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Post-disaster shelter design and CPoDS

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Abstract

Post-disaster management and reconstruction are complex processes which have many phases and actors working in order to recover the damage. Sheltering is one of the many problems in post-disaster management. Disasters leave tens of thousands homeless each year in need of rapid solutions for mass-housing or sheltering.

In Turkey, earthquakes occur frequently and cause heavy damage in settlements. Preparedness for these earthquakes and ability of rapid recovery play crucial roles in order to minimize the damage. Lessons learnt from previous experiences such as Kocaeli and Van earthquakes in Turkey in 1999 and 2011 respectively are valuable.

Post-disaster shelter with a variety of features to meet the needs of the survivors is designed. In the need of very large numbers of shelters, the accumulation of ideas and projects produced create a valuable library both in unit and neighborhood scale. Different projects used different criteria in order to design these shelters. All these criteria are taken into consideration and evaluated and with previous earthquake experiences a set of criteria is selected. The projects produced in ITU's graduate program are assessed according to the selected criteria, producing alternative houses for different user-household scenarios and formation of the modules.

CPoDS (Container Post-Disaster Shelters) is also detailed which is a tool to generate temporary shelters with containers. The generation is made by a productive system which produces alternatives for different communities.

Keywords
Post-disaster shelter, Temporary shelter unit, Digital design, Generative system, Container.

1. Introduction

Natural disasters, such as earthquakes, tsunamis, hurricanes, floods, etc., cause loss of life and damage the property all around the world. The severity of the damage differs based on the size of the affected population, as well as the level of development. Especially in developing countries which have high population densities, the damage can be catastrophic where in many cases the responses are inadequate and late. Preparedness for these disasters and ability to recover rapidly play crucial roles in order to minimize the damage. Post-disaster management and reconstruction are complex processes which have many aspects, need resources, seek various skills and experience and they require involvement from different actors. There are many organizations and agencies (governmental, intergovernmental, NGO's etc.) which work to help survivors. After the extent of the damage is assessed, reconstruction according to the assessment is planned. In order to be prepared for a disaster, lessons learnt from previous experiences are valuable. There are also many organizations working on shelter design and how to improve it [1, 2].

In Turkey, devastating earthquakes occur frequently. When earthquakes occur in regions where the population density is high, many lives are lost and much additional damage is caused (Coburn and Spence, 2002). Earthquakes leave tens of thousands homeless which needs rapid solutions for mass-housing or sheltering. Even though there are many aspects and different actors in post-disaster management, in this paper, the main focus will be on the shelters, design criteria of these shelters and various shelter studies. Throughout the past nine years, a library is created for these shelters in ITU's Architectural Design Computing Graduate Program. In this program, designing post-disaster shelters for earthquake is the main theme, in result of which various projects are designed and some of them are detailed in this paper. Especially CPoDS, which is a tool designed in this course and later on developed in 3dsMax environment to create various alternatives for post-disaster shelters.

2. Temporary Shelters

Baradan (2002) stated that earthquake aid studies are analyzed in three phases, first aid phase, rehabilitation phase and reconstruction phase. Other than these phases, pre-disaster phase must also be mentioned which is the phase for preparedness, risk reduction and mitigation (UNDRO, 1982). The following time phases are used although it is recognized that, they will vary based on the type of disaster and the local conditions (UNDRO, 1982). First aid phase is the emergency period which involves debris removal, saving lives, medical treatment and providing basic needs. It can last from a few days to several weeks. Rehabilitation phase is the temporary period which involves immediate preservation of life with optimum convenience. Building temporary emergency shelters or buildings occur in this stage which can last from a few weeks to several months. Reconstruction phase is the rebuilding period which involves building infrastructures and permanent houses and satisfying the needs of life at least to the pre-disaster stage.

Arslan and Ünlü (2008) stated that shelter problem after the disasters are generally followed by four overlapping phases which are; spontaneous shelter (first 72 hours), emergency shelters (first 60 days), interim housing (first year and beyond) and permanent housing. In other words, these temporary shelters need to serve up to one year or more until interim housing is built.

Temporary shelters are built in order to fulfill the basic needs of the survivors rapidly with optimum convenience. There are different definitions of shelters. One of the definitions of shelter is "a habitable covered living space, providing a secure, healthy living environment with privacy and dignity to those within it" (Foster S. and Fowler J. (ed.), 2003).

In the Oxfam Briefing Notes, the specific objectives of transitional shelter depend on the context are described as (Sahota S. S. and Jawahar M. B., 2008):

- To be structurally sound and provide adequate protection from the environment

- To contribute to personal safety and security, health and well-being
- To enable normal household duties and livelihood activities to be undertaken
- To bridge the gap until durable housing is organized
- To provide psychologically assurance of progressive recovery towards normalcy

For shelter design, beyond survival, the key considerations are:

- providing protection from the climate
- ensuring privacy and dignity
- providing personal safety and security [3].

Temporary earthquake shelters are the first places for survivors after their own houses have been demolished; they ought to be habitable for survivors (Acerer, 1999). They need to create at least minimum living conditions, which must involve spaces to live, sleep and socialize as well as areas for food preparation, personal hygiene, and privacy (Yüksel and Hasırcı, 2012). In other words temporary shelters need to accommodate all the daily activities optimally.

According to the final report a variety of models are developed regarding the earthquakes in various sizes (JICA and IMM, 2002) In two different scenarios, 51000 and 59000 housing units are forecasted to be heavily damaged in a possible earthquake in Istanbul. Therefore, besides being prepared and taking precautions in order to reduce the damage of a possible earthquake, it is important and time saving to act rapidly in the rehabilitation phase and produce needed amount of shelters for the survivors. In the need of very large numbers of shelters, it is positive to have an accumulation of creative design ideas for these shelters. Also producing alternative houses, for different user scenarios especially with the experience of disaster preparedness since Kocaeli (1999) and Van (2011) earthquakes in Turkey becomes an important step for shelter design.

Table 1. *Criteria of the "What if NYC?" competition.*

Criteria	Goals
Density	Maximize number of housing units per land area
Rapid Deployment	Provide units ready to be occupied as soon as possible
Site Flexibility	Maximize the ability to accommodate as many different sites as possible
Unit Flexibility	Maximize the ability to accommodate as many variable household types and sizes as possible
Reusability	Maximize the potential for reuse of the structures either for future disasters or other purposes
Livability	Maximize the strength, utility, convenience, and comfort of the dwellings
Accessibility	Allow access for people who have limited mobility
Security	Make public space defensible and help people feel safe
Sustainability	Reduce energy costs and the carbon footprint of the dwellings
Identity	Maximize the ability of New Yorkers to feel a sense of identity and even pride in where they live
Cost Efficiency	Maximize the best value for investment

3. Criteria and studies

There can be different criteria in order to design temporary shelters. As aforementioned, safety, privacy, security and protection are some basic consideration that shelters need to fulfill. In 2008 NYC Office of Emergency Management, in collaboration with other organizations held a competition "What If New York City- Design Competition for Post-Disaster Provisional Housing" challenging participants to propose innovative designs for temporary urban housing for use after a disaster [4].

With the experience of many hurricanes (especially after hurricane Katrina in 2005), this competition has been focused on the recovery after a catastrophic coastal storm hits New York City. To aid the competitors' understanding of the context for which they are designing, the sponsors have illustrated the changing conditions of a hypothetical neighborhood, Prospect Shore.

The scenario unfolds on three parallel tracks: what happens at the scale of the city, what happens at the scale of the neighborhood, and what happens at the scale of a household. The criteria for the shelter designs for the competition (Table 1) has emphasized the needs of flexibility (site and unit), efficiency (in land use, implementation and cost), and sustainability. There have been 117 project submissions which reflect, in part or in whole the given criteria which in fact creates a library for shelter projects. Even though the type and context of the disaster is different, the criteria have many similarities with post-earthquake shelters.

In ITU's Architectural Design Computing Graduate Program, the studio's main theme is also post-disaster shelters for earthquake survivors since 2005. With approximately 100 projects throughout the years, this studio also creates another library for shelter projects. Similar to the aforementioned competition, the location is hypothetical in this studio too. In the years, various results are obtained regarding material and application, and the main focus is mostly on the creative ideas for mass and rapid production both in the unit and neighborhood scale. Many problems arise after disaster and the problems on sheltering in rehabilitation phase. The problems especially after disastrous earthquakes in Turkey (Songür, 2000 and Limoncu and Bayülgen, 2005 etc.) are also taken into consideration while stating the criteria.

Workforce is limited during the rehabilitation phase. Therefore, temporary shelters need to be dismountable, light, can easily be transported and can be constructed by a few people. Sustainability, being dismountable on demand and lightness are essential features especially for the temporary shelters to be designed after the disaster.

Various materials and application procedures can be used while designing post-disaster shelters. In terms of co-production it can be collected under three categories: generally, compact fundamental modules can be obtained by using basic materials and units with several changes or it consists of previously manufactured materials and/or modules (or with pre-fabric elements) or it can be designed from materials manufactured on-site.

In the need of mass production, resolving a single module is not enough. Therefore, designing a sheltering area composed of modules (or variations of the modules) is also sought. In other words, design solutions are needed for both in the unit and the neighborhood scale. Capability to accumulate and derive modules and the relation between them are also important.

Projects that are developed in the studio, are discussed and evaluated in accordance with a set of selected criteria based on literature, experience from previous earthquakes and other design briefs:

- habitability: responsive to the needs of the survivors (psychologically, physically, culturally and environmentally –e.g.: privacy, security, identity, space requirements, climatic conditions, etc.),
- feasibility: in the sense of economy, time and implementation in sense of a single unit as well as mass production,
- sustainability: ease of recycling of the material used, reusable, mountable and demountable units or parts

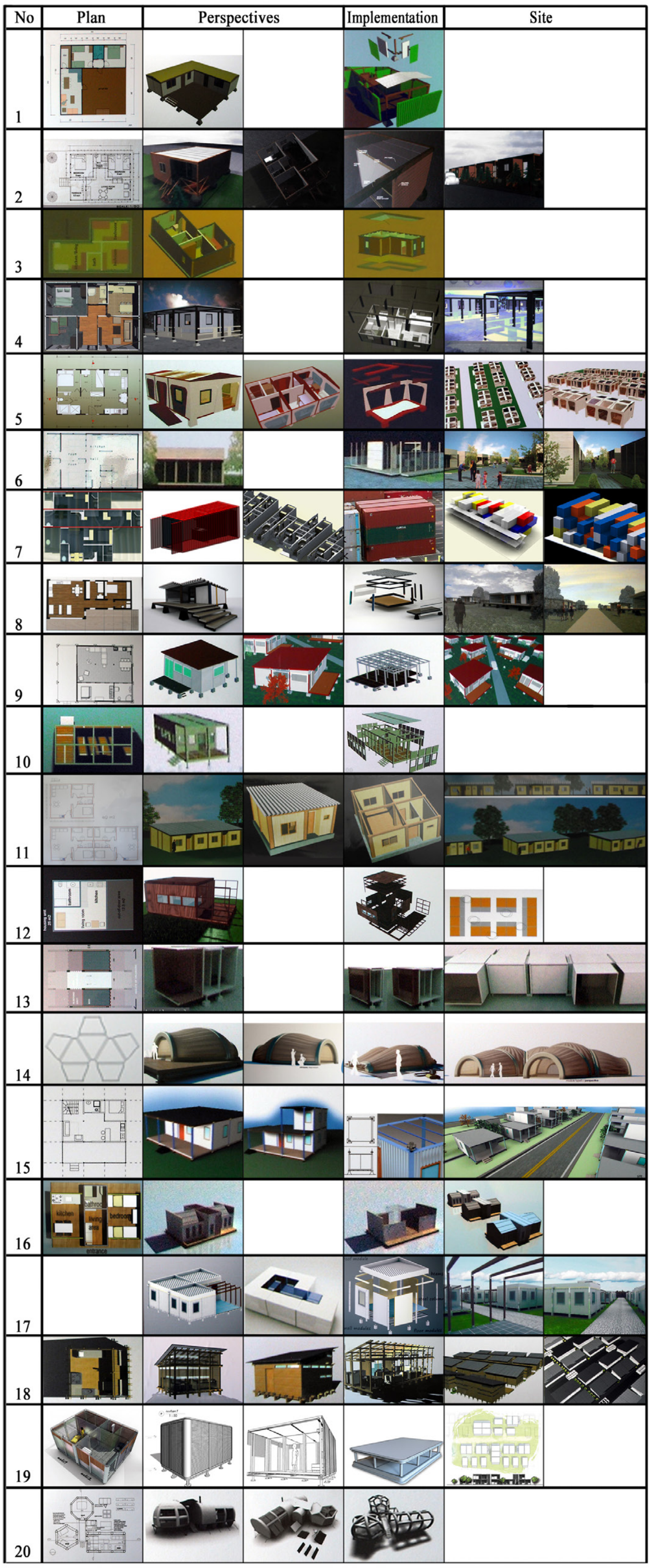
Table 2. *Evaluation of the projects according to the criteria.*

	units			site		site generation			criteria								
No	ready-made	prefabricated	on-site assembly	alternatives	generative	linear	cluster	other	lightness	flexibility	reusability of material	reusability of the unit	easy transportation	rapid implementation	economy	security	environment compatibility
1			X		X				X	X	X		X	X	X	X	X
2			X		X	X			X	X	X		X	X	X	X	X
3			X		X				X	X	X		X	X	X	X	X
4			X		X	X			X	X	X		X	X	X	X	X
5			X		X	X			X	X	X		X	X	X	X	X
6			X		X	X			X	X			X	X	X	X	X
7	X			X	X			X	X	X		X	X	X	X	X	X
8			X	X	X	X			X	X	X		X	X	X	X	X
9			X	X	X	X			X	X	X		X	X	X	X	X
10			X	X	X				X	X	X		X	X	X	X	X
11			X	X	X	X			X	X	X		X	X	X	X	X
12			X		X		X		X	X	X		X	X	X	X	X
13		X			X	X			X	X	X	X	X	X	X	X	X
14			X		X		X		X		X	X	X	X	X	X	X
15			X	X	X	X			X	X	X		X	X	X	X	X
16			X		X	X			X	X	X		X	X	X	X	X
17			X	X	X	X			X	X	X		X	X	X	X	X
18			X		X	X			X	X	X		X	X	X	X	X
19			X		X	X	X		X	X	X		X	X	X	X	X
20			X		X				X	X	X		X	X	X	X	X
21			X	X	X	X			X	X	X		X	X	X	X	X
22			X		X				X	X	X		X	X	X	X	X
23			X		X	X			X	X	X		X	X	X	X	X
24			X		X	X			X	X	X		X	X	X	X	X
25			X		X		X		X	X	X		X	X	X	X	X
26			X	X		X			X	X	X		X	X	X	X	X
27			X	X			X		X	X	X		X	X	X	X	X
28			X		X	X			X	X	X		X	X	X	X	X
29			X		X	X			X	X	X		X	X	X	X	X
30		X				X			X		X		X	X	X	X	X
31			X	X		X			X	X	X		X	X	X	X	X
32			X		X	X			X	X	X		X	X	X	X	X
33			X	X		X			X	X	X		X	X	X	X	X
34			X		X				X	X	X		X	X	X	X	X
35			X	X			X		X	X	X		X	X	X	X	X
36			X		X			X	X	X	X		X	X	X	X	X
37			X	X			X		X	X	X		X	X	X	X	X
38			X		X	X			X	X	X		X	X	X	X	X
39			X	X				X	X	X	X		X	X	X	X	X

without harming natural environment.

Some other criteria must also be mentioned despite of the similarities to the aforementioned ones.

Table 3. *The unit and configuration of the units.*



- flexibility: designing, usage and generation of the single unit and the site,
- rapid and mass implementation: less workforce, easy transportation, easy implementation for a large number of shelters in case of need,
- lightness: less workforce and easy transportation of materials,
- usage of various/pre-fabricated materials: include different materials as well as design elements in the project which are already built or exist elsewhere.

4. Evaluation and selected projects

The projects are evaluated according to the selected criteria, and the projects which matched them uttermost are selected and shown in this paper. Some projects have single modules and they are simply increased in number by duplication. On the other hand, some projects are focused on basic modules, which can be altered based on the number of household. While some projects mostly comply with the criteria, they are deficient in augmentation or providing multi-production solutions. In terms of a single module solution, most of the projects are adequate. In this study, the selected projects are classified and evaluated in terms of formation of a structure in terms of modules (unit production), projects' capability to produce alternatives (site), their capability to be generated (site generation), and the selected criteria (Table 2 & 3).

Most of the project examples are designed as single-story linearly expanding settlements. Therefore, settlements tend to be sprawling and low-rise. Construction systems enabling multi-story modules may be preferred for site efficiency. Since most of the settlements are comprised of same duplicated modules or similar ones, façades and streets also look similar. Hence, variant and non-uniform façades are intended to be designed in this studio in order to create a certain degree of individuality. Even though some of the projects are designed and detailed as a single unit, the formation of grid-based or similar systems enables different unit alternatives and generative site formation. Moreover modular structural systems also encourage alternatives for units.

Generally linear and clustered settlements are designed in the horizontal orientation. Moreover, one or two-story designs are made generally at the third dimension. Copying, moving, mirroring, rotating and deleting procedures are employed when transformation processes regarding reproduction are considered.

Some of the projects are selected in order to represent some generic ideas and main features of the studies. In table 2, the features such as being manufactured on-site, customized or prefabricated, creating alternatives, multi-assembly of modules, being demountable and transferable etc. is shown combined with the selected criteria. While in table 3, the basic units (plans), perspectives (or façades) and implementation of the shelters and site relation of the modules is shown.

In this paper, different cases are shown in order to give an idea about sheltering design. MobARCH project, case examples from ITU's graduate program, container projects and lastly CPoDS will be discussed.

Figure 1. MobARCH Project (Şener and Altun, 2009).

Figure 2. MobARCH Project (Şener and Altun, 2009).

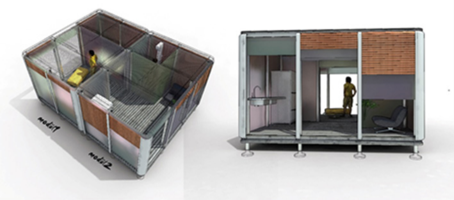
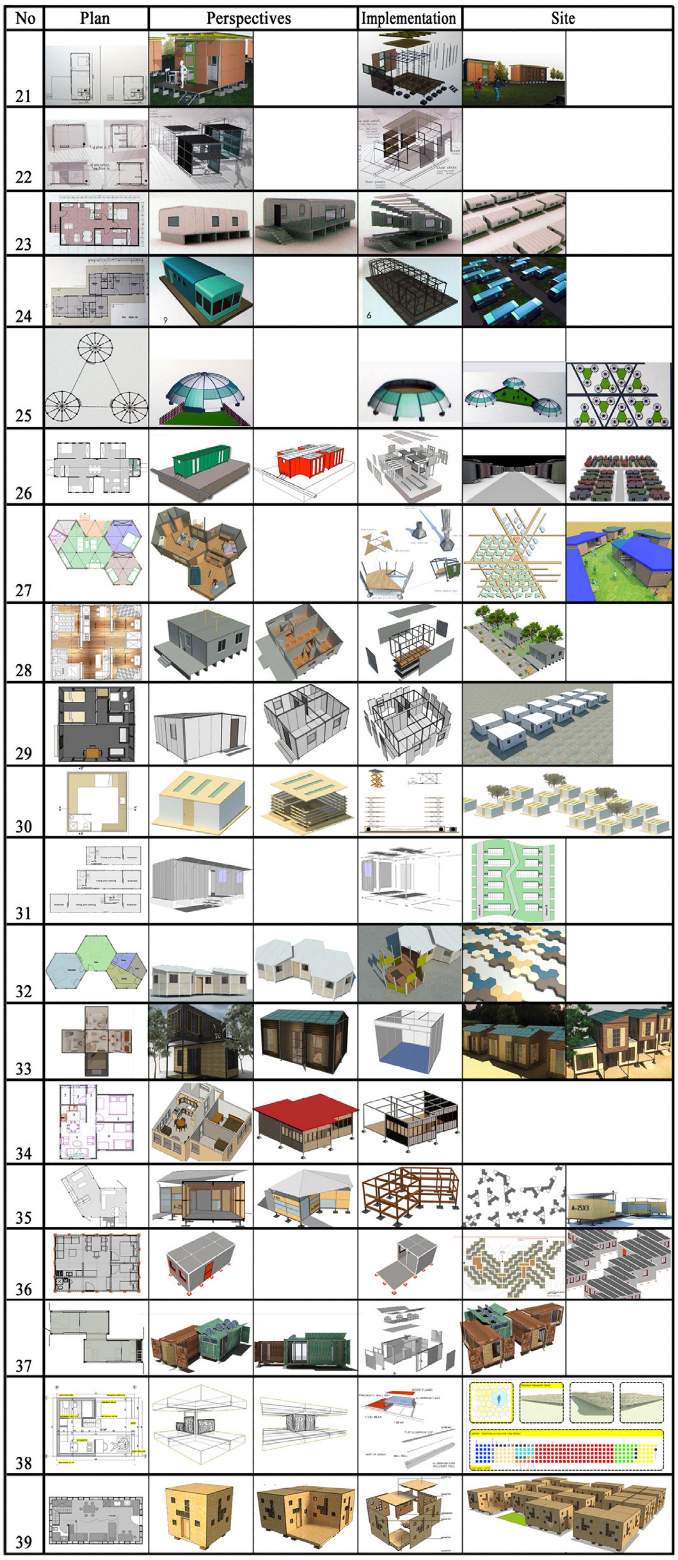


Figure 3. Single module.

***Table 3.** The unit and configuration of the units (continued).*



No	Plan	Perspectives	Implementation	Site
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				

CASE 1: MobARCH: Various temporary housings are produced in the post-earthquake dwellings that put into practice after 1999 Kocaeli earthquake. Projects carried out contain one story or two story alternatives. Some projects that are put into practice cause

some difficulties in utilization owing to inadequate detailing and poor executions. Since multi-story solutions are not used, dwellings have to be dispersed into a wide area. In other words

Figure 4. The site configuration.

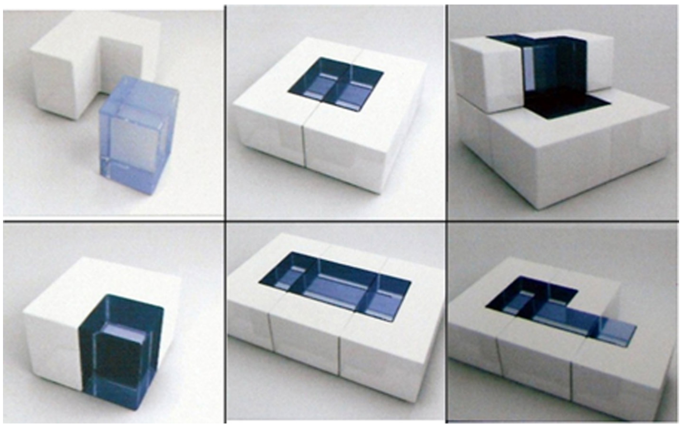


Figure 5. Alternatives for shelters.

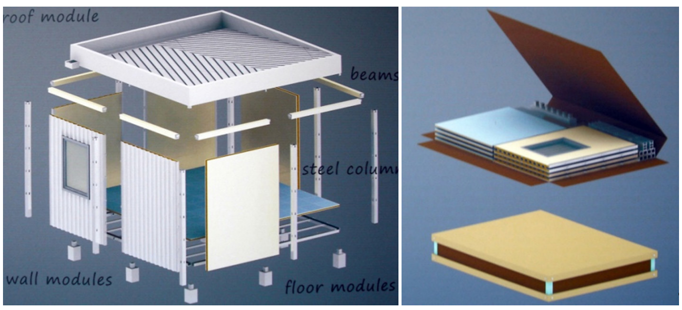


Figure 6. Disassembled and stocked unit.

Figure 7. Single module and site.

sites are used inefficiently and vast areas were needed in order to accommodate the required amount of housing projects. When project MobARCH (Şener et al, 2003, Şener and Altun, 2009) is taken into consideration at single module scale, it meets the necessary criteria in many ways. The shelter unit is elevated from the ground for less impact on the environment (Figure 1 & 2). Also the unit is demountable and reusable. It can be implemented rapidly with minimum workforce.

CASE 2: NO-19 (Table 2 & 3): This example provides dwelling alternatives developed on the grid and modular system. Previously manufactured modules which are assembled in various forms generate alternatives. Solutions provided as a single or two story dwellings are assembled in different ways and they form settlements. Placing modules on grids is an excellent example in terms of creating alternatives, easy stacking and transportation (Figure 3 & 4).

CASE 3: NO - 17 (Table 2 & 3): Having similar features with the first project, this one has special features like its capability to create alternatives with different wall arrangements, facilitate transportation and implementation. Dwelling alternatives placed on the grid system is presented in this project. These dwellings come in packed parcels, are constructed on-site, and create alternatives by being assembled different ways with other boxes produced on-site. The most important difference of this project from the previous one is creating alternatives for different needs during on-site assembly. One or two-story solutions are linearly assembled and form settlements. This project is important in terms of placing the modules on the grid systems and applying the alternatives with the materials form parcels (Figure 5 - 7).

CASE 4: NO – 14 (Table 2 & 3): Module can be produced in a customized fashion in the third example in which material is also an important feature. There are only one-story houses and although having no alternative is a negative aspect of this project, it is important because it is developed in a cluster that emanates from two modules; the basic and the secondary one.

Cluster is formed as a result of primary modules' coinciding with the edges and secondary (triangle) formed modules' coinciding with the center (Figure 8 & 9).

In other words, triangular module forms the central part and helps the generation while basic modules forms the edges. With this clustering, different number of households can be accommodated in case of need and a flexible utilization is encouraged.

CASE 5: NO - 23 (Table 2 & 3): In the fourth project, a family of four is taken into account to create the single module. The settlement is formed by linear repetition of the modules which does not support individuality. This caravan-like structure has become available through on-site assembly process. Even though the detailing is only for a single unit, it has the potential to be constructed for different sizes (Figure 10 & 11).

CASE 6: Container projects: As a fundamental module, containers are also selected which are widely used in international transportation. The installation on demand and removal of the containers when the demand has disappeared will be possible since they can be rapidly transported and installed. Instead of on-site manufacturing, treating a ready-made product in various ways and making it functional are aimed. For the architects, shipping containers provided a useful building material given their strength, durability, ability to stack, modular form, and ample availability.

Containers were also used in rehabilitation phase after the many earthquakes, e.g.: Van Earthquake. Container residential areas; four in Erciş and thirty-one in Van are built. In accordance with the instruction to manage these places where almost 180 thousand earthquake survivors would live until the permanent housing is complete is done, social and public services related to these areas are done (Turan, 2012, 47)

Previous instances constructed with the containers are assessed and their features and deficiencies are taken into account. Containers appraised in the instances are assembled in clusters (by being placed side by side or putting one upon another).

An dormitory project which was designed and built in Amsterdam in

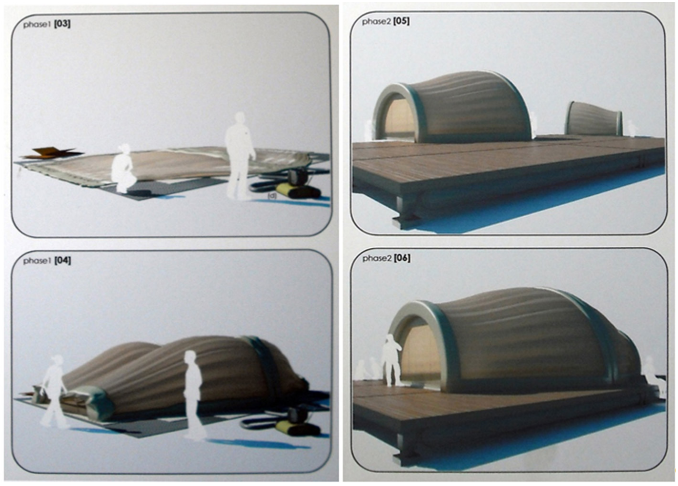


Figure 8. Single module.

Figure 9. Clusters.

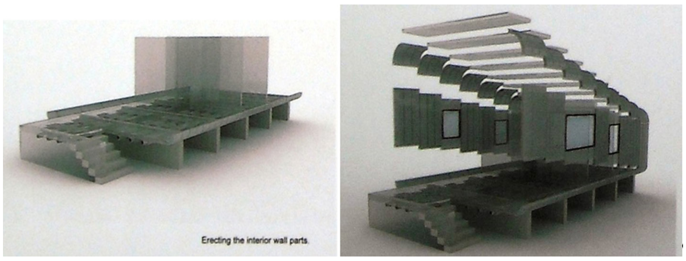


Figure 10. On-site assembly.

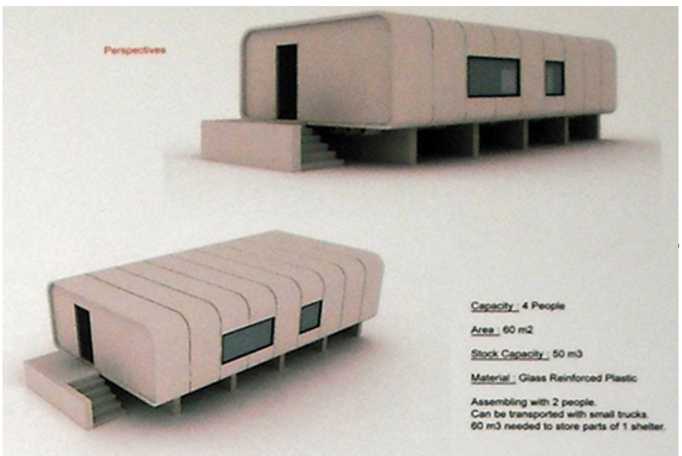


Figure 11. Single module.

2005, meets all the necessary conditions for sheltering. In addition it is the second most preferred dorm among students. Dormitory was estimated to reside until 2010 however it attracts a great deal of attention and a decision has been made on continuing to use it until 2016 (Figure 12) [5].

The container has been envisioned as a module in this project, and is completed with toilets and kitchen worktops. Modules are assembled in clusters. Modules being put one upon another without any movement create plain and uniform façades.

Another example is the Container City projects that were planned in London in 2002 and they are composed of a school and workshops (Figure 13) [6]. In this project containers are put one upon another perpendicularly. The goal is to create variance in façades. Containers were made ready for use by several modifications and were put into operation in the application area. The project which took five months to design, was implemented in the short span of four days.

ARQtainer is a bright yellow earthquake-proof home that sits on the outskirts of Santiago, Chile consists of five steel shipping containers The house, was developed as an earthquake-resistant and low-cost home that could be built in a small time frame (Figure 14, [7]).

CASE 7: NO – 7 (Table 2 & 3) - CPoDS (Container Post-Disaster Shelters): There are two important features of CPoDS which need to be emphasized. First one is the usage of containers as a ready-made module and the second one is the computational generation which enables to generate a large range of possible solutions.

Containers that are treated as ready-made modules are taken into account in terms of two most common sizes and several modifications have been made on them. Portable toilets, showers and worktops are designed.

Two different sized containers are used in order to create shelters for different number of households in CPoDS. Small-sized containers are elaborated in a way that one or two persons can live; large-sized ones are for three or four people (Figure 15). And for more people consecutive containers can be designed in need. Narrow façades are designed to be completely transparent

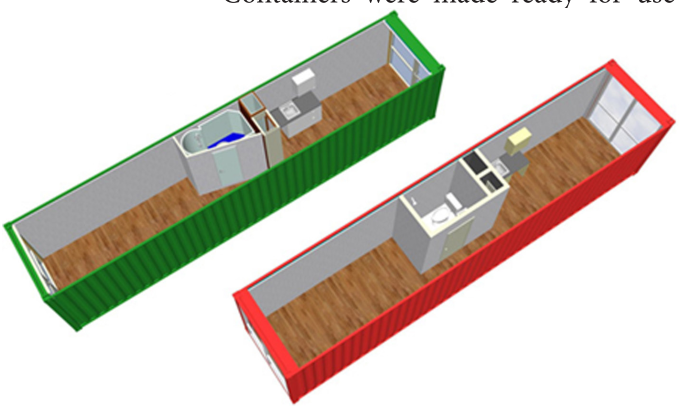


Figure 12. *The modified containers in the dormitory project [5].*

Figure 14. *ARQtainer project in Santiago, Chile (2013) [7].*

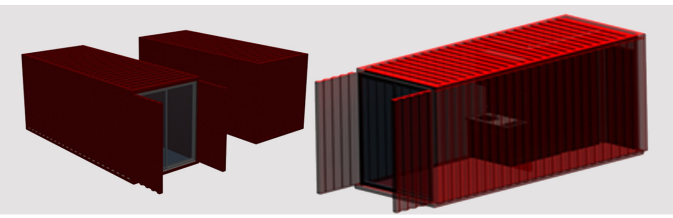


Figure 15. *Small sized containers.*

Figure 13. *Container City II project in London (2002) [6].*

as they are the façades receiving light.

Containers designed and improved as alternative modules have been grouped with regard to horizontal and vertical development and consumption and have been worked on to create shelter sites. As the number of survivors is unforeseeable, one of the main goals is providing alternatives for different number of survivors. In order to realize this goal CPoDS is designed via a productive system and a script developed in the 3dsMax environment (Şener and Torus, 2009). Design, algorithm and development stages have been preceded for the system in use in order to produce horizontal and vertical variations of a container in an urban sense and to design in a way to increase environmental variety.

An interface is generated by writing a script in 3dsMax with the ability to intervene in the design process at various points (Figure 16). Intervention can be made in the desired areas and for a preferred number of dwelling production. The number of containers required for the number of people (each one has shown with a different color for manufactured products) implementation area and the coefficient can be set.

Yellow and red colored (small) containers are for sheltering households consisting of one or two, while blue and white (large) ones are for three or four people. As mentioned above these containers can be combined and used accordingly for families with more than four members.

If the projects need space between units, this can be entered into the interface as well. The major difference from the manual design process is that it can be designed randomly to create alternatives. By enabling movements of the linear building blocks (containers), an attempt is made to reduce uniformity and to eliminate a monolithic effect particularly. Furthermore, producing alternatives by random assignments are possible for unlimited sites.

Production can be especially made in accordance with the immediate and desired criteria by means of such a productive system. Alternatives that are more difficult to attain and time consuming and their variations acan

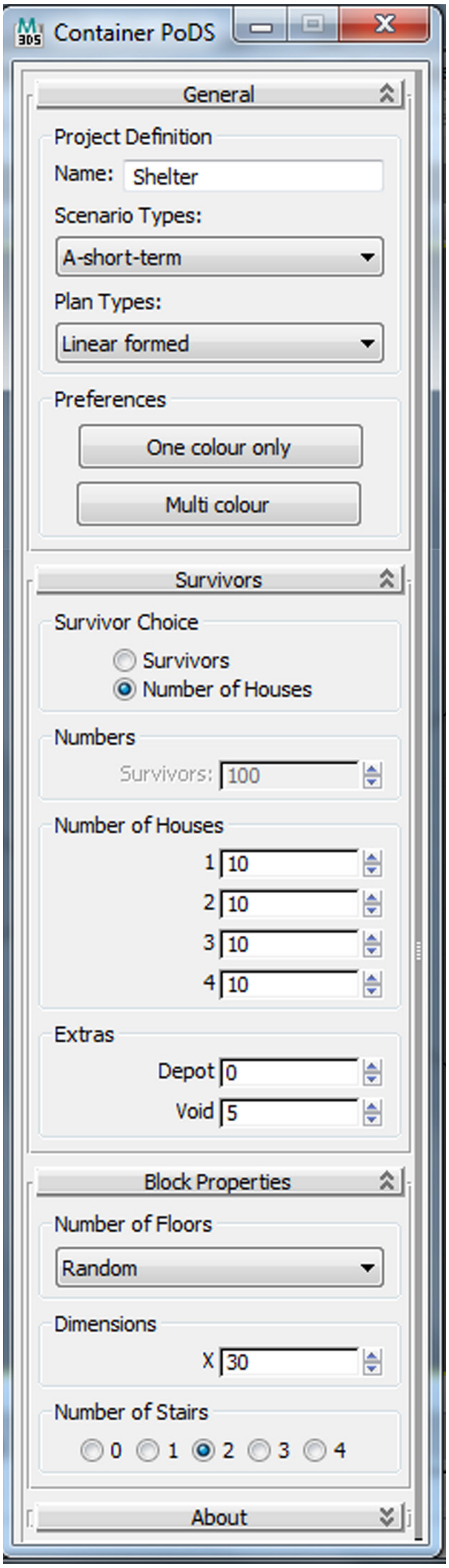


Figure 16. *CPoDS interface.*

be obtained according to the variable criteria. Of all the variable criteria in the article, in particular directly controlling population, population-area relation, occupancy-vacancy rate gain importance. Providing alternatives

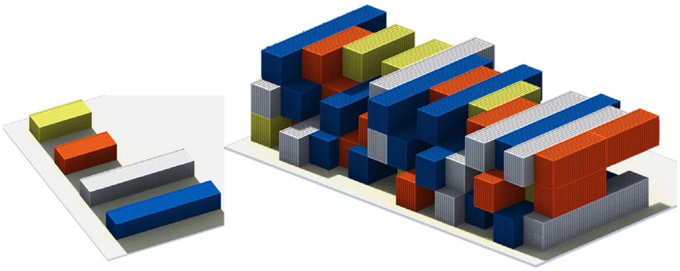


Figure 17. Containers for different number of inhabitants in CPoDS.

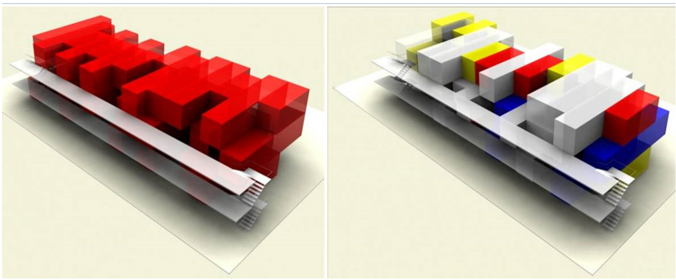


Figure 18. *Linear generation in CPoDS (Şener and Torus, 2009).*

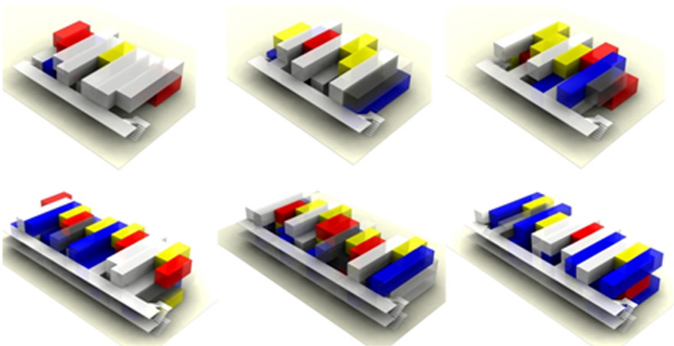


Figure 19. *Different generations in CPoDS (Şener and Torus, 2005).*

for different stories on demand helps providing multi story solution alternatives when the population is dense, and there is not enough space or single story solutions when these is enough space (Figure 17 - 19).

When a written interface script is examined, it is seen that produced blocks can be constructed by entering data in two ways. First one is derivation by entering the number of disaster survivors who need housing and the second one is the derivation achieved by entering the number of required containers. Hence, it is possible to cater to the number of disaster survivors. As such, it will also be possible to manufacture required amount of housing for the existing area after the disaster and to remove them partially or completely when the need has disappeared.

According to the selected scenario, it is possible to generate single-loaded or double-loaded corridor solutions. CPoDS can be developed by working on different alternatives without neglecting the variance and the randomness in the development of the script.

The designed modules satisfy the fundamental criteria with regard to modules, even though modifications can be made later. Also alternatives and different derivations and generation rules can also be added in the script in order to improve the alternatives.

For the first time at CPoDS production is made by a productive system. Consequently an instrument which produces alternatives for different populations is developed. The instrument makes products according to the desired population, area and number of floors. So, not only at a single module scale but also in multi-production alternatives are rapidly produced in which area, number of floors, occupancy-vacancy, population are controlled.

One of the most important advantages of dwelling production for post-disaster is being able to directly control volume population, area to be used, occupancy-vacancy rate (and other criteria that can be added) with productive systems like CPoDS. Variety that cannot be obtained by manual production and products that quickly respond are attained according to the variables. Besides, various parameters can be included to the script at the further stages for improving CPoDS or production can be made by means of alternative scenarios except generated scenarios.

5. Concluding remarks

There are numerous temporary sheltering projects which are designed and implemented based on the needs of the survivors'. Unfortunately there is no perfect shelter which is economic and can be mass-produced and implemented rapidly and respond all the needs of a shelter, and the needs of the survivor. Each project is valuable and lessons are learnt from each disaster, about how to manage, plan and design better. The aforementioned projects as well as the designed projects in competitions and case studies in shelters create an accumulation of knowledge in shelters and help us to respond rapidly to the needs of the survivors.

In Turkey's case, the forecasted earthquake scenario is alarming and preparedness in every phase is needed. With regards to shelter, the studio in ITU is significant because the context of the studio is Istanbul and the criteria are developed after Kocaeli and Van earthquakes. CPoDS is also an important project because of the container based modules and computer based generation. While container modules enables implementation rapidly and economically, the computer based generation enables to be ready to design and create alternatives within the desired criteria even though the numbers (of survivors, of size of the site, or of shelters etc.) are uncertain or variable.

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Afet sonrası barınak tasarımı ve CPoDS

Afet yönetimi ve afet sonrasında yeniden yapılanma süreci karmaşık, çok aşamalı ve her aşamasında birçok aktörün yer aldığı, pek çok kaynak ve uzmanlık isteyen bir süreçtir. Barınma, afet sonrası yönetimindeki birçok sorundan biridir. Afetlerden çok sayıda kişi aynı anda etkilendikleri için, ihtiyaca cevap verebilecek miktarda geçici barınak çözümlerinin ve uygulamalarının hızlıca üretilmesi gerekmektedir.

Türkiye'de ciddi hasarlar meydana getiren depremler sıkça gerçekleşmektedir. Bu depremlere hazırlıklı olunması ve afet sonrası için gerekli olan ön çalışmaların yapılması depremin zararını azaltabilmektedir. Ayrıca rehabilitasyon ve yeniden yapılanma sürecini hızlı ve doğru bir şekilde planlamak da depremzedelerin ihtiyaçlarını hızla çözerek, afetin etkisinin azalmasına yardımcı olmaktadır. Türkiye'de 1999 yılında gerçekleşen Kocaeli ve 2011 yılında gerçekleşen Van depreminden öğrenilen bilgiler çok değerlidir. Bu bilgiler deprem sonrası geçici barınak üretimi için çeşitli girdiler vermektedir. Geçici barınakların, ihtiyaç halinde bir seneye kadar barınma ihtiyacını karşılayacağı öngörülmektedir. Dolayısıyla hızlı uygulamanın yanı sıra, barınakların depremzedelerin temel ihtiyaçlarını karşılayacak düzeyde olması gerekmektedir. Depremzedelerin tüm günlerini barınaklarda geçirecekleri göz önünde tutularak, günlük aktivitelere yemek pişirme, uyuma, hijyen vs. gibi ihtiyaçlara cevap verebilmelidir. Depremzedeleri çevre ve iklim koşullarından korunmanın yanı sıra, depremzedelerin mahremiyetinin korunması, kişisel emniyet ve güvenliğinin sağlanması gerekmektedir [3].

2002 JICA ve IMM raporuna göre İstanbul'u etkileyecek olası bir depremde iki farklı senaryoya göre 51000 ve 59000 konut ihtiyacı olacağı öngörülmektedir. Bu ve benzeri senaryolara hızlı ve etkin bir şekilde cevap verebilmek için öncelikle iyi bir planlama ve hazırlık süreci gerekmektedir. Barınak ölçeğinde ise, ihtiyaç halinde binlerce barınağın hızlı bir şekilde tasarlanması ve üretilmesi gerekmektedir.

Bu yazıda barınaklar üzerine yapılan çeşitli çalışmalar ve örneklerden kriterler belirlemiştir. Bu kriterler; barınağın yaşanabilir olması (psikolojik, fiziksel, kültürel ve çevresel etkilere cevap verebilmesi), fizibilitesi (uygulamanın tekli ve komşuluk ölçeğinde maddiyat ve zaman kullanımı açısından uygulanabilir olması), sürdürülebilirlik (geri dönüşüm, tekrar kullanılabilirlik, çevreye zarar vermeden sökülüp takılabilmesi), esneklik, hızlı ve toplu uygulanabilmesi, hafiflik ve farklı malzeme kullanımı şeklinde tanımlanabilmektedir. Ayrıca hem birim ölçeğinde hem de komşuluk ölçeğinde çeşitli hane halklarının ihtiyaçlarına cevap verebilecek, farklı uygulamaların tasarlanması da önemli kriterlerden biridir.

İTÜ'de yürütülen Sayısal Tasarım Stüdyosu'nda, 2005 yılından beri barınak tasarımı üzerine çalışılmaktadır. Bu çalışmaların oluşturduğu kütüphaneden örnekler seçilerek, yukarıda belirtilen kriterlere göre değerlendirilmiş ve son olarak da barınak uygulamalarında sıkla kullanılan konteynırlar ele alınmıştır. Aynı derste üretilen ve daha sonra geliştirilmeye devam eden PoDS (Container Post-Disaster Shelters - Konteynır Afet Sonrası Barınakları) projesi de detaylı olarak açıklanmaktadır. Bu projenin detaylandırılmasının en önemli nedeni ise ilk defa barınaklar için bilgisayar ortamında alternatiflerin üretilmesidir. CPoDS, konteynırları temel birim olarak kullanarak üretken bir algoritmayla farklı kullanıcı ihtiyaçlarına göre varyasyonlar türeten araçtır. İki farklı boyuttaki konteynırlar temel elemanlar olarak kullanılmakta; alan, kat sayısı, doluluk-boşluk oranı ve nüfus gibi kontrollerle üretim gerçekleştirilmektedir. Dolayısıyla afet sonrasındaki sayı belirsizliğine karşı böyle bir üretken sistemin kullanılması CPoDS'un avantajlı noktasıdır. Ayrıca, çeşitli parametreler oluşturulan senaryoların da CPoDS veya bu tarzda üretken bir sisteme dahil edilmesi, projenin ihtiyaçlara göre geliştirilebilir olması da önemlidir.

Sonuç olarak, her koşula ve kritere tam olarak cevap verebilecek, ucuz, hızlı ve seri üretime uygun bir barınaktan söz etmek mümkün değildir. Bu açıdan bakıldığında bir deprem ülkesi olarak özellikle deprem sonrasındaki ihtiyaçlara cevap verebilecek özelliklerde olan yaratıcı barınak tasarımlarının olduğu bir kütüphaneye sahip olmak ve ihtiyaç halinde bu kütüphaneden yararlanmak hazırlık sürecinde daha etkin sonuçlar alınmasını desteklemektedir.