TEMPORARY HOUSING DESIGN FOR POST-EARTHQUAKE IN ISTANBUL; LESSONS LEARNED FROM JAPAN

İlke CİRİTCİ
Assoc. Prof. Dr., İstanbul Gelisim University, Turkey
ORCID NO: 0000-0002-1492-0727
Semih Göksel YILDIRIM
Asisst. Prof. Dr., İstanbul Gelisim University, Turkey
ORCID NO: 0000-0002-7832-6575

ABSTRACT

After the recent and devastating earthquakes in our country, the need for temporary shelter on a large scale has become a major problem. Problems such as emergency shelter, access to temporary shelter areas and solutions according to density have come to the fore. The abandonment of the disaster victims and the inadequacy of the areas offered in the city create traumatic effects and experiences on the earthquake victims, especially health problems. The town of Onagawa in Miyagi Prefecture, Japan, was severely damaged by the earthquake and tsunami of March 11, 2011, and architect Shigeru Ban sought a solution by designing a multi-story temporary housing complex for the survivors. This paper aims to propose a model of multi-storey temporary shelter housing for the expected Istanbul Earthquake with the teachings of the Onagawa Container Temporary Housing Project and to draw attention to the potentials of high-density unit production after the disaster.

Keywords: Cargo Container, Temporary Housing, Disaster Management, High Density, High-Rise Container Design

INTRODUCTION

Today, many cities are at risk of disasters. Recent disaster statistics for the effects of natural disasters worldwide show that meteorological-based events are in the first place, but geophysical-based disasters are the leading cause of loss of life and injury (Munich, 2019). Disaster statistics covering a 60-year period (1950-2008) for Turkey show that earthquake-related disasters are in the first place (Gökçe, Özden, & Demir, 2008). On the other hand, disaster statistics for the twenty-five-year period (1990-2014) show that loss of life and economic losses are mostly caused by earthquakes, and floods are second only to earthquakes in terms of frequency of occurrence (UNDRR, 2019). There is an earthquake risk on the North Anatolian Fault Line, part of which is located in the Marmara Sea, which will significantly affect Istanbul and its surroundings. The magnitude of this risk reveals the importance of taking measures to reduce potential disaster risks for Istanbul (Yücel and Ciritci, 2020).

Literature review

The literature review has been narrowed within the scope of this paper to be related to the post-disaster use of containers. In order to reveal the solution potential of containers for the shelter problem, the post-disaster temporary shelter centers proposed for Izmir by Izmir AFAD Provincial Directorate Improvement Branch were examined and a container city design was proposed for the most suitable area (Dayanır, 2019). In particular, the shipping container is suitable for post-disaster situations as a temporary housing application and design examples are

found in the literature. However, it has been observed that the social impacts during use have been ignored in general studies and have not been included in the research topics. In order for the implementation of such projects to be successful in a post-disaster environment, the social dimensions of temporary housing should be investigated. In this context, the field studies and temporary housing experiences of communities affected by Hurricane Katrina in the United States in 2005, the Christchurch Earthquake in New Zealand in 2011 and the bushfire in Australia in 2009 can be mentioned. These studies have identified a number of key social factors that have been found to be important for the success of temporary housing projects with shipping containers. These are issues related to flexibility in ownership, reuse and settlement arrangement, in addition to pre-disaster planning by authorities, taking into account the varying characteristics of different types of disasters. In addition, it is recognized that these are not suitable for all post-disaster applications and further research is needed for relevance in different contexts (Zhang G. et al. 2014). An architectural adaptation of a shipping container for housing internally displaced persons in Southern Nigeria was studied. The available options for architectural adaptation of shipping containers were explored. The study recommends that the most preferred architectural adaptation options based on the survey results are the construction of accommodation from shipping containers in the region. It highlights two severe social and environmental problems found in Nigeria, namely mass displacement leading to homelessness and an increase in the number of empty shipping containers abandoned at ports (Obia, 2020). Similarly, the housing problem of Syrian refugees has been addressed through the use of shipping containers (Rahman, 2017). After the 2011 Christchurch earthquake, studies on the transformation of urban spaces and post-disaster reconstruction have been carried out, and how they can contribute to the resilience of a city has been discussed (Brand and Nicholson, 2016). It has been observed that the subject of this paper, multi-storey post-disaster temporary housing examples, especially for dense settlements, has not been sufficiently studied academically. A housing community built by architect Shigeru Ban in the city of Onagawa in Miyagi after the 2011 earthquake in Japan can be seen. Within the scope of this paper, this work will be analyzed and its potentials for Istanbul will be emphasized.

Scope and content of the paper

There are various examples of post-disaster temporary settlements in Turkey and around the world, built with different materials and construction methods. In some of these applications, there are problems identified during the use of temporary housing, such as public open space and common areas that can be handled together with social assistance and common areas that will make it possible to enable this. Within the framework of this problem, social common areas should definitely be included in the design of temporary housing units in post-disaster plans in the urban fabric, and it should be taken into consideration that this area is a necessary need not only for mutual aid, but also for disaster victims to establish contact and rejoin social life. Therefore, the first important requirement is social public common areas.

Another important problem is how the expected Istanbul Earthquake will take shape within the dense population of Istanbul and how it can be designed to be both inclusive and functional. Density analysis should be made by taking into account the post-earthquake scenarios of the Istanbul Metropolitan Municipality and AFAD, and special solutions should be made for densely populated settlements. At this point, solutions can be developed through containers that are currently used in temporary housing designs. This paper will focus its studies on these two issues based on these two problems.

CHAPTERS

Preparations and gathering areas for the expected Istanbul earthquake

According to Istanbul Metropolitan Municipality (IBB) data (URL-1), the nighttime residential population of Istanbul is 15 million and the daytime residential population is 6 million. According to the "Earthquake and Damage Loss Estimation Study" conducted by IBB Earthquake and Soil Investigation Directorate and Boğaziçi University in 2018, economic and physical losses and damages are expected in Istanbul under the scenario of a 7.5 magnitude destructive earthquake. According to a 7.5 magnitude destructive earthquake scenario, the number of very heavy and heavily damaged buildings in Istanbul is around 48 thousand, and the number of buildings with moderate and higher damage is around 194 thousand. According to these figures, 22.6 percent of buildings will collapse, 25 million tons of debris will be generated, 30 percent of roads will be closed and infrastructure will be severely damaged. In the earthquake mobilization plan published by IBB, there is an article on 'post-disaster gathering/sheltering areas' that is directly related to the post-earthquake scenarios discussed in this study (URL-1). According to the presentation of Ekrem Imamoglu, the mayor of IBB, a total of 859 gathering areas with a capacity of 21 million people are being studied for the identification and construction capacity of shelter areas after the Istanbul earthquake (Figure 1).

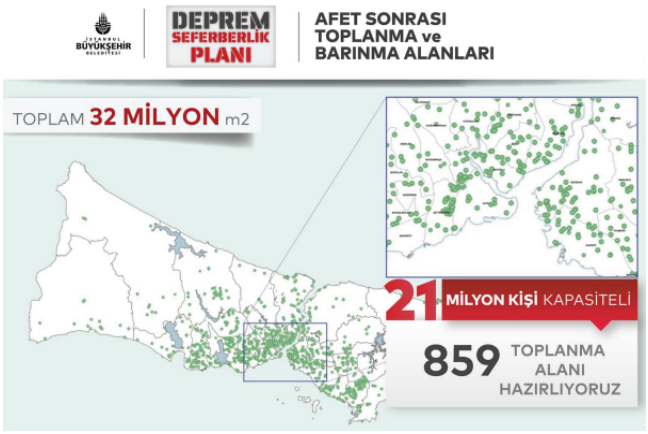


Figure 1. An image from the presentation made by IBB Presidency (URL-1)

IBB Department of Earthquake Risk Management and Urban Improvement has identified the Gathering and Temporary Shelter Areas of 39 districts (URL-2). Decision Support Model was applied in the selection of the areas. In the model, the criteria for the selection of assembly areas were determined, a scoring method was applied, and a model was put forward based on scientific bases involving AFAD, Directorate of Parks and Gardens, AKOM, Coastal Safety Directorate and many other relevant institutions (URL-2). IBB's detailed earthquake-related studies are ongoing. The size and quality of the assembly areas (Figure 2), which vary according to the districts they have integrated into the city maps, are shared transparently on their website (URL-3).

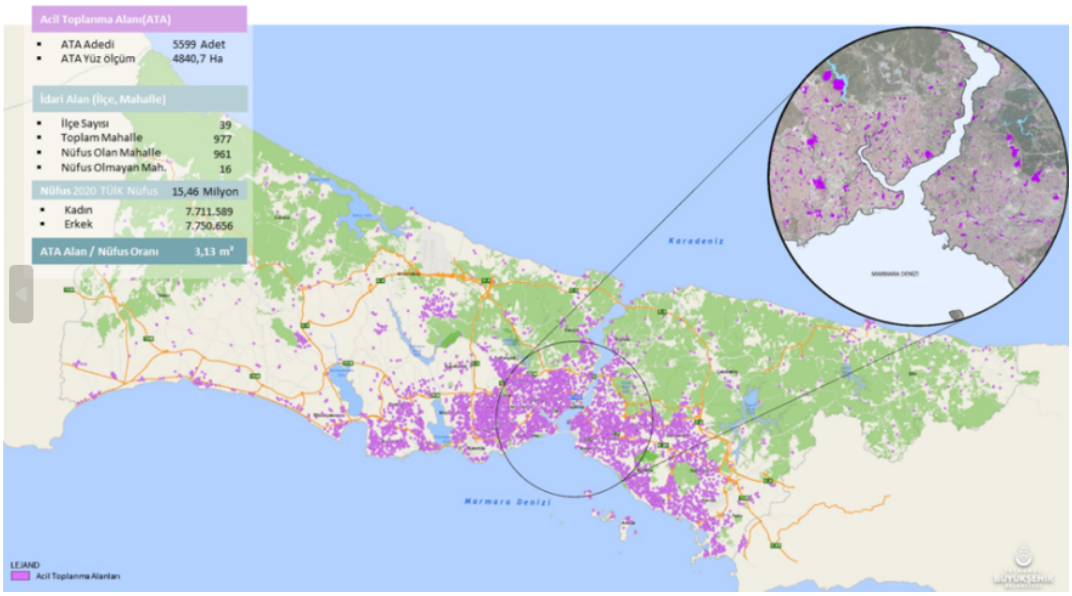


Figure 2. Istanbul Emergency Gathering Area Map, IBB (URL-3).

Although publicly supported studies, which have increased in recent years, have created a positive impact and awareness, it does not change the fact that the studies we have are insufficient and that the resilience of the megacity against earthquake in a possible Istanbul Earthquake is not at an adequate level and that all institutions, including the public, are unprepared. In this regard, Uyar and Özkan's (2023) First Stop After the Earthquake: A Review of Gathering Areas in Istanbul, Uyar and Özkan (2023) provide a very detailed analysis of Istanbul's gathering areas. The article, which is quite overlapping with the subject we are working on, answers some of the questions it seeks within the framework of the title 'Proposals for the solution of temporary housing areas in densely populated districts with multi-storey containers', which is proposed as a research question in the content of this paper. In this respect, their work has not only formed a basis for us, but also provides the quality of seeking answers to some of the questions they have opened as a continuation.

GENERAL CHARACTERISTICS OF GATHERING AREAS AND SETTLEMENTS FOR ISTANBUL

When AFAD's 'Directive on the Establishment, Management and Operation of Temporary Accommodation Centers' (AFAD 2015) dated 04.11.2015 is examined, it is seen that it contains detailed information on the site selection and characteristics of temporary accommodation units after disasters. When we extract the *capacity* parameter from this content, the following two articles draw attention.

- Suitable for capacity expansion to accommodate new containers/tents in case of population growth,

- Closed area per person for tents or containers should be between 3.5-4.5m2.

The biggest problem for Istanbul, whose population density is quite high compared to its surface area, is the determination of temporary shelters. Uyar and Özkan (2023) investigated the spatial adequacy of assembly areas in districts with high earthquake risk. The authors overlapped IBB (2020) and JICA (2002) studies with priority areas in terms of earthquake risk and determined the districts that will need the most assembly areas after an earthquake. The gathering areas identified by IBB include parks, gardens, parking lots, cemeteries, gardens of public buildings,

shopping mall squares, marketplaces, etc. (Figure 3). In addition to the assembly areas on IBB's web pages, 39 district municipalities also share a detailed map of their neighborhood-based assembly areas on their own websites. Figure 3 shows a screenshot from Küçükçekmece Municipality's web page as an example.

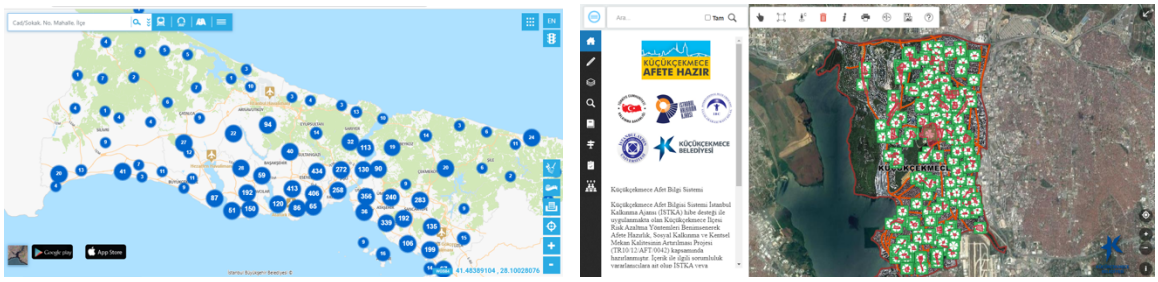


Figure 3. Left- Istanbul Gathering Areas Map, IBB City maps (URL-4)- Right- Küçükçekmece Municipality Web page- Mapping of gathering areas (URL-5)

Uyar and Özkan (2023) give the number of Istanbul Gathering Areas as 823 in their article, but after the article was published, it was updated as 859 on IBB web pages as can be seen in URL1. The authors' findings that 'the assembly areas in the districts of Adalar, Bağcılar, Bayrampaşa, Büyükçekmece, Çatalca, Esenyurt, Fatih, Gaziosmanpaşa, Güngören, Kadıköy, Kağıthane, Kartal, Küçükçekmece, Sancaktepe, Sultanbeyli and Sultangazi will be insufficient for the population in the region in the event of a possible earthquake' remain valid since the updated number of assembly areas is negligible. According to the studies of the Istanbul Planning Agency (IPA), the earthquake risk in Istanbul threatens a large area between the Golden Horn and Küçükçekmece Lake on the European side, Bakırköy, Zeytinburnu and Fatih districts on the coastal line, and Bahçelievler, Güngören, Bağcılar, Esenler, Bayrampaşa and Küçükçekmece districts with high population density (URL-6). Among the districts mentioned here, it is possible to make an example of Küçükçekmece, which has gained a rapid acceleration in the rate of population growth in recent years.

Within the framework of detailed studies conducted by public institutions and the findings they have reached over the years, Küçükçekmece ranks first among the districts of Istanbul with high probability of damage after an earthquake and districts with high population density. According to the information obtained within the scope of IBB's 'Istanbul province possible earthquake loss estimates update project', which was shared with the public in June 2020, 778,889 people live in the district according to the 2019 census. This number is 808,957 by 2022. According to the probable loss scenario prepared by taking into account many parameters, the number of casualties is expected to be around 1515, the number of seriously injured 925, the number of those who will be treated in hospital 4079 and the number of slightly injured 7413 (URL-7). Küçükçekmece Atakent neighborhood is densely populated with high-rise buildings and housing estates. When we subtract the numbers given in the scenario, there is a need for temporary shelter for the remaining over 790.000 people. If we consider containers as housing units for families of 4 people, there is a need for around 197.500 containers. Of course, temporary shelters do not consist entirely of containers; they also include tents and similar shelters that can be quickly set up with lightweight materials. If we make a realistic projection, it is not possible to produce or transport to the city in a short period of time the number of containers that can meet all the post-earthquake needs. In addition, after a certain period of time has passed and the damage assessments have been made by the institutions, some of the people will settle back into their undamaged houses. According to the same report, the number of households in need of temporary shelter on a neighborhood basis is also given. Atakent Neighborhood is the 3rd most populous neighborhood in Istanbul with a population of 102,682

as of 2022 (URL-8). In total, 72.774 households will be needed according to the scenario. Atakent Neighborhood has been included in the scenario as 3.055 temporary shelter needs in the report.

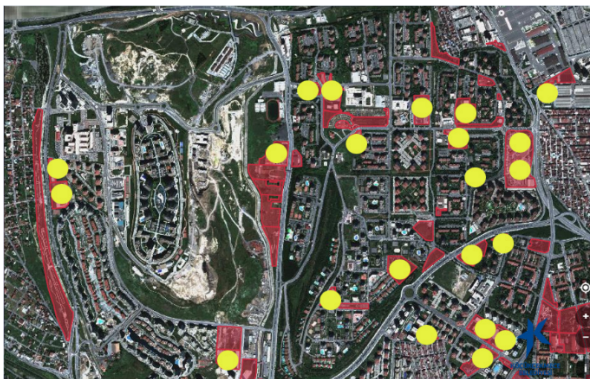


Figure 4. Unbuilt assembly areas of Küçükçekmece district

When we took the gathering areas for Atakent Neighborhood example from the web page of Küçükçekmece Municipality, it is seen that some of the designated areas already have buildings on them (areas marked with yellow color), which is possible for gathering but not for temporary shelter (Figure 4). The number of temporary shelter units in Atakent neighborhood, which is determined as 3055 in the report, constitutes a capacity of 12,220 people on the assumption that each unit will accommodate 4 people, and this number is well below the need. Precisely at this point, since we cannot expand the number of areas where the existing temporary housing units will be located to the lands that we cannot ignore the construction on the neighborhood, some innovative solutions should be proposed and new searches should be questioned.

Applications in Japan- Shigeru Ban's multi-storey container design

Japan, which is one of the countries highly affected by disasters such as earthquakes, tsunamis and forest fires, has reduced the number of losses considerably with a series of measures and regulations they have taken against disasters with very destructive consequences in their history. Within the scope of the study, the most striking design encountered in the literature review in the research involving multi-storey containers as a temporary housing unit after the disaster is the settlement realized by Pritzker Prize-winning architect Shigeru Ban in Onagawa, Miyaki region of Japan.

On March 11, 2011, a 9.0-magnitude earthquake and tsunami struck the Pacific coast of Tohoku, Japan. In Onagawa-Cho, the centre of the town was completely swept away by a 15m tsunami. To provide shelter for displaced families, Japanese architect Shigeru Ban, famous for his disaster relief projects around the world, proposed to construct multi-storey temporary housing units using shipping containers. Conventional single storey units would not supply enough housing because there was onlylimited flatland available in the hilly region above tsunami height. In his presentation with Sci Arc organization, Shigeru Ban explains that the reason for designing a multi-storey container design is that the users cannot even open curtains due to the noise and privacy problems arising from the proximity of the settlement in the limited area of the buildings and the social areas are not of sufficient quality in the designs made with single containers in the conventional layout (URL-9). In the presentation, Ban states that they designed

the settlement, which is normally single-storey, as multi-storey, creating 188 units, and thus they were able to accommodate more disaster victims without exceeding the budget (Figure 5).



Figure 5. Photograph of the campus designed by Shigeru Ban, Shigeru Ban Architects, (URL-10)

Hikone, a director at Ove ARUP & Partners, Japan, and Tokubuchi, a civil engineer at the same company, explain their motivation for the initial design process in their paper (2014);

> ''The standard type is a single storey house; therefore, we needed a large and flat area for the site in order to accommodate the required number of units. The standard specification was a set minimum for a shelter, with especially less consideration for sound and thermal insulation due to the assumption there will be a short occupancy because the houses are temporary. But this time everybody understood that most of the people needed to rely on the temporary houses for a much longer period due to the destruction of the community and infrastructure in the disaster area. The standard specification was not reviewed or improved in this specific condition, which was a double pain for the people who needed to live there. We wanted to improve the quality of life in the temporary houses.''

The designers first identified the advantages and disadvantages of using containers as shown in Table-1.

Table 1. Advantages and disadvantages of using Containers according to Hikone and Tokubuchi (table prepared by the authors)

Advantages of containers	**Disadvantages od containers**
Unit construction	They had limited size of openings in the walls
Ready made in the shop before shipping to the site	
Standard size and quality for shipping and automobile transportation	There was no flexibility in having large openings in the walls from a structural load path view point
Reuse after the event	

This post-disaster multi-storey container design is the first multi-storey temporary housing unit in Japan and due to Hikone and Tokubuchi (2014) those living in the houses reported that the comfort level of the users was excellent.

DISCUSSION

The multi-storey construction of containers as dwellings is an approach that has been practiced around the world. Recently, it is possible to see different forms of container architecture, which has significant advantages in terms of cost and convertibility (Figure 6).



Figure 6: From left to right, 'Muangthongthani Carcare' (URL-11), 'Multi-Story Prefab Steel Modular Modern Design Container House' (URL-12), 'Cité a Docks' (URL-13)

Dayanır et al. (2022), in their article on the compilation, grouping, definition and ranking of criteria for the site selection, planning and design of post-disaster temporary shelter areas using the Delphi method, carried out the suitability analysis of the post-disaster temporary shelter areas proposed for Izmir with the help of the list of site selection-planning criteria put forward by the Delphi method. None of the 83 assembly areas examined for Izmir within the scope of the article met all the criteria, and since only the "seferihisar2" area met all the criteria except for the proximity to health facilities, the authors designed a pilot container city based on the design implementation criteria. At this point, for the container city that meets the design criteria in Figure 7, the implementation of 3-storey containers provides more green space, more common areas for socializing and reserve space in case of the need to increase capacity.



Figure 7: On the left, the container city prepared by Dayanır et al. (2022) for İzmir-Seferihisar, taking into account its compliance with the regulations; on the right, the expression of the remaining common areas in yellow and green when the containers are worked in 3 floors with black spots (Prepared by the authors).

Project Manager Yasunori Hirano (2012) stated in a post-implementation interview that when disasters occur in Japan, prefabricated housing manufacturers and other large companies often mass-produce simple temporary housing units very quickly and architects are not involved. However, he emphasizes that with this project, starting from container projects, some architects started to work on temporary housing and it was a beginning for architects to establish an environment for building temporary housing that is more suitable for the quality of the living environment of disaster victims (URL-14).

The aim of this study is to look for ways to place as many temporary housing units as possible in their neighborhoods, within the framework of the fact that after the earthquake, whether slightly damaged or heavily damaged, people do not prefer to move to a settlement far away from their houses and neighborhoods, firstly for news from their relatives, neighbors and families, and secondly, in order to save their property left in their houses with their own efforts or with the help of the state, in order to be assured against the difficult situations awaiting them. Another point that is as important as this is to create social spaces that can respond to the socialization needs of disaster survivors after the earthquake. Because we know from our bitter experiences in Turkey that the social psychological dimension of the process is very heavy for the survivors, and in order to minimize this devastating effect, it is an important part of designing these settlements to create environments where they can socialize after creating spaces worthy of human dignity. As the authors, we believe that Shigeru Ban's design will inspire new similar designs considering the conditions, topography, physical conditions and population of Istanbul.

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