Research Paper: Explaining the Conceptual Model of the Post-Disaster Sustainable Temporary Housing System (Case Study: Sar-e-Pol Zahab)

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Citation: Javanforouzande, A., Asgari Namin, E., Asefi, M., & Shakeri, K. (2020). Explaining the Conceptual Model of the Post-Disaster Sustainable Temporary Housing System (Case Study: Sar-e-Pol Zahab). *Journal of Sustainable Rural Development, 4*(2), 185-200. https://doi.org/10.29252/jsrd.01.02.101

doi: https://doi.org/10.29252/jsrd.01.02.101

Article info:
Received: 04 July 2019
Accepted: 09 Feb. 2020

Keywords:
Post-disaster temporary Housing, Cultural Inadequacies, Sustainability, Resilience, Vulnerability

ABSTRACT

Purpose: The present study aims to identify the main problems of temporary accommodation strategies and discuss some principles and guidelines in order to assist decision-makers in choosing the most suitable strategy and reach better sustainable temporary housing solutions.

Methods: Through a qualitative and applied approach, the present research was conducted using descriptive-analytical method. Documentary and library methods were used to collect data, and the case study was analyzed in order to discuss the main sustainability issues regarding temporary housing. In this study, the main focus is on providing a qualitative sustainable conceptual model as a platform for decision-makers in crisis situations.

Results: It is only by applying the system to every region according to its local data before a disaster, determining the activity steps needed to be done before a disaster, at the time of disaster and post-disaster and developing a sustainable temporary housing approach that we will be able to house the victims in healthy and comfortable environments in a progressive way with the productive usage of the country's resources and will be ready to protect people against the disasters.

Conclusion: Lack of a sustainable strategy prevents community resilience and disaster preparedness. At present, the post-disaster housing approach cannot meet the cultural, social, economic and ecological needs of the victims.

1. Introduction

An average of 22.5 million people have lost their homes due to disasters related to climate or weather each year since 2008. Moreover, this trend is expected to magnify in the future based on the increment of weather-related events and population vulnerability (Yonetani, 2014). Therefore, all areas prone to natural disasters need to have a resilience program for dealing with the displaced people's (DP's) accommodation, not only in

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terms of items of provision but also with regard to the impacts of large-scale temporary housing for the years to come.

Temporary housing, which should supply security and safety against climate, disease, and other possible dangers (Collins et al., 2010; Davis, 1978; Félix et al., 2013), has considerable economic, social, and environmental negative impacts (Alexander, 2010; Barakat, 2003; Chandler et al., 2007; El-Anwar et al., 2009a; Hadafi & Fallahi, 2010; Johnson, 2002; Wei et al., 2012). The temporary housing phase as one of the four organizing phases mentioned by Quarantelli (1995), i.e. (1) emergency shelter, (2) temporary shelter, (3) temporary housing (TH), and (4) permanent housing, cannot be concealed or canceled. Additionally, as this issue affects multiple stakeholders with different and at times opposing requirements, the selected strategy cannot completely satisfy all the beneficiaries.

Temporary housing, which can be started a few weeks after the disaster and be completed within a couple of years, is applied to provide secure and safe conditions for the victims (Collins et al., 2010; Davis, 1978).

TH is often criticized in terms of the stakeholders' satisfaction. In general, according to Barakat (2003); Chandler et al. (2007); El-Anwar et al. (2009a); Hadafi and Fallahi (2010); Johnson (2002); and Wei et al. (2012), the problems of TH can be categorized into economic, social, and environmental aspects; in other words, the sustainability concept. The undesirable outcomes of most previous recovery programs reported by the researchers have been: (1) long delivery time, (2) cultural contradictions, (3) large public expenditure, (4) consumption of investment and resources assigned to permanent buildings, (5) delay on permanent building delivery, (6) inappropriate second life, (7) environmental pollution, (9) multiple changes of strategy, and (10) top-down approaches.

The problems can worsen when an initial chosen strategy is changed by decision-makers in order to select a more suitable one. However, the new recovery strategy can lead to DP's higher satisfaction compared to the previous ones, but the process of changing strategies can be time, cost, and energy-consuming. These situations demonstrate that the decision-makers could have chosen the most suitable strategies from the beginning and by doing so, reduced the negative impacts, if they had been aware of the outcomes. There are three stages in the current approach to post-disaster:

- Emergency Relief Stage
- Rehabilitation Stage
- Reconstruction Stage

However, there are no specific and decisive strategies for all these stages. This lack of strategies prevents being prepared for disasters. The current post-disaster housing approach cannot provide the needs of victims progressively, urgently, economically and ecologically. In the present approach, each of these is viewed as an isolated issue. Rather than a piecemeal approach, a view of the whole is needed. Therefore, this paper aims to achieve the following objectives:

- To tackle the problem with the systems approach before the disasters in order to keep all serving disciplines and related components under control and be ready for the post-disaster housing.
- To come up with a solution equipped with sustainability principles in order to solve the housing problem ecologically, progressively, urgently, and economically.

Thus, the objective of this paper is to present a strategy for TH to reduce negative impacts by considering concepts of sustainability and stakeholders' satisfaction. In other words, this study aims to assist decision-makers in choosing the most suitable strategy, which will lead to beneficiaries' higher satisfaction by considering local conditions, and therefore lead to the minimum negative effects compared to other alternative strategies.

2. Literature Review

Although the trends of publications on disaster research are increasing, the number of published studies in academic journals related to post-disaster housing (PDH) is still not representative. For instance, according to Yi and Yang (2014), the paper by Kennedy et al. (2008) entitled "The Meaning of 'Build Back Better': Evidence from Post-Tsunami Aceh and Sri Lanka" was cited thirty four times in 2014 (Yi & Yang 2014). This increasing citation trend could also confirm the considerable amount of publications related to PDH (Yi & Yang, 2014).

Still, despite the relevance of the subject, the research conducted in this area is not enough representative. Table 1 summarizes the research on the sustainability of post-disaster temporary housing.

3. Methodology

Through a qualitative approach, this research uses a literature review to discuss the main sustainability issues regarding temporary housing for post-disaster reconstruction. The present research was conducted using descriptive-analytical method. By analyzing a case study and theoretical studies, this research discusses the role of sustainable post-disaster temporary housing and tries to identify the common patterns, namely the strategies and solutions that have and have not succeeded. Then, these findings are used to develop guidelines and strategies for decision-makers to support and improve the development of sustainability in post-disaster temporary housing.

Table 1. Studies in the area of PDH sustainability

Author	Paper title	Journal title
Berke et al., 1993	Recovery after Disaster: Achieving Sustainable Development, Mitigation and Equity	Disasters
El-Masri & Tipple, 2002	Natural disaster, mitigation and sustainability: the case of developing countries	International Planning Studies
Shaw & Goda, 2004	From Disaster to Sustainable Civil Society: The Kobe Experience	Disasters
Alexander et al., 2006	Sustainable livelihood considerations for disaster risk management: Implications for implementation of the Government of Indonesia tsunami recovery plan	Disaster Prevention and Management
Chandler et al., 2007	Environmental factors influencing the sitting of temporary housing in Orleans Parish	LSU Master's Theses
Limoncu & Çelebioğlu, 2006	Post-Disaster Sustainable Housing System in Turkey.	Third International Conference / Post Disaster Reconstruction (Florence, Italy),
Kennedy et al., 2008	The meaning of 'build back better': Evidence From post-tsunami Aceh and Sri Lanka	Contingencies and Crisis Management
El-Anwar et al., 2009	Optimizing large-scale temporary housing arrangements after natural disasters	Computing in Civil Engineering
Chen et al., 2013	The temporal hierarchy of shelters: a hierarchical location model for earthquake-shelter planning	International Journal of Geographical Information Science
Félix et al., 2013	Guidelines to improve sustainability and cultural integration of temporary housing units	i-Rec conference
Yi & Yang, 2014	Research trends of post-disaster reconstruction: The past and the future.	Habitat International
Afify et al., 2016	Temporary Houses from Emergency to Sustainability	Proceedings of International Conference
Atmaca & Atmac, 2016	Comparative life cycle energy and cost analysis of post-disaster temporary housings	Applied Energy
Hosseini et al., 2016a	Multi-criteria decision-making method for assessing the sustainability of post-disaster temporary housing unit's technologies: A case study in Bam, 2003	Sustainable Cities and Society
Asefi & Farrokhi, 2017	Proposing a Model for the Design of Post-Disaster Temporary Housing Based on the Needs of the Injured with Post-Implementation Evaluation Approach (Case Study: Earthquake-Stricken Villages in Heris of East Azerbaijan)	Journal of Research and Rural Planning.
Celik, 2017	A cause and effect relationship model for the location of temporary shelters	International Journal of Disaster Risk Reduction.
Walker & Crawford, 2017	Cash in a housing context: Transitional shelter and recovery in Japan. Reduction	Journal of Disaster Risk
Wagemann, 2017	Need for adaptation: the transformation of temporary houses	Disasters
Peacock et al., 2018	Post-Disaster Sheltering, Temporary Housing and Permanent Housing Recovery	In Handbook of Disaster Research. Springer
Sphere Association, 2018	Humanitarian Charter and Minimum Standards in Humanitarian Response	The Sphere Handbook. Geneva, Switzerland.
Yu & Bai, 2018	Research on Modularization and Sustainable Design of Temporary Housing.	Art and Design Review
Askar et al., 2019	From Temporary to Permanent; A Circular Approach for Post-disaster Housing Reconstruction	In IOP Conference Series: Earth and Environmental Science.
Biswas, 2019	Exploring Indian post-disaster temporary housing strategy through a comparative review	International Journal of Disaster Resilience in the Built Environment,
Perrucci & Baroud, 2020	A Review of Temporary Housing Management Modeling: Trends in Design Strategies, Optimization Models, and Decision-Making Methods	Sustainability

Source: Research findings, 2020

Post-disaster housing phases

According to Johnson et al. (2006) and Quarantelli (1995), the post-disaster housing phases are in general as follow: (1) emergency shelter (within hours), (2) temporary shelter (within days), (3) temporary housing (TH) (within weeks), and (4) permanent housing (within years). Quarantelli (1995) makes a distinction between sheltering and housing. While sheltering refers to a place to stay during the aftermath of the disaster suspending daily activities, housing immediately denotes the return to household responsibilities and daily routine (Johnson, 2002). In addition to the four terms presented above, Johnson (2002) proposes the term temporary accommodation referring to all different types of temporary lodging commonly used after disasters until the relocation in a permanent house. Therefore, temporary accommodation includes all the solutions used during the emergency shelter, temporary shelter, and temporary housing stages, see Figure 1.

Temporary housing

To bridge the time gap between the emergency phase and permanent housing, the TH phase is required despite the fact that the investment in TH has been questioned by most experts (Johnson, 2009). However, this stage is unavoidable and cannot be concealed because DP (displaced people) need somewhere to live during the permanent housing construction process.

Two main groups of temporary housing solutions can be identified (Félix et al., 2013a):

a) Ready-made units, which are totally manufactured in the factory, and then transported to their future place, which may require a few simple assembly works on site

b) Kit supplies, which consist of the provision of all the elements that constitute the building to be totally assembled on the site

As most types of temporary housing units (THUs) are constructed after disasters in a short period of time and in large quantities, THUs do not meet common needs of beneficiaries.

THUs have been criticized for their incapability to meet the expectations of DP (Chen et al., 2013). This criticism stems from various reasons, including:

• The TH late delivery (Abulnour, 2014; Johnson 2007a).

• Failure to fulfill the social, psychological, and economic needs of displaced families (Johnson, 2007a; Marcillia & Ohno 2012).

• Poor TH locations (Chen et al., 2013; El-Anwar et al., 2009a; Kelly, 2010).

• High cost of TH process (El-Anwar et al., 2009b; Félix et a., 2013; Johnson, 2002, 2007a).

• Shortage optimization and analyzing models (El-Anwar et al., 2009a; Chen et al., 2013).

• Negative impact on the environment (Arslan, 2007; Arsalan & Cosgun, 2007; Chandler et al., 2007; Félix et al., 2013).

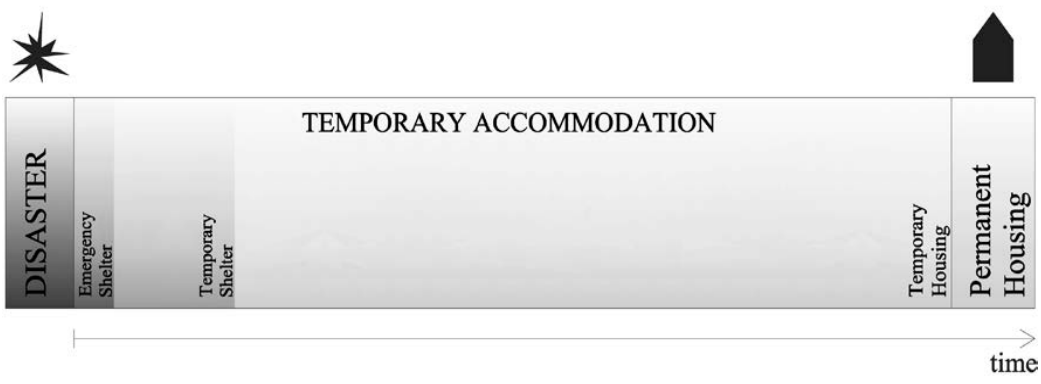

Figure 1. Temporary accommodation phases during reconstruction programs (Félix et al., 2015)

In general, researchers state that using THUs should be avoided because of the negative impacts associated with this technology. Meanwhile, analysis of previous recovery programs shows that THUs have been applied in the vast majority of situations. This confirms that there are still no suitable alternatives for replacing THUs. Therefore, this technology must be accepted and assessed in order to determine in detail the related problems to minimize negative effects. To this end, although negative impacts of THUs should not be disregarded, the disadvantages of these units should be mitigated to obtain more sustainable solutions.

Sustainability of post-disaster housing

The sustainability of post-disaster housing (PDH) has been defined in different ways by researchers. Sustainable construction embraces economic, social, and environmental aspects that are required to be considered from planning to monitoring phase. In this regard, Hayles (2010) stated that the sustainability concept changes the focus on medium to long-term process; thus, all process involved in a recovery program should fit the requirements of DP in order to achieve sustainability. Also considered these three main vertices of sustainability as the differences between conventional and sustainable constructions.

In general, it could be affirmed that sustainability is achieved from the optimized integration of these three vertexes (economic, social, and environmental). To obtain suitable outcomes, each particular case should be decoupled in two aspects: (1) how to achieve maximum satisfaction in each indicator considered, and (2) optimize the stakeholders' satisfaction in relation to these three vertices.

Almost all studies related to the PDH issues have been conducted to address the suitable responses for the first aspect. However, few studies have considered all related factors and interconnections; in other words, integration of these three vertices. Indeed, previous researches normally embraced few indicators among those relevant, although assessing sustainability is necessary to maximize the satisfaction of the great majority of the indicators.

Additionally, a problem with both approaches is different characteristics of diverse areas, since (1) no global sustainability measure exists sustainably, and (2) these could completely vary according to the diversity of features, requirements, limitations, potentials, and properties.

To this end, in order to guarantee the sustainability of PDH, it is essential to apply models able to handle both stages. These approaches should have enough adaptability for dealing with limitations, such as diversity of local requirements; in other words, customizable and flexible models are necessary.

Sustainability indexes of temporary housing

According to Da Silva (2010), Hayles (2010), and Limoncu and Celebioglu (2006), the following factors must be considered during the sustainable post-disaster temporary housing management in order to guarantee sustainability:

(1) suitable housing, (2) community participation, (3) neighborhoods, (4) culture acceptance, (5) local resources (organized into hard and soft by Lizarralde et al. (2009)), (6) fitting climate conditions, and so on.

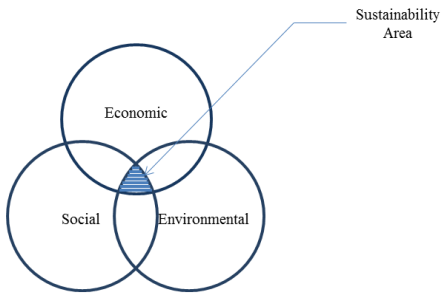

Figure 2. Main requirements of PDH sustainability

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Therefore, it could be concluded that sustainable PDH is a process that meets optimized integration of three main vetices of sustainability concept (see Figure 2): (1) minimizing economic, (2) maximizing social, and (3) minimizing environmental impacts, based on local conditions.

These requirements embrace other specific indicators and sub-indicators for PDH. They can be organized as presented in Table 2. These aspects should be consdiered to achieve a high satisfaction level of all stakeholders. However, as local conditions and scales vary from an area to another area (United Nations Disaster Relief Organization (UNDRO), 1982), previous recovery programs should be adjusted to each new case.

These defined factors must be considered during the whole life cycle of buildings, including planning, construction/provision, operation, and second life. The op-

eration phase of PDH is often assumed to be five years (Johnson, 2007a). Thus, it is necessary to assess all factors from planning to reusability or demolition of the first phase to the second life.

Case study

Sar-e-Pol Zahab earthquake with the magnitude of 7.3 occurred at 21:48 pm local time on November 11, 2017, near Azgaleh city in Kermanshah province in northwestern Iran. The earthquake destroyed large parts of Sar-e Pul Zahab city and many cities and villages of Kermanshah province. At least eight cities were affected by the earthquake in Sar-e Pol, Zahab (Qasr-e Shirin, Azgaleh, Salas Babajani, Gilan-e Gharb, Sar-e Poltabah, Dalahoo, Islamabad West and Javanrood) and 1933 villages were damaged. According to forensic statistics as of 18 December 2017, over 579 people were killed in the earthquake and thousands were injured (International Institute of Earthquake Engineering and Seismology, 2017).

Provision of temporary accommodation

Due to the destruction of most public buildings in affected areas, especially schools, it was not possible to use these places for the temporary accommodation of earthquake survivors. As a result, the government's main program provided 15,000 container houses, for the quake-hit areas. In addition, people, donors and celebrities took action to provide shelters for the affected areas. There are various ways to provide container houses; in some cases, prefabricated parts are shipped and assembled in the workshop and then transported (Figure 3). Also in some cases, prefabricated shelters are sent to the area in a relatively complete form by truck or trailer and then they are installed. There were major challenges in providing temporary housing for survivors, some of which are as follows:

Problems Related to Infrastructure Requirements

One of the problems related to the camps and temporary shelters was water supply needed for drinking, sanitation, and health issues, as well as electricity supply and phone access.

Thus, it was necessary to prepare and install them before the camps were set up. Water pipelines, electricity and telecommunication equipment, as well as sewage disposal facilities were also considered.

Table 2. Sustainability indexes of temporary housing

Main Index	Main Indicator	Definition	Reference
Ec.	Provision cost	Considers all expenditures that are required for providing TH (e.g. renting, land price, construction cost, material cost, and utility cost)	Häkkinen et al., 2012
	Maintenance cost	Takes into account activity and material cost during and after DP usage	Hosseini et al., 2016a,b
S.	Health	Presents mental and physical factors of those involved in TH program and includes security, risk resistance, water and sanitation, infrastructures, and communications	Da Silva, 2010; Häkkinen et al., 2012
	Well-being	Embraces all those elements that provide comfort for DP: TH delivery time, access, facilities, privacy, climate comfort conditions, participation, etc. Additionally, this indicator embraces the well-being of third parties, such as neighbor acceptance	Da Silva, 2010; Hayles, 2010; Kennedy et al., 2008; Pearce, 2003
	Culture	Considers the fitting range of TH to DP's culture	Hayles, 2010; Johnson, 2007a; UNDRO, 1982
En.	Resource consumption	Takes into account consumed material, water, and energy for all phases	Häkkinen et al., 2012; Hayles, 2010
	Pollution	Includes all improper gas emissions and liquids leach	Häkkinen et al., 2012; Johnson, 2007a,b
	Solid waste	Takes into account waste materials	Häkkinen et al., 2012
	Reusability	Considers TH possibilities factors for second life	Arslan, 2007; Häkkinen et al., 2012; Limoncu & Celebioglu, 2006

Figure 3. (A) Left: The container houses, construction workshop near the quake-hit villages

(B) Right: A fully prefabricated temporary shelter carried by a trailer

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Climatic Problems

The container houses are not suitable for the climatic conditions of the region. They are not very compatible with the climate of the region. There have been reports of displacement and reversal of some of the container houses due to local storms.

In some villages, indigenous tents are being developed by people using fabrics such as cloth, straw and nylon, which are also more adaptable to the climate of the region (Figure 4). The heating mechanism of these tents is often petroleum heaters or valve lights which can endanger the health of survivors due to the limited space inside the tent.

Cultural Issues

Given the establishment of shelters without considering cultural issues and with the social problems persisting in the region, in the future, privacy and ethnic issues can create problems for the affected community.

Rights and Ownership

Installing container houses on lands owned by other people can cause tension. For example, in the village of Zarde Payin, the landowners requested the IRGC to prevent the camps from being set up on their lands and tensions were caused in the village.

Feeling Discriminated against

Considering the differences in the type of shelters offered to people in temporary housing projects, it has created a sense of discrimination among the people of the region. While some people in tents have a hard time living, some others take advantage of well-built shelters. Even the difference in the type of prefabricated shelters has intensified the feeling of being discriminated against among the people. Shelters funded by the government have the same size and specifications, but the shelters donated by people range in size from small to large. Hence, the conflicts at the regional level are observed when receiving shelters.

Debris Removal

Many of the buildings in the area were destroyed by the earthquake, and a large amount of debris was left behind. The problem of lack of proper space for the debris depot has caused the debris to be discharged in areas where it can have future environmental consequences.

Figure 4. Manufacture of indigenous tents by some survivors

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People's Participation

Weak communication between local and senior managers in the area, which disrupts processes, has been noticed in providing services to survivors. Also, the lack of proper definition of how organizations communicate with each other in terms of responsibilities and job descriptions has made it impossible to make optimal use of forces. There are no specialized volunteers, people's forces and non-governmental organizations on the scene.

Livelihood

The region's economic infrastructure is severely damaged and in the future, employment and livelihood will be a major problem for the people. Many livestock in the villages have perished or have been inevitably sold. Therefore, besides paying attention to housing reconstruction, there are ways to ensure people's livelihood. For instance, the effects of unemployment could be reduced as much as possible.

4. Findings

A sustainable solution to disaster relief or temporary housing needs to have a multi-factorial approach. Understanding users' needs and wants based on cultural or regional norms, adaptability to local geographic and climatic conditions, affordability of housing by governments or those affected by the disaster, and the ease of mantling and dismantling the housing units are some of the factors that determine the success of any proposed temporary housing.

The sustainability of PDH should be addressed in terms of two views: (1) integration of building industry and, (2) natural disaster conditions. On the one hand, negative impacts and requirements of the building sector and how this is affected by natural hazards is an aspect of paramount importance when dealing with PDH. Natural hazards have always occurred and will do again with different characteristics according to climate change; these, as consequence, have an impact on economic, social and environmental aspects. Meanwhile, in order to protect societies from the impacts of natural disasters, it is required to achieve complete societal resiliency, which is still far from being reached. In this regard, according to 'build back better' concepts (Kennedy et al., 2008; Steinberg, 2007), if PDH is provided based on sustainability concept, the accommodations will be resistant to future natural disasters. Therefore, it should be emphasized that a suitable way to achieve resiliency is sustainability. Contrarily, the frequently used temporary house units, meant to house DP in the aftermath of natural disasters, are rather an unsustainable solution.

This unsustainability happens due to shortfalls in pre-disaster planning, provided in a short time under emergency pressures, such as DP's needs, political and climatic conditions, etc. On the other hand, a huge amount of DP's needs for residing leads to the operation of building industry, which is one of the main energy and resource consumers and generators of solid waste. Thus, the combination of these factors compels decision-makers to focus more on this issue for the next recovery programs. Figure 5 aims to collect all the effective factors in the sustainability of post-disaster housing in social, cultural, economic and environmental groups. And Table 3 also collects and categorizes the guiding points of the prominent researchers in this field.

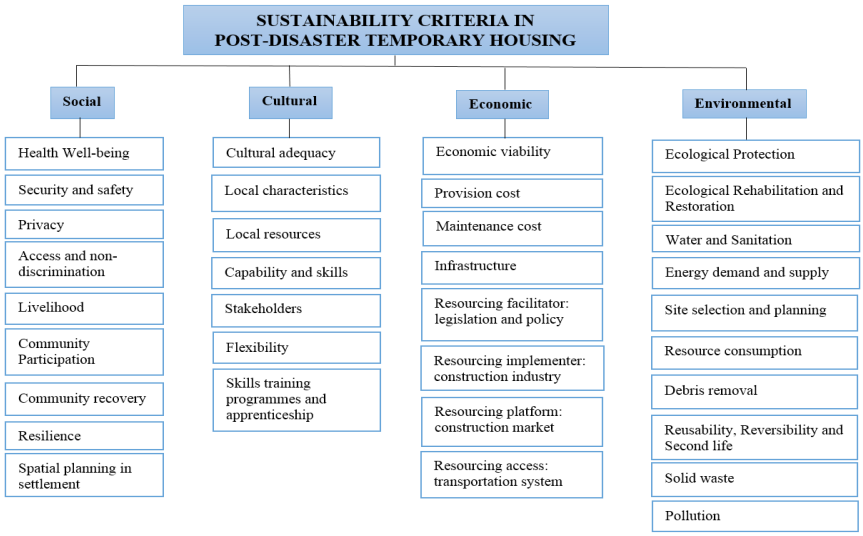

Figure 5. Sustainability criteria in post-disaster temporary housing (Source: Research findings, 2020)

Table 3. Guidelines for sustainable temporary housing solutions

Main Index	Definition	Reference
Ec.	It is useful to consider the similarities and differences in the interests of stakeholder groups affected by temporary settlement. This might help to develop common operational guidelines which could improve co-ordination and co-operation between different organizations in the field.	Corsellis & Vitale, 2011; Shelter Center, 2012
	Livelihood is defined as a range of resource arrangement strategies of production, consumption, and exchange for improving human living conditions.	Twigg, 2006
	Spac The surroundings of the units can also be used as cultivating zones or workspaces, which may be profitable for the families' economy. Since a settlement is not just a collection of individual households, designing the area beyond the units is a key to creating a better living environment for temporary settlements.	Kellett & Moore, 2003
	Resource management for post-disaster reconstruction projects	Chang, Wilkinson, Seville, & Potangaroa, 2010
	Simple construction systems that are easy to assembly and dismantle, and that use small elements, which are easier to handle, should be preferred.	Arslan, 2007
S.	Recovering the sense of community is very important in post-disaster situations and the real meaning of the term community is in the richness of social-relationships	Kellett & Moore, 2003
	The relation between the temporary housing units and these public spaces and buildings has to be carefully designed too. It is important to yield buffer zones from the public domain to the units' private area in order to ensure privacy among neighbors, as well as to facilitate social support and interaction.	Caia et al., 2010
	The units' location has to be carefully established to ensure that people do not feel displaced and that they are closer to their workplaces, services and amenities. Usually, temporary housing units are built in periphery areas, which can cause social isolation and the need for extra infrastructure and services such as bus transportation.	Johnson, 2007b
	Participation has to be locally decided according to the context.	Davidson, Johnson, Lizarralde, Dikmen, & Sliwinski, 2007
	Community recovery. community-based approaches	Lizarralde & Massyn, 2008
	An awareness of local and national laws (legal context), is essential in order to understand the socio-political context of a settlement. Local and national laws will affect the use of land for settlements.	Corsellis & Vitale, 2011; Shelter Center, 2012
	Skills Training programs and apprenticeship schemes can maximize opportunities for participation during construction, particularly for individuals lacking the required building skills or experience.	Sphere Association, 2018
	Neighborhood planning should support existing social networks, contribute to security and enable self-management by the affected population. The plot layout in temporary planned camps should maintain the privacy and dignity of separate households by ensuring that each household shelter opens onto a common space or a screened area for the use of the household instead of being opposite the entrance to another shelter.	Sphere Association, 2018

Table 3. Guidelines for sustainable temporary housing solutions

Main Index	Definition	Reference
Cul.	Local resources, such as materials, construction techniques and workforce, greatly contribute to reduce costs, improve local economy and provide better cultural and local integration.	Gulahane & Gokhale, 2012
	Local characteristics: (1) Local potentials, which consider local possibilities of providing temporary accommodation based on material and immaterial properties; and (2) affected population by natural disaster with different features which include DP and others, that play an important role in PDA provision.	Blaikie et al., 2014; UNDRO, 1982; Sliwinsky, 2007
	Ensuring adequate space provision and privacy in both individual household shelters and temporary collective accommodation. Sufficient space should be provided for culturally appropriate burials and associated rituals.	Sphere Association, 2018
	Understanding the precise local context in order to provide solutions that match with their future users and environment	Johnson, 2007a; UNDRO, 1982
	Flexibility is crucial to allow simple and quick transformations that make the unit able to accommodate these multifunctional spaces. It is essential to make users capable of customizing and personalizing their units, and making additions or modifications according to their needs and possibilities. In disaster scenarios, housing is often a workplace for families.	UNDRO, 1982; Kellett & Tipple, 2000; El Masri & Tipple, 2001; Barakat, 2003; Bedoya, 2004; Lizarralde & Davidson, 2006; Lizarralde & Root, 2007; Arslan & Cosgun, 2008
	Meeting people's aspirations and incorporating local forms of housing	Barakat, 2003
	The use of local resources does not mean that innovation should not be used; if properly introduced and culturally integrated, some new materials and technologies may considerably contribute to improve housing solutions after disasters.	Davidson et al., 2008; Garofalo & Hill, 2008
	Existing local practices in the use of covered living space accommodation of extended family members should inform the covered area required.	Sphere Association, 2018
En.	Construction resilience should be consistent with known climatic conditions and natural hazards and should consider adaptations to address the local impact of climate change.	Corsellis & Vitale, 2011; Shelter Center, 2012
	Reversibility of the construction process; this strategy proposes the possibility to reintroduce materials and spatial resources into another production cycle or to reintegrate them into the natural environment without production of waste or resides. Just like the reuse possibilities, the reversibility concept is only possible if properly planned ahead during the design phase.	Bologna, 2004
	Debris removal is a priority to enable the provision of shelter and the establishment of appropriate settlement solutions. The use, management, ownership and environmental impact of disposal sites should be considered.	Sphere Association, 2018
	The impact of a disaster on the natural environment should be assessed to inform the response and mitigating activities required.	Sphere Association, 2018

Source: Research findings, 2020

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The identification of the common problems, as well as their origin, opens space to the discussion of some principles like what was discussed about Sar- Pol-e Zahab that can improve the outcomes of temporary accommodation solutions. It seems that main principles can be proposed as follows:

Pre-planning

Developing a strategic pre-plan has crucial importance, as decisions may be best taken before the disaster (Gulahane & Gokhale, 2012). The problems of sustainability and cultural inadequacy previously discussed regarding Sar-e Pol-e Zahab would be considerably reduced with a strategic pre-plan establishing beforehand the type of shelter or house and the places for temporary settlements, as well as the priorities, ways of action, principles, and rules to follow in case a disaster occurs.

In terms of temporary accommodation, a strategic pre-planning should consider the following issues to succeed:

Preparing an area with infrastructures beforehand for temporary settlements

Having an already defined and prepared site for temporary settlements after disasters is a profitable way to offer public spaces for citizens and simultaneously be prepared for disasters and emergencies. The site may be a garden, park, etc., which can be used by people for leisure and cultural activities during ordinary times, and used for temporary accommodation during crisis scenarios (Bologna, 2004).

Forecasting

Having an idea about what could be the consequences of a disaster in terms of housing destruction helps to predict the possible number of houses damaged or destroyed. To reach that anticipation, it is necessary to make a complete assessment of the state of repair and structural safety of the existent buildings.

Making a broad and accurate characterization of the local context

A complete understanding of the cultural, social, economic, political, religious, climactic, and many other local issues is the key to design temporary accommodation buildings that fit local conditions and simultaneously may be sustainable. The satisfaction of users is directly connected to the involvement in the assessment of needs and expectations (Lizarralde et al., 2009).

Establishing the ways of action

With the data collected from the previous tasks, it is possible to establish the priorities in terms of works, the type of temporary accommodation solutions to use and their materials, and how the units will be erected and spatially organized on the ground (Johnson, 2007a).

The pre-planning may also determine actions to be taken in the existing buildings before a disaster occurs, such as consolidation, reinforcement, and maintenance.

Using local resources

If available, local materials are probably culturally and socially more appropriate, as well as more economical, since they are familiar and the high costs that transportation imposes can be avoided.

The use of local materials empowers the possibilities to involve the local workforce in the erecting works because local people are used to handling them. The design should balance a combination of technological and local ways of construction and materials (Félix et al., 2013).

Supplying more than just temporary accommodation units

The buildings have to be designed from the point-of-view of the users rather than from functional and technical approaches (UNDRO, 1982), considering their daily activities, as well as the symbols and patterns adopted (Bedoya, 2004).

On the other hand, the exterior spaces surrounding the units have to be designed and well organized. Outdoor areas belonging to the units are relevant to create buffer zones between public spaces and the private domain, which is essential to create some privacy among neighborhoods and encourage interaction (Caia et al., 2010).

Livelihood

As the length and severity of disaster recovery are highly correlated with the loss of returns from livelihood activities, livelihoods and self-protection are the link between poverty and disaster vulnerability. As this vulnerability is determined by access to self-protection and social protection, post-disaster vulnerability reduction must not only strengthen social protection through support to relevant institutions but also strengthen self-protection through reinforcement of livelihoods.

To move towards livelihood mechanisms, a threshold level of security must be regained through the provision of essential goods and services before many people are enabled to return to employment of their labor in livelihoods (Alexander, Chan-Halbrendt & Salim, 2006).

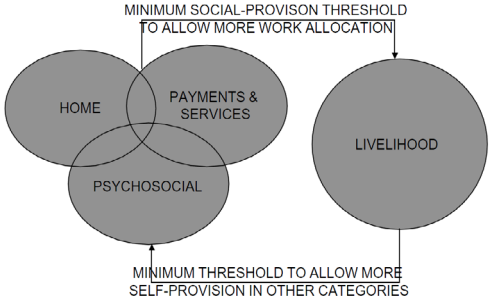


Figure 6. Roles of categories of processes in improving human living conditions (Alexander, Chan-Halbrendt & Salim, 2006)

Resourcing for a resilient post-disaster reconstruction environment

According to UNISDR (2017), resilience to disasters is the 'ability of a system, including through the preservation and restoration of its essential basic structures and functions through risk management.'

Resourcing broadly encompasses a wide range of activities that have a bearing on resource management for post-disaster reconstruction projects, embracing pre-event resource planning and preparedness, resource procurement, resource delivery, and development of resource alternatives. Four principal components of resourcing to resilient and sustainable built environment after a disaster are:

(1) Resourcing facilitator: legislation and policy;

(2) Resourcing implementer: construction industry;

(3) Resourcing platform: construction market; and

(4) Resourcing access: transportation system.

Management of these four components could reduce the frustrations in the post-disaster resourcing environment (Chang et al., 2010).

5. Discussion

The current post-disaster housing approach is not responding properly to the interrelated problems of speed, time, and economy and is actually giving no response or a partial response. Whenever one type of problem is addressed singularly, it is seen that the severity of other problems increases. The many related components of post-disaster housing need to be analyzed as a whole. The development of a systems approach has made it possible to take all the components of a system into consideration, understand their relationships, perceive alternative solutions and foresee their impact and make adjustments when needed through constantly checking results. Thus, each system is a coherent and indivisible whole that can be distinguished from its surroundings.

Moreover, this whole is organized since it reflects the dynamic and reciprocal interactions of its various components, and any change in one element will necessarily change others and consequently the entire system.

A system cannot be reduced to the sum of its parts, since the latter do not have the same significance when studied in isolation as when seen as contributing to the whole. If we look at each component separately, therefore, we might miss the factors that constitute the system as such. As a result, system approach is determined appropriate to be used as a tool to solve this problem. The components of the "post-disaster sustainable temporary housing system" can be defined as below.

• Objectives of the "post-disaster sustainable temporary housing system" determine the goals that are aimed to be achieved in return for the solution of the housing problem by providing the victims' necessities economically, urgently, and progressively with productive usage of the country's resources,

• Resources of the "post-disaster sustainable temporary housing system" include all the facts needed in order to develop the solutions regarding post-disaster housing,

• Activities of the "post-disaster sustainable temporary housing system" include the activities and all the activity stages that took place while developing the aimed progressive post-disaster housing,

• Outputs of the "post-disaster sustainable temporary housing system" show the reached situation according to the determined objectives with the help of the resources and activities.

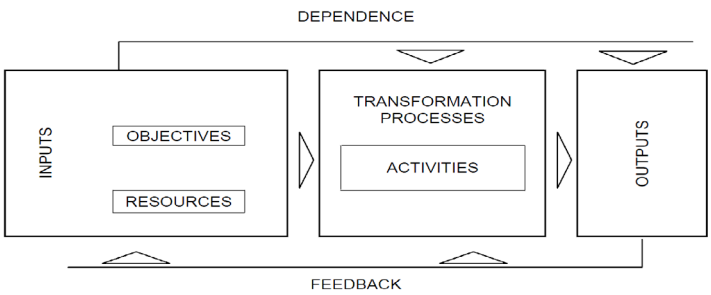


Figure 7. System's Conceptual Model

Various facts, relations and processes exist in the components of the "post-disaster sustainable temporary housing system". Also, these components form a new system by coming together and this gives each component a property of being a system, namely subsystem of the "post-disaster sustainable temporary housing system". In the end, the conceptual model of this system is given in Figure 6, 7, 8 and Table 4.

As a result of having the advantage of being aware of the successful and unsuccessful sides of the current approach, the new approach established and named as "post-disaster sustainable housing system" should be seen as a guide that can be followed by all the regions of the country. The system should be applied to all the regions by the government according to their local data and the decision steps regarding before-disaster, at the time of disaster and post-disaster should be determined.

The decision steps needed to solve the post-disaster housing problem, to be prepared against the disaster beforehand, and to develop an urgent, economic, sustainable approach can be summarized orderly as given below.

• To take the problem/subject as a system

• As a result of the comparison between problems/needed qualifications of the current approach and sustainability principles determined by the commission of World Environment and Development, to comprehend that the system should include or be established based on the sustainability principles

• Afterwards, to name the new system as "post-disaster sustainable housing system", to develop it comprehensively, to form the components of the system; objectives, resources, activities, and outputs

• As the objective of the system is to give the victims progressively developed houses, the activity stages of the system should be determined as follows:

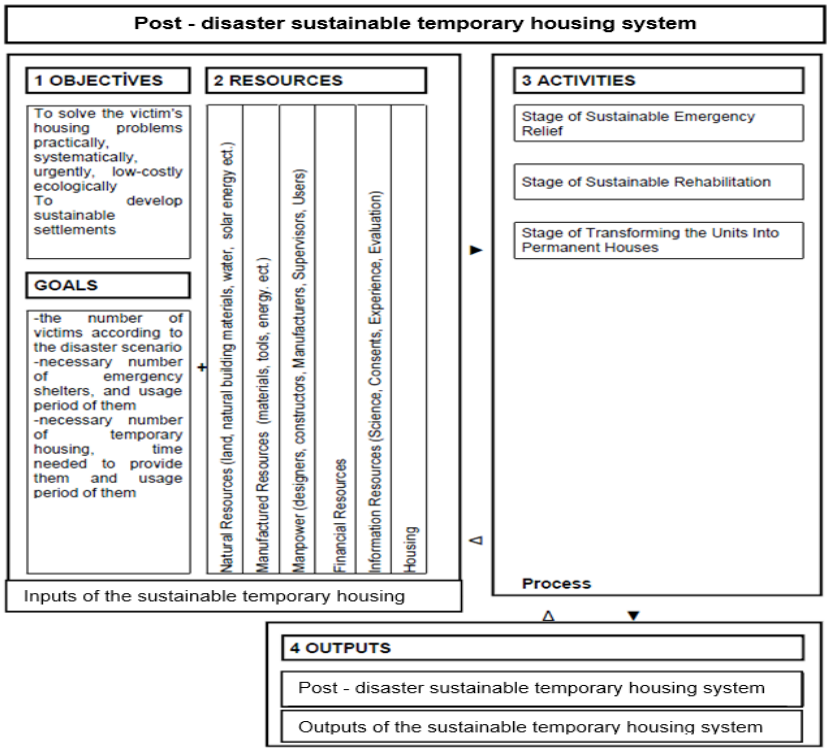
Stage of Sustainable Emergency Relief

Stage of Sustainable Rehabilitation

Stage of Transforming of the Units into Permanent Houses

The three stages under the activities sub-systems of the "post-disaster sustainable housing system" should be also taken as a system and solved by the systems approach comprehensively. The objectives, resources, activities and outputs of the sub-systems of each stage should be developed and formed.

Figure 8. The conceptual model of "post-disaster sustainable temporary housing system"



As the post-disaster sustainable housing system is an inter-disciplinary subject, the organizational structure that will work on this system should include professionals of all related disciplines like architecture, urban planning, geophysics, sociology, environmental psychology, civil engineering, ecology, economy, management and law.

In short; by adopting this type of approach at the base of all the regions, it seems that the post-disaster housing problem will be solved in accordance with the environmental and climatic conditions of the region, urgently, economically, and progressively and with the productive use of the country's resources.

Acknowledgements

The current paper is extracted from the PhD thesis of the Second author (Elnaz Asgari Namin) in the Department of Architecture, Ardabil Branch, Islamic Azad University, Ardabil, Iran.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declared no conflicts of interest.

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