion. Additionally, the corrugated panels are welded to the frame, creating a sealed shell. For these reasons, internal insulation is often preferred. Typically, a secondary layer is formed using wooden or galvanized steel profiles on the interior wall surface, with the necessary thermal insulation applied between these frames. The second layer is finished with gypsum board on the inside.

4.2 Social networking; volunteer management program

This study proposes a model aimed at constructing a social network that supports disaster victims in maintaining their connection to their habitat. In this research proposal, the term refers specifically to disaster victims. The social network described here is fundamentally based on the participation of local individuals who are experiencing post-disaster trauma. As illustrated in Figure 2, the proposed model consists of two stages, and it is anticipated that the design process will be completed in advance. The social networking aspect highlighted in the second stage also emphasizes a participatory production model.

Efforts are being made to prevent earthquake-prone zones from becoming abandoned areas. A neighborhood-level solution will contribute to addressing regional security, workforce issues, and post-earthquake trauma. Prior to a disaster, public and relevant institutions should be informed about the temporary settlements to be established in predetermined areas for each neighborhood, as well as how these social networks will function. Each neighborhood is affected by disasters to varying degrees. The status of the evacuation corridors designed for neighborhoods impacted by the disaster should also be evaluated during this process. Therefore, in addition to constructing buildings in the proposed model, user prioritization can be implemented based on the victims' status affected by the disaster. Along with prioritization, a timeline may also need to be established. After a disaster, the daily transfer of first responders from the nearest suitable accommodation can result in them spending hours on the road. A temporary accommodation plan can be developed for these individuals, and the proposed model presented herein can also address their needs. Local volunteers, municipalities, the national emergency agency (AFAD), and NGOs are considered essential components of this social network. The organization of volunteers and professionals who will work at temporary local or regional manufacturing facilities and construction sites will be defined by a volunteer management program. This initiative particularly aims to prevent the qualified workforce from leaving the earthquake-affected areas.

The manufacturing facility" will help retain skilled labor in the disaster-affected area. The proposed social network lays the groundwork for transforming initial voluntary activities into professional endeavors over time, fostering a vision that will support the region's development following the disaster. The volunteer management program cycle has been extensively studied in social work, and valuable insights can be drawn from these experiences [74].

5. Execution Plan for the Proposed Model

In the project proposal aimed at developing a solution for post-disaster shelter, the project stakeholders will be identified. A due diligence study will be conducted to assess the locations where temporary settlements are planned to be established in high-density urban areas. Site selection will be analyzed, and the chosen sites will be evaluated based on criteria that include not only susceptibility to earthquakes but also risks related to flooding, wildfires, and transportation limitations.

Site evaluation will be followed by structural performance assessment. Since the temporary settlements will be designed as two or three stories rather than a single story, their structural performance against earthquake loads shall be assessed through simulation. Related risks, if any, will be identified. The execution plan for the model proposal is presented in Table 4, which corresponds to Phase 1 in Figure 2.

Table 4: Execution plan for pre-construction period by professionals / experts for Phase 1 depicted in Figure 2

Phases	Type	Notes
1. Project Stakeholders		
Public institutions and non-governmental organizations	O*	Definition of emergency assembly areas, scope of technical guide, boundary of social networking
University-led workshop		Establishment of a participatory production model, a temporary manufacturing facility operation plan, and integration strategies for production with the social network.
2. Design Process		
Design of temporary settlements	DE**	Determination of required land sizes, number of units and floors, and etc.
Design of temporary structure		Determination of sizes, storey usage characteristics, and other relevant factors.
Design of temporary infill		Determining the integration of kitchen, bathroom, and plumbing systems
3. Documentation		
Supply/shipping specification	DO***	Preparation of sanitary and transportation specifications for reusable containers
Production specification		Preparation of installation manuals defining production phases
Technical and social networking (volunteer management) guide		Establishing a comprehensive guide for preparation and training prior to a disaster, as well as for following established procedures in the aftermath.

* O=Organizational, ** DE=Design, *** DO=Documentation

After the proposed model is successfully implemented, a case study will be carried out in the chosen location. The technical documents to be produced (such as the user manual and volunteer management program) will be utilized in pre-disaster training conducted by public institutions and NGOs. Phase 1 of the pre-construction period is the primary focus of this execution plan, as Phase 2 is directly dependent on the work completed in Phase 1.

Conclusion

Following the recent earthquakes in Turkey, it has been determined that the demand for post-disaster temporary housing exceeds the production capacity of prefabricated structures. Temporary settlements located outside the city center present various challenges, highlighting a significant need for social connectivity. Based on these findings, the primary objective of the proposed model is to repurpose shipping containers to enhance the diversity of prefabricated housing options. This approach aims to enable facilities to address housing needs at the neighborhood level, rather than in peripheral areas, while also fostering a social network to support the aforementioned technical initiatives.

The article prepared for this research outlines a theoretical method for a project model. The primary objective of this research is to contribute to addressing the challenges associated with post-disaster shelter needs. The key steps to achieve this research goal, which encompasses both technical and social aspects, are illustrated in Figure 2 as follows:

- *Technical aspect:* A key objective is to develop a prototype that incorporates the features outlined in the article, utilizing a shipping container within an appropriate indoor facility to facilitate real-scale handling. Throughout the development of this prototype, it will be possible to create an application kit and engage in the process using the most realistic dimensions.

- *Social aspect:* Following the implementation kit, the content can be shared with relevant institutions and NGOs to achieve widespread impact. Another primary objective is to outline how to establish a participatory production model. In the context of defining social networking, it will be recognized as an academic platform for discussing the topic in various workshops and contributing to the post-disaster response plans of public authorities in Turkey.

In Table 4, an execution plan is proposed for Phase 1, as illustrated in Figure 2. Documentation for Phase 2 will be prepared during Phase 1. Cities located in earthquake-prone regions, particularly Istanbul, will be examined as case studies. Due to its dense population and limited emergency assembly areas in the city center, Istanbul faces challenges in establishing large-scale temporary settlements. The design for temporary settlements will focus on the emergency assembly areas identified as suitable. Unlike single-storey prefabricated temporary dwellings, the plan aims to maximize density within a limited area by incorporating two or three-story structures. It is anticipated that the production of "infill" elements, such as kitchens, bathrooms, doors, and windows, will be independent of the overall structure. The kitchen and bathroom are designed as separate modules, enabling manufacturers to produce these units independently and transport them to a temporary local manufacturing facility. In the context of a disaster, it is crucial to encourage local residents and disaster victims to engage in recovery activities, assisting them in overcoming the trauma they have experienced. Keeping them in their own environment will mitigate many sociological issues that may arise.

The proposed model has significant social, cultural, academic, economic, and national security implications. In addition to first aid and debris removal activities, residents of the region can also volunteer during the production phase. In this context, the establishment of a temporary manufacturing facility based-on the concept of flying factory falls within the scope of this project. This model, which is based on participatory production, is characterized as a social networking or volunteer management program in this study. Indoor spaces selected from organized industrial zones within or near the disaster area will be allocated or rented and used temporarily for structural production and transformation. This approach ensures that temporary shelters, supported by local and regional production, will not rely solely on existing prefabricated facilities in the construction industry, thereby eliminating dependency in production. The social networking initiative, designed to support the production phase, will also help prevent the evacuation of the region and mitigate potential domestic migration. Various public institutions and NGOs will participate in the shelter production process. Upon completion of the project, a user manual will be created to outline the work accomplished, along with a document that can be utilized in the aftermath of a disaster. This document will also serve as a resource for public institutions and NGOs for preparation and training purposes prior to a disaster. Following the successful completion of the model proposal as a technical document, a case study application will be implemented based on the selected location.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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