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IJAPAS

International Journal of Applied Arts Studies

IJAPAS 5(3) (2020) 41–52

Effective Parameters on Post-Disaster Temporary Housing Design in Rural Settlements

Farzaneh Hadafi[a], Alireza Fallahi[b]*, Seyed Gholamreza Islami[c]

[a]*Ph.D. in Architecture, Department of Architecture, Science and Research Branch,* ***Islamic Azad University****, Tehran, Iran*
[b]*Professor of Disaster Studies and Reconstruction Department, Faculty of Architecture and Urban Planning,Shahid Beheshti University, Tehran, Iran*
[c]*Professor of Architecture, School of Architecture, College of Fine Arts,* ***University of Tehran****, Tehran, Iran*

Received 30 November 2020; revised 04 December 2020; accepted 01 January 2021

Abstract

Provision of temporary housing for victims and survivors of a disaster is one of the most important issues in disaster management process. The purpose of this study was to identify the parameters affecting the post-disaster temporary housing design in rural settlements by reviewing the theoretical literature over previous experiences. Based on the findings, the effective parameters were: "Standards of dimensions and housing size with a minimum occupancy level"; "Durability and useful life of the proposed structure and details"; "Optimal construction costs such as components and materials"; "Structural strength"; "Ease of production and possibility of using prefabricated constructs"; "Possibility of building using vernacular-local details"; "Ease of transferability (size and weight)"; "Possibility of storage and maintenance in minimum space"; "Multiple applications and reusability"; "Simplicity and ease of installation, establishment, assembly, and repair"; "Familiarity of the local-vernacular people with the applied structural form"; " Possibility of using local-vernacular people in establishing the settlement"; "Adaptation to the local, social, and cultural characteristics of the context (providing a private environment)"; "Taking into account the physical condition and needs of special people (children, women, and injured people)"; "Flexibility in arrangement and location in different geological and environmental situations"; "Flexibility in lay-out and arrangement in indoor spaces according to the users' needs"; "Possibility of using local people to build and set up"; "Applying safety tips"; "Providing thermal comfort"; "Energy consumption"; and "Adaptation to the micro-climate conditions of the region".

* Corresponding author. Tel: +21-29902864.
E-mail address: alireza.fallahi@outlook.com.

This paper was extracted from the Ph.D. thesis of the first author, supervised by the second author, and advised by the third author. The thesis was entitled: Design Principles of Temporary Shelters after Earthquakes.

The findings of this study can be considered by experts, planners, and policy makers in the field of architectural design and temporary housing.

Keywords: Temporary Housing; Rural Settlement; Architectural Design; Crisis Management; Earthquake

1. Introduction

Natural disasters include unforeseen events that occur as a result of natural processes such as earthquakes, floods, glaciers, tornadoes, volcanoes, and droughts (Lahmian and Gholami, 2019). Among the natural hazards, numerous earthquakes occur in Iran, which is due to the location of Iranian plateau on the seismic belt of the Alpine-Himalayas and existence of numerous faults in this region. This indicates that this region is tectonically active and shows emergence of irreparable damages, especially in rural settlements (Nourizadeh et al., 2020; Zaheri et al., 2015). The frequency of destructive and catastrophic earthquakes in recent decades show that a strong earthquake occurs in Iran every four years on average, resulting in destruction of 97% of the rural units in the earthquake zone (Badri et al., 2019). Statistics of destructive earthquakes in the country show that rural buildings are highly vulnerable, so that not only severe earthquakes, but also weak earthquakes have a devastating effect on them (Golabchi and Taybat, 2007: 32).

Extensive earthquake damages to the environment and body of human settlements have turned temporary settlements to an important field of study in the realm of crisis management. Given that temporary housing of earthquake victims is highly essential (Jamalabadi et al., 2019), provision of temporary housing is one of the most important issues in the crisis management process (Fallahi et al., 2016). Therefore, one of the most important challenges in post-earthquake crisis management is temporary settlement of the victims (Bahadori et al., 2017). Post-earthquake temporary settlement has been studied for more than five decades in the world, but the conducted research mainly focused on the study of technical issues by related organizations and thinkers in this field (Félix, et al ., 2013; Narooyi and Aghaeizadeh, 2017).

The types of temporary housing vary from country to country according to various factors, such as the type of natural disasters, environmental conditions, and economic factors (Hong, 2017).

The global need for temporary housing is expected to increase due to the following factors: increased severity of natural disasters that result in a large number of displaced people; increased number of climate refugees as a result of the change in climate; and inability of developing countries to provide sufficient infrastructure in pace with their rapid population growth (Perrucci, et al., 2016).

One of the basic needs of victims of natural disasters is planning for their temporary settlement, which plays a decisive role in preserving and saving human lives and providing security in the early stages after an accident (Khorshidiyan, 2010). According to the accident literature, the purpose of temporary housing is to choose a suitable place and plan to create a healthy, safe, and relatively comfortable living space that meets the basic individual, family, and social needs. In general terms, temporary settlement is more than a four-walled house; in other words, it includes livelihood, cultural, and psychological dimensions (Fallahi, 2007).

Temporary settlement was studied comprehensively, not only as a physical product, but also as a process, ranging from emergency sheltering to permanent sheltering in various contexts (Fallahi, 2007). Despite the performed efforts, the existing experiences show that no significant progress has been made in providing temporary settlement or in particular, post-disaster settlement. Various

methods were employed of providing temporary settlement for victims of the recent natural disasters in Iran, but they were not effective in practice due to their lack of compliance with conditions of the disaster area. On the one hand, these solutions caused long-term problems and difficulties in the disaster area and on the other hand, they were a waste of financial resources (Khorshidiyan, 2010). The type, severity, and location of the disaster, conditions of the local community, ability of the community to cope with the accident, amount of damages and casualties, as well as local methods of housing and construction prior to the accident affect the type of settlement and housing (Fallahi and Zenian, 2017). Temporary settlement plays an important role in repairing the interrupted process of normal life in the field of economic and collective activities in the affected areas (Khorshidiyan, 2010). Temporary housing facilities, often referred to as shelters by authorities should provide: (1) protection from environmental hazards and harmful factors; (2) maintenance of properties and assets; as well as (3) privacy and emotional security (Barakat, 2003; Félix, et al., 2013; Jamalabadi et al., 2019; Li et al., 2017). Observance of gender considerations in programs reduces women's vulnerability during the crisis with regard to temporary housing. Consequently, the entire crisis-stricken society can use positive results of such programs (Saedi Khameneh and Hosseini, 2010). Settlement should provide the families with security, comfort, and a sense of belonging. So, in providing shelter for the injured, special attention should be paid to restoring their status and dignity (Fallahi, 2007).

The main problem is that in most cases, temporary housing is considered as a shaky, unstable, cheap, and perishable building. The plans proposed by the shelter designers failed since they presented their plans far away from the accident scene, without an appropriate understanding of the victims' basic needs, and with little awareness about the victims' the special social, cultural, economic, and livelihood needs (Fayazi and Alizamani, 2012). In this regard, one of the shortcomings is lack of an in-depth view towards the temporary housing phase by managers and executives in the field of crisis management. Since authorities consider temporary housing as a mere transitional stage, they do not take appropriate measures according to the victims' conditions and many weaknesses occur over time consequently (Hadafi and Fallahi, 2010; Hadafi et al., 2020). Therefore, our main question in this study was: What are the effective parameters in designing post-traumatic temporary housing in rural settlements?

2. Literature Review

Recent research addressed the criteria for designing temporary housing in various ways.

Sener and Alton (2009) examined the indicators of evaluating and designing temporary housing such as construction technology and materials, building structure, cost, aesthetics, ecology, spatial organization, and sociology (Sener and Alton, 2009).

Mottaki et al. (2019) studied the design pattern of temporary housing after a possible earthquake in Qom and listed the principles of temporary housing design as: public participation, cost, labor, users' needs of space and privacy, transportation, manufacture technology, materials, durability, aesthetics, characteristics of the affected population, storage, thermal comfort, duration of construction, and moisture resistance (Motaki et al., 2020).

Bemanian and Bakhtiari (2014) compared the capacities of the lightweight steel structures (LSF) system with the ICF for temporary housing in post-earthquake crisis conditions and reported the following features: high construction speed; low weight; low volume in pre-setup mode; easy storage conditions in warehouse; easy portability; low number of connections; simple implementation requiring little technical skill; possibility of expansion in the future; manageable

and implementable in various areas; prefabricated production; construction with available materials; and replaceability of parts (Bemanian and Bakhtirain, 2014).

Khorram et al. (2015) investigated temporary housing design criteria in earthquake (a case study of Khorasan Razavi) through a user-centered approach by assessing the users' needs. They noted the following characteristics in designing temporary housing: fast construction; easy connections; possibility to divide spaces with a modular design for different sizes of households; provision of restroom; appropriate materials; easy access to equipment using portable elements inside the settlement; provision of thermal comfort; consideration of microclimate, human dimensions, people with disabilities; maximum use of space; and low production cost (Khorram et al., 2015).

Tayarani Najjaran and Khorram (2016) designed a modular temporary shelter based on user-centered approach for survivors of natural disasters (earthquake). They reported the following criteria in designing temporary housing: comprehensible form and structure for the local people; rapid construction; production costs; uniform and mechanized connections; ease of construction; maximum use of interior space; consideration of local micro-climate; ability to divide and increase the space for minimum and maximum households; application of insulating materials suitable for temperature changes; consideration of the required facilities for each household to live (hypothetically) for one year; provision of private security; and attention to people with disabilities (Tayarani Najjaran and Khorram, 2016).

Seyed Sharafi and Hatami (2015) evaluated the feasibility of using LSF in temporary housing in the affected areas. These researchers introduced the features of a temporary settlement as the following: prefabricated production; easy maintenance and storage; social and cultural acceptability; implementable by the local people with low technical skills using the guides; ease of transfer; durability of materials; adaptation to weather conditions; thermal comfort; reusability; and provision of the required necessities to continue livelihood activities (Seyed Sharafi and Hatami, 2015).

Forghani and Darbandi (2015) addressed some important points in building temporary housing: providing quick access for the victims; using local resources and forces; paying attention to local living standards; being usable during the required length of time for temporary housing; having the possibility to relocate settlements and their parts after the end of temporary housing period; and being environmentally friendly (Forghani and Darbandi, 2015).

Fallahi (2007) noted that the designed temporary housing should be: easily portable; protective of residents against climate / weather conditions; established easily by local people and victims; made by high-quality and durable materials; constructed by recyclable materials; private and protective of residents; responsive to various activities and functions; expandable; and economic (Fallahi, 2007).

Lindell et al. (2007) investigated the physical and structural characteristics of temporary housing and reported the following features: low weight and volume in storage; high speed in construction; easy to set up; low number and variety of connections; expandability in the future; possibility of replacing and changing parts; as well as application of prefabricated and simple connections (Lindell et al., 2007).

Bahrainy and Akhoundi (2000) listed the characteristics of temporary settlements from the victims' viewpoints: protecting victims from heat, cold, wind, and rain; storing and preserving furniture; establishing and maintaining the house boundaries (ownership and right of possession); providing psychological security and private environment; providing access to the workplace (Bahrainy and Akhoundi,2000).

Sartipipour (2011) presented the idea of architecture with paper materials for designing and implementing temporary housing. Their features included: protection of residents from the changing conditions of the natural environment such as heat, cold, wind; fast portability and start-up; applicability in different situations; use of appropriate structures; ease of production; ease of installation and simple execution details; as well as harmonization with the environment and climate (Sartipipour, 2011).

Asefi and Farrokhi (2018) introduced the indicators of temporary housing evaluation as: provision of security; preservation of human dignity and privacy; easy participation; environmental perception; appropriate body and form; consideration of health issues; provision of justice; architecture and design; facilities and energy; easy maintenance, installation, and establishment; consideration of technical and structural standards; as well as application of vernacular resources (Asefi and Farrokhi, 2018).

Johnson (2007) also examined the components of temporary housing and reported that they should: have low price and fast construction; provide easy and non-polluting removal; and be in line with the victims' culture; reusable; and in compliance with the standards (Johnson, 2007).

Momeni and Zeinali (2018) proposed constructing temporary housing by palm tree branches in accordance with the characteristics of Balochistan landscape. The mentioned features were: use of available materials; establishment by the local people and women; cheap price; establishment with no cost; adaptation to the climatic conditions of the region; high speed of establishment; possibility to establish in less than a week; establishment in specific dimensions and sizes; establishment in various sizes; application of vernacular materials; reusability in establishment of permanent houses; familiar with people; current application in everyday life of local people; environment friendly; portability; respect for the family privacy; possibility of cooking; possibility of residence; maintenance of agricultural products; applicability as warehouse for storage of equipment; lightweight structure; and possibility of improving its durability by suitable materials (Momeni and Zeinali, 2018).

Nikravanfard (2007) referred to the criteria for designing temporary housing and mentioned the following factors: having a special identity in terms of general, technical, and functional characteristics; considering different areas tailored to the needs of users; using prefabricated, light-weight, durable, and stable constructs; using the existing and vernacular materials; being established easily by people with low skills and women; and considering the factors affecting thermal comfort.

A review of literature shows that studies conducted in this area investigated the dimensions of temporary housing in rural or urban areas in details. However, no study has ever identified and introduced the effective parameters in designing post-traumatic temporary housing in rural settlements comprehensively. Accordingly, this research reviewed and analyzed previous studies to identify and introduce these parameters. In this regard, we searched the valid scientific databases to identify the related sources of information. Later, these sources were screened in accordance with the study objectives and finally, effective parameters were extracted and introduced for designing temporary housing.

3. Theoretical Concepts

3.1. Temporary Housing

Housing is one of the basic human needs. Given that permanent settlements are damaged followed by accidents and natural disasters and construction of settlements for the victims requires

a lot of time and money, the issue of temporary housing is of great importance (Givechi et al., 2013). Temporary settlements are necessary when the victims of an accident are not able to return to their houses; i.e., where they lived before the accident (AbdulAlipour, 2017). Temporary housing is defined as providing a shelter according to the victims' basic needs, living needs, and psychological comfort in order to maintain their human dignity within the family and social system in difficult circumstances (Fallahi, 2007). The duration of temporary settlement may vary from a few days to two years, depending on the circumstances, the type of crisis, and the required facilities (Forghani and Darbandi, 2015). Findings show that features such as low cost, appropriateness to climatic conditions of the region, application of vernacular materials, and victims' participation affect desirability of the temporary housing process (AbdulAlipour, 2017). Depending on the extent of the accident, climatic conditions, and duration of reconstruction, temporary housing can be observed as a step in the reconstruction process (Bashiri and Bemanian, 2020).

In order to provide the necessary facilities and the possibility of designing apropriate settlements in the temporary housing phase, case studies conducted over temporary housing should be investigated. The aim is to obtain the necessary characteristics, strengths and weaknesses, as well as application of these settlements in new designs (Asefi and Farokhi, 2016). Experiences of previous earthquakes in Iran indicated a lack of a comprehensive housing program based on the spatial capacities of the affected community (Danaeinia and Zaghiyan, 2019). In a study, the main tasks of temporary housing was determined from the viewpoints of victims or those who experienced accidents: protecting against heat, cold, wind, and rain; storing furniture and preserving what survived the disaster; establishing and maintaining the boundaries of the house (ownership and right of possession); creating initial conditions for the next operations (transferring the properties, reconstruction of the building, as well as reorganization of the social organization); creating psychological security and private security; determining a specific address for receiving services (medical services, food); accommodating people where they can have access their work environment; and providing housing for families who evacuated their homes due to the fear of further accident damages (Omidvar et al.,2007; Bahrainy and Akhoundi,2000). However, we should acknowledge that temporary housing is not a fixed or identical issue and is fraught with differences.

Some believe that temporary housing is the interface between emergency sheltering and permanent reconstruction. In this vein, temporary housing is considered as a connection chain between initial stages of accident management and permanent reconstruction. Proponents of this idea do not consider the nature of temporary housing as a separate stage. Some other people believe that temporary housing is a separate stage that should be considered separately. In this regard, temporary housing plays a vital role after an accident and should be improved as a system in itself and as a part of a larger system to deal with the accidents. On the one hand, temporary housing provides reconstruction planners and managers with the opportunity to make decisions and plans more easily and effectively. On the other hand, it ensures the people's safety in temporary housing. Based on the Article 25 of the Universal Declaration of Human Rights, adequate housing is the right of everyone. With the occurrence of destructive natural disasters and in post-traumatic crisis situations, the society functions and social institutions are disrupted in a certain period of time. Moreover, the victims are deprived of the right of proper housing. Due to the prolonged construction of housing, this right should be preserved for the victims in terms of temporary housing (Asefi and Farrokhi, 2016; Omidvar et al., 2007; Mohammadzadeh and Farrokhi, 2016; Johnson, 2007).

3.2. Temporary Housing Design Approaches

The three main approaches to temporary housing design are: "design-based" and considering technical aspects; "material-based"; and "public-based", which are described in the following (Fayazi and Alizamani, 2012; Fallahi, 2007; Motaki et al., 2020):

"Design-based" approach mainly focuses on technical aspects of housing. For example, the methods of designing and building a unit at the scene of an accident or in the factory and moving it to the accident area are among the issues of interest. Temporary houses in this approach constitute a wide range of pre-fabricated and post-fabricated items that are very diverse in terms of materials including tents, foam and polyurethane, concrete, wood, sandwich panels, and metal. In a special project by the United Nations Development Program for the structural aspects of temporary housing, this approach was divided into physical categories of "unit", "tent", and "plate".

"Materials-based": the main focus of this approach is on temporary housing. In recent years, much attention was paid to the type of building materials in constructing temporary settlements. In this regard, the emphasis is on applying local materials and recycling. However, discrepancies exist considering the advantages and disadvantages of using these materials in the long run as well as their effects on the natural ecology in the developing and developed countries.

"Public-based" approach takes into account people's satisfaction with the evaluation of temporary and permanent housing in terms of functionality and architecture. Moreover, the changes made over time by the household to turn this temporary settlement into a home are another available approach in the literature with regard to disasters. Although the nature of this approach is different from the two previous approaches, the criteria of changes made in similar previous disasters with regard to temporary housing are the basis for its application in the subsequent accidents.

3.3. Temporary Housing in Terms of Layout

Different views exist on the layout of temporary housing, which can be investigated under three approaches (Sabt et al., 2006; Fayazi and Alizamani, 2012; Hadafi et al., 2020; Hadafi, 2013; Sajedi et al., 2018):

Scattered approach: In this method, affected people are provided with temporary settlements based on some considerations, so that they can install these settlements in any suitable situation as they prefer according to their desire.

Integrated or camp approach: Although this approach is considered as the most common and perhaps the simplest method in setting up temporary settlements after accidents, it is simultaneously faced with the most environmental, economic, social, and security problems. In fact, area near the accident site is leveled and prepared for setting up tents and prefabricated structures as temporary housing for the injured. In this method, factors such as demographic conditions, duration of residence, climatic conditions, available resources, and accessible budget are considered in making decisions about implementation of the camp. Davis studied shelter after the accidents and found that survivors of disasters preferred to set up temporary settlements near their destroyed house. Examples of this method can be observed after Rudbar earthquake in 1990 and Bam earthquake in 2003.

Combined approach: In this method, we assume that survivors of the accident are aware of their temporary housing based on a specific plan. In this method, temporary housing is located next to the survivors' house, so that they can be near their destroyed house and use the facilities of life as a whole.

3.4. Types of Post-Crisis Housing

Different categories were presented based on various aspects with regard to the post-crisis settlement stages. For example, Quarantelli (1982) proposed four distinct types of post-crisis housing based on the case study documents from three different areas at the US Crisis Research Center. The typology included:

- Emergency sheltering: refers to a type of settlement in which survivors choose a place near their permanent residence for a short period of time; i.e. from a few hours to a maximum of one night;
- Temporary sheltering: is defined as a type of housing that survivors choose to reside temporarily for a short time based on their expectations;
- Temporary housing: does not easily meet the expected minimum of housing, but can still meet the daily activities and responsibilities of households;
- Permanent housing: causes the survivors to return to renovated or new homes and provides permanent housing for victims (Quarantelli, 1995).

Generally, emergency, temporary, and permanent housing stages were experienced in the post-crisis literature, which are explained in the following (Mosayebzadeh et al., 2017; Sajedi et al., 2018; Jasmpour, 2012: 12; Saedi Khameneh and Hosseini, 2010; Nigg, et al., 2006: 120; Bolin, 1993; Lindell, 2013; Behzadfar, 2005: 27):

Emergency housing: Immediately after the crisis, the need is felt for rapid settlement of the victims. This type of housing is established to protect survivors and victims from the bad weather conditions such as heat, wind, and rain. Settlement in this phase does not have high standards and the means of settlement usually include tents and vernacular materials. The duration of settlement at this stage is less than one month and may be less than 72 hours depending on the type of crisis.

Temporary housing: Few days after the crisis and prior to the provision of permanent housing, the living standards are low in the emergency housing phase. So, temporary housing tries to improve the living conditions of victims. In this type of housing, all necessary measures are taken, including collection and identification of distressed and homeless victims, transfer of people to housing centers, and creation of safe and healthy living conditions until they can return to their original places of residence. The duration of temporary housing may last from six months to two years, depending on the circumstances, type of crisis, and required facilities.

Permanent housing: At this stage, permanent settlements are provided for the people, so that they can return to their normal and daily life.

In Iran, a lot of discrepancies exist regarding the existence or non-existence of temporary housing as an intermediate stage between emergency housing and permanent housing (Momeni mokoee and Zeinali, 2018). In fact, the concept of temporary housing is a combination of the three types of housing mentioned above, since it includes both physical and non-physical aspects of post-traumatic shelter and residence. Therefore, temporary housing can be considered as a set of activities, including collecting and identifying the distressed and homeless victims, transferring people to a housing center, and creating living conditions until they can return to their original houses. The duration of temporary housing can range from 6 months to 2 years depending on the conditions, the type of crisis, and the required facilities. Some researchers and relief organizations consider this type of housing as the core of permanent housing (Hadafi, 2013; Fallahi, 2007).

4. Results and Suggestions

The aim of this study was to identify the effective parameters in designing temporary housing in the rural settlements and to explain a comprehensive structure for evaluating these settlements. Examination of the theoretical and experimental literature in the field of evaluating and designing temporary housing indicated that it is a multidimensional problem based on temporal and spatial situations. Based on the findings of this study, 21 effective parameters were found in designing temporary housing in rural areas: Standards of dimensions and housing size with a minimum occupancy level, such as a modular spaces; Durability and useful life of the proposed structures and details; Optimal construction costs such as components and materials; Structural strength; Ease of production and possibility of using prefabricated constructs; Possibility of building using local-vernacular details; Ease of transferability (size and weight); Possibility of storage and maintenance in minimum space; Multiple applications and reusability; Simplicity and ease of installation, establishment, assembly, and repair; Familiarity of the local-vernacular people with the applied structural form; Possibility of using local-vernacular people in establishing the settlement; Adaptation to the social and cultural characteristics of the context (providing a private environment); Considering the physical condition and needs of special people (children, women, and people with disabilities); Flexibility in arrangement and location in different geological and environmental situations; Flexibility in lay-out and arrangement in indoor spaces according to the needs of users; Possibility of using local people to build and set up; Applying safety tips; Providing thermal comfort; Energy consumption; and Adaptation to the micro-climatic conditions of the region. Since temporary housing is a multifaceted and complex process that requires comprehensive and dynamic attention, the following suggestions are proposed in line with these two approaches:

- Codifying experiences of the affected villagers with regard to living in the temporary housing phase;
- Presenting descriptive reports on the nature and differences of temporary housing in rural settlements with urban settlements;
- Developing specific instructions and standards for designing and constructing temporary housing units in rural areas;
- Developing temporary housing programs based on spatial capacities according to previous experiences;
- Explaining intervention methods based on technical and social dimensions;
- Holding competitions for designing temporary rural housing in order to produce and expand conceptual ideas with collaboration of architectural and industrial designers;
- Providing the ground for interaction and cooperation of architectural, landscape, industrial, and environmental designers with manufacturers and builders of units by trustees and decision makers regarding the design of temporary housing based on the needs.

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