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DESIGN OF TRANSFORMABLE TRANSITIONAL SHELTERS

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ABSTRACT

DESIGN OF TRANSFORMABLE TRANSITIONAL SHELTERS

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Since the natural disasters such as earthquakes, floods, storms, hurricanes and tsunamis may leave thousands of people homeless, the most important need after the disaster is the sheltering. Even though the basic needs are similar in the transitional shelters, they differ significantly in terms of spaces, materials and duration of use. Such shelters are temporary dwellings that can be transported to the places needed. However, most of the existing shelters are designed without considering the reusability or transportability. Moreover, some of them neither provide adequate flexibility within the space nor allow expansion. In fact, kinetic design solutions may meet such requirements. In this thesis, the aim is to design a transformable transitional shelter that fulfills the needs of a family with optimum convenience and to propose a settlement layout for such units. For this purpose, first, design criteria for the transitional shelters are presented. Second, the existing examples of the transitional shelters are analyzed whether they meet those design criteria. Third, a transformable transitional shelter is proposed which can transform from a closed configuration in size of 3x3m to an expanded form covering 21 m^2 to carry out domestic activities. Thanks to its expansion properties, the proposed unit can easily be transported to any desired location in its compact state. Several units can be combined to serve for either larger families or to be used for different functions such as supply unit, heath unit and activity unit. Finally, a settlement layout is presented to show how the proposed units can be combined in different arrangements.

Keywords: transitional shelters, emergency shelters, transformable structures, portable structures, natural disasters

ÖZ

BİÇİM DEĞİŞTİREBİLEN GEÇİCİ BARINAK TASARIMLARI

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Deprem, sel, fırtına, kasırga ve tsunami gibi doğal afetler binlerce insanı evsiz bırakabileceğinden afet sonrası en önemli ihtiyaç barınmadır. Geçici barınaklarda temel ihtiyaçlar benzer olsa da mekân, malzeme ve kullanım süreleri açısından önemli farklılıklar göstermektedirler. Bu tür barınaklar, ihtiyaç duyulan yerlere taşınabilen geçici konutlardır. Ancak, mevcut barınakların çoğu yeniden kullanılabilirlik veya taşınabilirlik özellikleri düşünülmeden tasarlanmaktadır. Ayrıca, bazıları yeterli düzeyde mekânsal esneklik sağlamamakta ve genişlemeye izin vermemektedir. Aslında, kinetik tasarım çözümleri bu tür gereksinimleri karşılayabilir. Bu tezde amaç, bir ailenin ihtiyaçlarını optimum düzeyde karşılayabilecek biçim değiştirebilen geçici bir konut birimi tasarlamak ve oluşturulan birimler için bir yerleşim planı önermektir. Bu amaçla, öncelikle geçici barınakların tasarım kriterleri sunulmaktadır. İkinci olarak, geçici barınakların mevcut örneklerinin bu tasarım kriterlerini karşılayıp karşılamadıkları analiz edilmektedir. Üçüncü olarak, 3x3m ebadında kapalı bir konfigürasyondan temel barınma ihtiyaçlarını karşılayabilecek 21m^2'yi kaplayan genişletilmiş bir forma dönüşebilen geçici konut birimi önerilmektedir. Genişleme özelliği sayesinde önerilen ünite kompakt halde istenilen yere kolaylıkla taşınabilmektedir. Daha büyük ailelere hizmet etmek veya tedarik ünitesi, sağlık ünitesi ve aktivite ünitesi gibi farklı işlevlerde kullanılmak üzere birkaç ünite birleştirilebilmektedir. Son olarak, önerilen birimlerin farklı düzenlemelerde nasıl birleştirilebileceğini göstermek üzere bir yerleşim planı sunulmaktadır.

Anahtar Kelimeler: geçici barınaklar, acil durum barınakları, afet sonrası konut, biçim değiştirebilen yapılar, taşınabilir yapılar, doğal afetler

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I would like to express my enduring love to my parents, who are always supportive, loving and caring to me in every possible way in my life.

Merve Cerrahoğlu

İzmir, 2021

TEXT OF OATH

I declare and honestly confirm that my study, titled "DESIGN OF TRANSITIONAL SHELTERS UNITS" and presented as a Master's Thesis, has been written without applying to any assistance inconsistent with scientific ethics and traditions. I declare, to the best of my knowledge and belief, that all content and ideas drawn directly or indirectly from external sources are indicated in the text and listed in the list of references.

Merve Cerrahoğlu

Signature

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October 11, 2021

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CHAPTER 1
INTRODUCTION

1.1. Motivation

Disasters cause not only significant damage to the built environment but also loss of human life and disruption of social and economic activities (Ergünay, 2005). Due to the destruction of human settlements especially after high-magnitude earthquakes, a need for building temporary shelters emerges. There are three stages need to be considered after the disasters which are immediate relief period, rehabilitation period and reconstruction period (UNHRC, 2016; Hacımahmutoğlu, 2009).

The immediate relief period includes search and rescue, first aid, treatment, evacuation, communication and transport, determination of needs, provision of food, drink, clothing and fuel, security, environmental health and preventative medicine, determination of damages, removal of hazardous debris, and prevention of secondary disasters like fire, explosions and contagious diseases (Çakır, 2007). In this period, emergency shelters such as tents are distributed to the people who lost their houses. The tents are cost-effective and lightweight; thus, they can be easily moved and installed in any desired locations. The tents can be a lifesaver for a short-term, but such shelters are not suitable for long-term use.

The rehabilitation phase is a period including the protection and continuation of life which aims to restructure the socio-economic order in the disaster zone, improve the ongoing situation and provide necessary infrastructure. Transitional shelters are used in this period until permanent housing is constructed. These shelters can be moved from temporary sites to permanent ones or made from supplies that can later be used in permanent structures (IFRC, 2011). They are built to provide protection from negative environmental impacts and improve daily living conditions.

On the other hand, the reconstruction period is the last stage in which permanent solutions are sought for rebuilding permanent and durable housing with more suitable infrastructure.

Among the aforementioned periods, the rehabilitation phase is so important since it is a transition period in which comfortable living conditions should be provided to the disaster victims until permanent housing is built. This transition period requires building transitional shelters. In fact, portable structures can be used for transitional shelters because they can meet the design criteria of transportability, reusability, flexibility and expandability. They can be easily transported to the intended locations and quickly installed. These structures can even be used as permanent shelters for the disaster victims. The advantages of the portable structures motivate to develop feasible and flexible design solutions for the temporary shelters.

1.2. Definition of the Problem

Most important design criteria such as durability, safety and privacy, reusability, transportability, rapid assembly, easy to store, expandability and compactness, flexibility, thermal insulation and water resistance should be considered while designing the transitional shelters. Moreover, the necessary spaces to carry out domestic activities such as sleeping, culinary activities, personal hygiene, storing, washing and drying should be created. Even though many design solutions have been proposed for the transitional shelters, they do not meet all the design criteria and technical requirements. Moreover, most of the proposed shelters are either tents or units that are not convenient for long term usage. Although the tents provide easy of store and set up, they have many disadvantages such as lack of privacy, vulnerability and insecurity, lack of durability, inadequate ventilation, lack of thermal insulation and inaccessibility to clean water and sanitary facilities. In addition, these shelters are insufficient to provide comfortable living space indoor due to the material used to form the tents (Songür,2000). Furthermore, they cannot respond to the changing weather conditions. On the other hand, the containers are generally used as transitional shelters, but they are not suitable for expansion and functional changes due to their structure and some difficulties may arise in terms of their transportation and rapid delivery to the desired location. Thus, it is necessary to develop practical design solutions for the temporary shelters to meet spatial, functional and technical requirements.

1.3. Aim of the Thesis

Developing a transitional shelter that has capable of changing its shape from a closed state to an expanded form to meet the design requirements is the main aim of the thesis. Since the proposed unit is transformable, it not only allows storing, transporting and installing the structure easily and quickly but also provides flexibility, expandability and reusability. This thesis also intends to develop different unit combinations that can be used either as housing unit for larger families or as supply unit, heath unit or activity unit. Other goal is to propose a settlement pattern to ensure creating protected, healthy and comfortable living environment.

1.4. Method of Study

Within the scope of the study, first, a systematic review on the portable structures is carried out to investigate their potential applications in architecture and to classify them according to their structural systems. Second, a critical review is conducted for the transitional shelters to discuss their design principles and requirements. Then, the design approach of the proposed transitional shelter is presented.

1.5. Outline of the Thesis

The thesis consists of five chapters.

Chapter 1 introduces the motivation, the problem definition, the aim and method of the study.

Chapter 2 presents a literature review on the portable structures. In this chapter, first, the concept of motion in architecture, the origin and development stages of the portable structures are investigated. Then, the selected examples of the portable structures are classified according to VLoM and VGoM properties to discuss their basic features, transformation capabilities, mechanical systems and operating systems.

Chapter 3 discusses the temporary shelters built after the disasters. The design criteria for the transitional shelters are presented. Then, the existing examples of the temporary shelters are analyzed whether they meet those design criteria.

In Chapter 4, a transitional shelter is proposed which can transform from a closed configuration to an expanded form to meet the needs of a family with optimum comfort such as sleeping, cooking, personal hygiene, storage, washing and drying. In this chapter, different unit combinations and settlement patterns are also presented.

Chapter 5 concludes the study by summarizing main achievements of the research.

CHAPTER 2
LITERATURE REVIEW ON PORTABLE STRUCTURES

In this chapter, a literature review on the portable structures is conducted not only to analyze the existing structures on the topic but also to reveal the superiority of the proposed portable structure within this thesis. First, the concept of motion in architecture has been investigated to understand the portable structures better. Later, a systematic review has been presented according to the basic features, transformation capabilities, mechanical systems and operating systems of the existing portable structures.

Existing examples have been categorized into two main groups: the structures with variable location or mobility (VLoM) and the structures with variable geometry or motion (VGoM). Depending on these groups, the structures have been examined in sub-groups based on their systems and characteristics. VLoM includes all the static examples of those that are transported in parts or assembled on site. On the other hand, VGoM refers to the structures that can change their geometric forms from one configuration to another. In this thesis, the examples have been reviewed based on the structural type, form expansion, spatial flexibility, motion and operating system.

2.1. The Concept of Motion

Motion is the change of the position of an object over time relative to a fixed point (Zuk & Clark, 1970). The concept of motion has arisen with the life began, because the motion is the basic need of nature and humanity. Accordingly, the conditions that provide the dynamics of mobility have been included in the created living spaces.

To understand the concept of motion better, it is necessary to state what Friedrich Engels says:

> "motion is the form of existence of matter. An immobile matter has never existed and can never in any place at any time. Motion is the space of the universe, mechanical motion of smaller masses on every celestial object; molecular vibration in the form of heat, electricity, or magnetic current; chemical dispersal and composition; organic life: every single atom in

the universe participates in any one or many of these motion types simultaneously at every certain time. Every immobility, every equilibrium, is the only relative, but it has a meaning according to one or another particular form of motion. An object can be found in a state of mechanical balance, a state of being mechanically motionless, on earth. This can neither prevent it from participating in motions of the World, solar system nor the smallest particles from being exposed to vibrations conditioned by its eat, and nor its atoms from performing a chemical process" (Engels, 1977).

According to this discourse, the concept of motion depends on the situation. Thus, first, it is necessary to define what the concept of "motionless" is. In fact, it can exist only in mechanical equilibrium, every other object except for this one can be in motion (Ekmekçi, 2005). The force that initiates the movement is either of natural (manmade) or artificial origin (construction automation).

Another definition of the concept of motion can be found in Zuk and Clark (1970) who are the authors of the first book depicting and classifying the motion in architecture. They have pointed out that nothing is permanent since the "design is a continuous process that will continue after the building is established. Its kinetics and architectural form can naturally be displaced, deformed, be expanded or be in motion" (Zuk & Clark, 1970). Likewise, Robert Kronenburg has stated that the kinetics is "components having variant mobility, location or geometry or building components" (Kronenburg, 2003).

When the components of the design are examined, it is seen that the concept of form has an effective field in architecture. For the motion to take place, a strong bond must be established between form and force. The force shapes the existing form by affecting it. On the other hand, the form is shaped based on the effect of the force. As Zuk and Clark (1970) have denoted, those who live in harmony with the forces maintain their existence while those who resist are compelled to perish.

The forms have changed over time with the technological developments, and the human beings have made themselves independent of nature. Human-centered design has become a basic criterion to develop forms (Gündoğmuş, 2005). Nevertheless, engineers and architects have inspired from nature while implementing the forms of structures. For example, the desire to create an adaptive environment has led to explore and develop new structural systems that can change their directions and shapes such as plants, or their locations such as animals.

Inspired by the state of living things in nature, these structural systems provide movements in such a way that they can be expanded or moved. Those structures can easily adapt to external environments depending on the changing living conditions. Among those structural systems, portable structures may not only allow motion flexibilities but also offer creative solutions to the complex design problems with respect to the specific requirements. Besides, the developability characteristics of those structures are high. Compared to the static structures, the portable structures provide flexibility in form and space (Kronenbourg, 1995).

2.2. Background

Even though the aim of early humans was solely to protect themselves from the external environment at the beginning, the circumstances had changed over time. The housing need of the first humans was met in caves or rock hollows. With the effect of the changing life patterns, the desire to have more free spaces increased. The people started to build their own shelters accordingly. The most dominant features of those shelters were the stability and non-changeability. However, they could not meet the needs of the users since they did not have mobility and changeability. Therefore, new design solutions had been sought.

Temporary dwellings in past residential areas show that the shelters were shaped based on the people's lifestyle (Schittich, 1998). People did not know about the areas outside their territory before they started to migrate. They earned their livelihoods by foraging and engaging in agriculture. Due to the inefficiency of the land, the conflicts between different migration groups and the natural disasters, people were in a state of migration to live in a safe environment.

When the previous periods are investigated, it can be seen that nomadic life was undoubtedly a tradition, culture and identity of the society which requires traveling to new locations for better living conditions (Kronenburg, 2002). Migration from one place to another indicates that the society had a dynamic structure. This dynamic structure was shaped according to the conditions that affect the living environment and reveal differences in human life. As the conditions and places changed, it provided not only renewal in life but also an advantage to build a new life form from the past experiences.

Because the migration took place in very frequent and long processes, it affected the structures where the people lived in. Thus, they preferred a kind of shelter, i.e. tents, that could easily be moved and assembled (Gündoğmuş, 2005). The tent life became a symbol of the nomadic life. Different types of tents were started to build which can be shown as the earliest examples of portable shelters. In each new migration area, a spatial settlement was established by comparing it to the previous settlements. This is an evidence that the portable structures have been used throughout the history (Ekmekçi, 2005) However, these structures were transformed into a built-in system when the people began to settle down.

When the settled life became established, it changed both the lifestyle and the living environment. Unlike the nomadic life, the settled life was provided not by the structure but by the similarity of spatial settlement. As a result of the impacts of the built-in living on the community, rapid urbanization emerged which requires a life filled with residential and commercial areas. Within this urbanization process, the cities were formed together with the modern society. As the people became more dependent on the places where they live and work, the flexibility of the nomadic life was abandoned. Belonging to a particular place and being stationary became more dominant with the settled life. However, the modern life required flexibility and mobility to adapt to the changing conditions.

With the developments in the technology, the human life started to change again. It became necessary to be in different living areas with changing professional groups. The people living in either large masses or smaller groups have started to migrate in order to improve their life conditions (Gündoğmuş, 2005). This has affected many areas including the architecture. The need for building portable structures has emerged in architecture.

Designed based on the concept of mobility, portable structures can be defined as movable buildings or structures that are easily transported and intended to be used temporarily. This system is also known as movable, disassembled or temporary architecture. Compared to the static structures, movable structures can offer spatially flexible solutions for the users (Kronenburg, 1995). Portable structures can be used for different functions including offices, classrooms, nurseries, doctor clinics, showrooms, restaurants, cafes and other social venues. They can also be used for storage spaces, garages and commercial shops since the installation and transportation of those structures are rapid and easy. In addition, it might be practical to use the portable structures in emergencies. For instance, emergency shelters can be used after a natural disaster since they provide a protected living space to conduct the daily needs and activities such as cooking, eating, sleeping, and bathing. They can be easily and rapidly assembled or constructed in large numbers on site to meet the needs. Thus, it can be claimed that high standards can be provided for those affected after the disaster (Songür, 2000).

In fact, the concept of portable structures was used in a primitive way at the beginning. Camper vans, ship houses and temporary vacation homes can be considered as the other examples of the portable structures. These structures were designed solely based on the criteria such as the relocation of the people and the usage difference. For instance, the small vehicle constructed in 1885 for Dr. W. Gordon-Stables was as a portable house with a trailer attached on which there were table, sink, bed and oven **(Figures 2.1).**

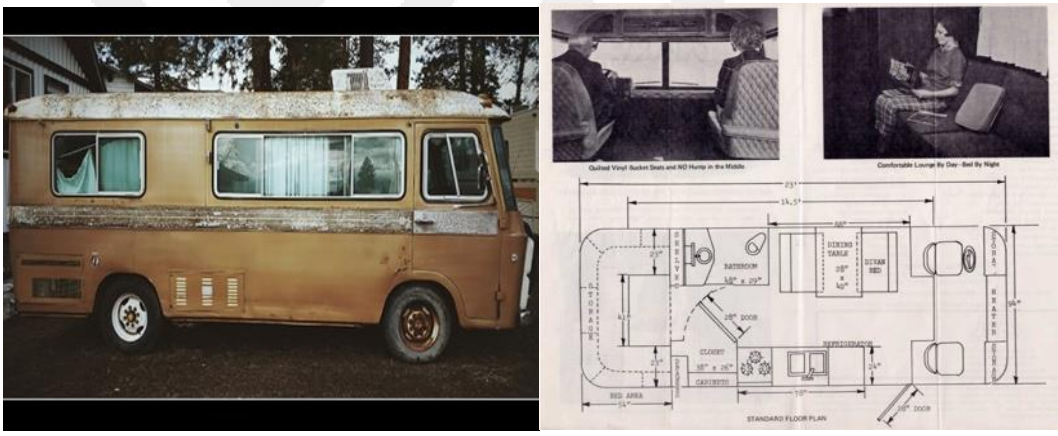


Figure 2.1. Motor Caravan Designed for Dr. W. Gordon-Stables

The advances in the technology allowed designing trailers that are lightweight and hauled fast having a house comfort. Another example of the portable structures belongs to Lowell Norman whose convertible structure can be promptly converted to fully extended configuration without disassembling or separating its basic parts. Its collapsed configuration is made by a person who is not helped by another (Norman, 1989) (**Figure 2.2**).

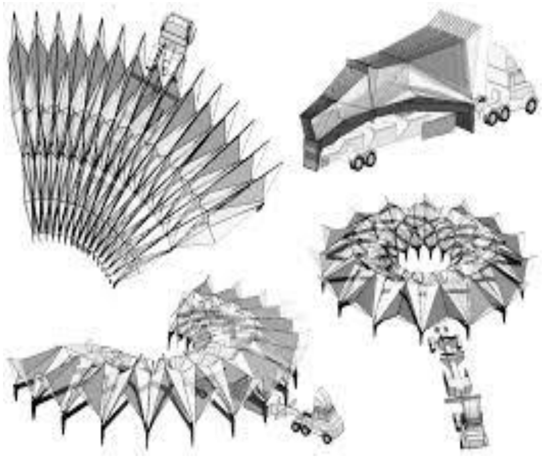


Figure 2.2. Convertible Structure

The portable structures became prominent again in the 1940s and started to be designed for the wars. During that period, many factories producing portable houses were established since they were cost-effective. The production of such portable structures had less impact on the economy of countries that were on the brink of war (Çolak, 2005). After the wars, the portable structures began to be used for housing purposes again.

After the 19th century, the demands for the portable houses increased. They were considered as housing units since they are cost effective and time efficient. It was thought that they can be solutions to the local problems and play a major role in encouraging the production of these structures (Drury, 1972). The portable houses first started to be produced industrially in 1955 as containers with a maximum width of 3m. Those houses were transported to the desired locations by means of trucks. However, they began to lose their popularity due to the increased cost of their transfers although the production cost was low (Drury, 1972).

With the beginning of the industrialization, new decisions made on the portable structures. Prefabricated structures became more dominant in that time. The parts of the structures were produced at factories and then transported to the site in order to assemble the whole structure. By this means, the structures could be dismantled or assembled later according to the needs. This property opened a new application area for the portable structures.

The portable structures can be used as emergency shelters after the natural disasters such as earthquakes. The aim of building such structures is to provide high standards for the people after the disaster (Songür, 2000). When the applications of the emergency shelters started to increase, new concepts and design solutions have been developed. Although such developments were initially limited to the structures to be manufactured and installed, new studies have been conducted to transform them into a guide, including the material and functional properties (Gönenç, 2004).

In the 1970s, the works on new living spaces led to a deep investigation of the portable structures. For instance, the design exhibitions opened in New York and Turin in 1972 pioneered the development of portable houses in which the function was considered at the beginning of the design process. After those exhibitions, the portable structures have become more important since they have potentials for future applications, and the designers have begun to work harder on this subject.

In the 2000s, many studies have been conducted to increase the contribution of the portable structures in our lives. The most notable works have been done by Robert Kronenbourg who published many papers and several books on the portable architecture and structures. Kronenbourg has defined the kinetics as “structural components or building components with variable mobility, location, or geometry” (Kronenbourg, 2003). He has expanded this definition by writing that “convertible structure comprises internal space or shape, area and design buildings that change by altering the skin physically. It is an architecture that opens, closes, enlarges and shrinks.” In addition, he has stated that portable architecture can be removed to somewhere else by rounding, swimming or even flying in order to meet needs. (Kronenbourg, 2007). On the other hand, Maziar Asefi (2010) defined the portable structures as “a different class of rigid or convertible elements that can change their geometry invertible and repeatedly and are connected together by moving joints with the innate property of controlled reconstruction.

2.3. Classification of The Portable Structures

There are many examples and classifications for the portable structures that vary in forms, functions, structural systems, kinematic properties and motions. Depending on the nomenclature and the methods, many researchers have made classifications based on their points of view and fields of study. The classifications have generally been carried out by evaluating the applications with respect to their structural, mechanical or transformation properties (**Table 2.1**).

Table 2.1. Classification on the Portable Structures

RESEARCHERS	W.ZUK & R.H. CLARK	R. KRONENBURG	ALAN BROOKES	MAZIER ASEFI	FELIX ESCRIG
CLASSIFICATION GROUPS	1. Kinetic Controlled Static Structures 2. Dynamically Self-erecting Structures 3. Kinetic Components 4. Reversible Architecture 5. Incremental Architecture 6. Deformable Architecture 7. Mobile Architecture 8. Disposable Architecture	1. Fully portable and transportable buildings which are manufactured whole. 2. Relocatable and transportable buildings which are assembled on site using transportable parts. 3. Discontinuous buildings which are fully disassembled in a few components for transportation	1. Flat Packed System 2. Pantograph (Scissors) System 3. Membrane Systems 4. Pneumatics Systems 5. Tensegrity Structures 6. Pods or Capsules	1. Transformable tensile structures 2. Transformable tensile membrane 3. Transformable compressive-tensile 4. Transformable bending and compression structures 5. Spatial bar structures 6. Spatial frame structures	1. Tensile folding structures 2. Tensegrity Roof 3. Retractable Roof 4. Umbrella Structures 5. Mobile Structures 6. Deployable Structures 7. Lifted Structures

In the early 2000s, the designers have started to use new techniques. In 2003, Marjetica Potrc designed a temporary structure using waste materials which can be moved and expanded when needed. (**Figure 2.3**). Another example is the design of the *AVL-Maxi Capsule Luxus* that was exhibited in Milan in 2006 (**Figure 2.4**). When the structure opened, it becomes a housing unit. Inspired from this exhibition, the people started to consider using portable structures as housing units for the homeless which led to develop new alternatives for portable housing.

Figure 2.3. Design of Marjetica Potrc

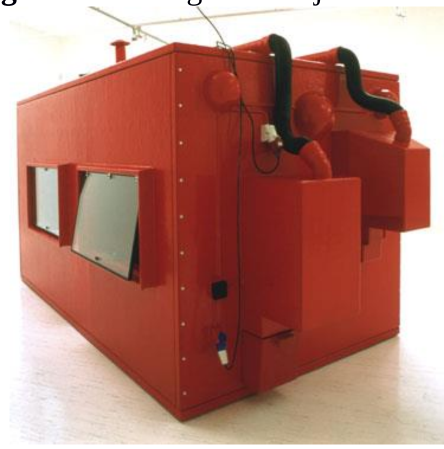


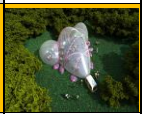
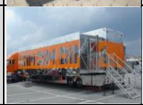
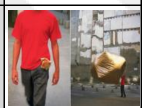
Figure 2.4. The *AVL-Maxi Capsule Luxus*

Classification methods are generally based on structural or mechanical properties of the structures. The most important point to be considered when evaluating the applications is that a single building cannot necessarily belong to a single class. Structures must first be examined depending on their properties and structural mechanisms. Structural mechanism forms the basis of the movable structure because it determines the operation of the structure or building. Based on the structural systems, the portable structures can be categorized as scissors and bar systems, folded plate systems, and pneumatic systems. Such portable structures can also be studied according to their functions. In this thesis, 5 different functions have been presented which are social spaces, cafes, showrooms, houses and shelters. Considering the structural systems and the functions of the portable structures, new classification tables have been proposed as shown in **Tables 2.2** and **2.3**. While the examples of the structures with VLoM have been indicated in **Table 2.2** and the examples of the structures with VGoM have been shown in **Table 2.3**.

Table 2.2. Classification of Portable Structures as VLoM

PORTABLE STRUCTURES																			
TYPES OF PORTABLE STRUCTURES	FUNCTIONS	STRUCTURAL SYSTEMS																	
		PROJECT NAME	1. HOLISTIC PORTABLES	FORM EXPANSION	SPATIAL FLEXIBILITY	MOTION	OPERATING SYSTEM	PROJECT NAME	2. PORTABLES THAT ARE DISMANTLED INTO ITS FUNDAMENTAL PARTS	FORM EXPANSION	SPATIAL FLEXIBILITY	MOTION	OPERATING SYSTEM	PROJECT NAME	3. PORTABLES THAT ARE COMPLETELY DISASSEMBLED	FORM EXPANSION	SPATIAL FLEXIBILITY	MOTION	OPERATING SYSTEM
VLOM	SOCIAL VENUES	BOX OF TRICKS		-	-	-	-	TWINSTAGE		-	-	-	HO	PABELLON LEBULENSE		-	-	-	HO
								CARLOS MOSELEY		-	-	-	HO	STREET CINEMA		+	+	-	HO
								IBM PAVILION		-	-	-	HO	PREFABRIC BEACH BUM		-	-	-	HO
								MOMI ENTERTAINMENT PAVILION		-	-	-	HO						
	SHELTERS	FUTURESHOCK		-	-	-	-												
		PAPER LOG HOUSE		-	-	-	-												
OPERATING SYSTEMS																			
H: Hydraulic power operation; **HO:** Hand Operated; **A:** Automatically operated with electrical energy; **HJ:** High lift hydraulic jacks; **HOP:** Hand operated and powered air supplied																			
MOTION TYPES																			
R: Rotational; **T:** Translational																			

Table 2.3. Classification of Portable Structures as VGoM

TYPES OF PORTABLE STRUCTURES	FUNCTIONS	1. SCISSORS and BAR SYSTEMS: PROJECT NAME		FORM EXPANSION	SPATIAL FLEXIBILITY	MOTION	OPERATING SYSTEM	2. FOLDED PLATES SYSTEMS: PROJECT NAME		FORM EXPANSION	SPATIAL FLEXIBILITY	MOTION	OPERATING SYSTEM	3. PNEUMATIC SYSTEMS: PROJECT NAME		FORM EXPANSION	SPATIAL FLEXIBILITY	OPERATING SYSTEM
VGOM	SOCIAL VENUES	PABELLONXUE		+	+	R	HO	NEBULA THE ARTS ACCESS VICTORIA POD		+	+	R	A	KUCHENMONUMENT		+	-	HOP
	SOCIAL VENUES	HOBERMAN ARCH		+	+	R	H	TRUSTEE SAVING BANK		+	+	R	HJ	COLOUR SPACE		+	-	HOP
	SOCIAL VENUES							MOBILE ARTIST STUDIO IN ULTECHT		+	+	R	A	ROSY THE BALLARINA BY RAUMLABOR		+	-	HOP
	SOCIAL VENUES							GUCKLHUPF		+	+	R	HO					
	CAFES	LA CHEMINAMBULE		+	+	R+T	HO	MUV-BOX		+	+	R	A	RAUMLABOR'S SPACEBUSTER		+	-	HOP
	SHOWROOMS							DIM MOBILE RETAIL UNIT		+	+	T	A					
	HOUSES							MOBILE TREE HOUSE		+	+	R+T	A	BASIC HOUSE		+	-	HOP
	HOUSES							DE MARKIES		+	+	R	A					
	HOUSES							KESA-KONTTI		+	+	T	A					
	HOUSES							ALL TERRAIN CABIN		+	+	R	A					
	HOUSES							M HOUSE		+	+	R	A					
	SHELTERS	MOVABLE THEATER		+	+	R	HO	EDV-01		+	+	T	HJ					
	SHELTERS	HOBERMAN DOME		+	+	R	HO											

OPERATING SYSTEMS
H: Hydraulic power operation; **HO:** Hand Operated; **A:** Automatically operated with electrical energy; **HJ:** High lift hydraulic jacks; **HOP:** Hand operated and powered air supplied
MOTION TYPES
R: Rotational; **T:** Translational

2.3.1. Portable Structures with VLoM

2.3.1.1. Modular Portables

Modular portables are the structures that carry all basic mechanisms and auxiliary mechanisms in their systems. Containers can be shown as an example of this type of structures.

The *Box of Tricks* is a kiosk designed by Entech Environmental Technology whose shape is based on origami principles. Aluminum panels were used as the main material in its construction. Combined with a hinge system that simulates the movement of folded papers, the front of the kiosks opens and closes in a simple but flexible way. The design is lightweight and easily transported where it will be used.

Large earthquakes occur in many areas of the world. Consequently, many people become homeless. Architect Sean Godsell designed a housing, named the *Future Shack*, as a social responsibility project. He developed a shelter for those who are affected by an earthquake or become homeless due to any reason. The container-shaped structure includes all the required spaces for the people to live in. Since the structure has its own supports, there is no need for an additional foundation. It can be installed within 24 hours on any land when needed **(Figure 2.5).**

Another example of the modular portables used after natural disaster is the *Paper Log House*. Designed by Shigeru Ban, this structure was built by combining the tubes made of recycled papers with soil mixtures. Because the structure is very light, it can be quickly carried to the desired locations whenever necessary. **(Figure 2.6).**

Figure 2.5. The *Future Shack*

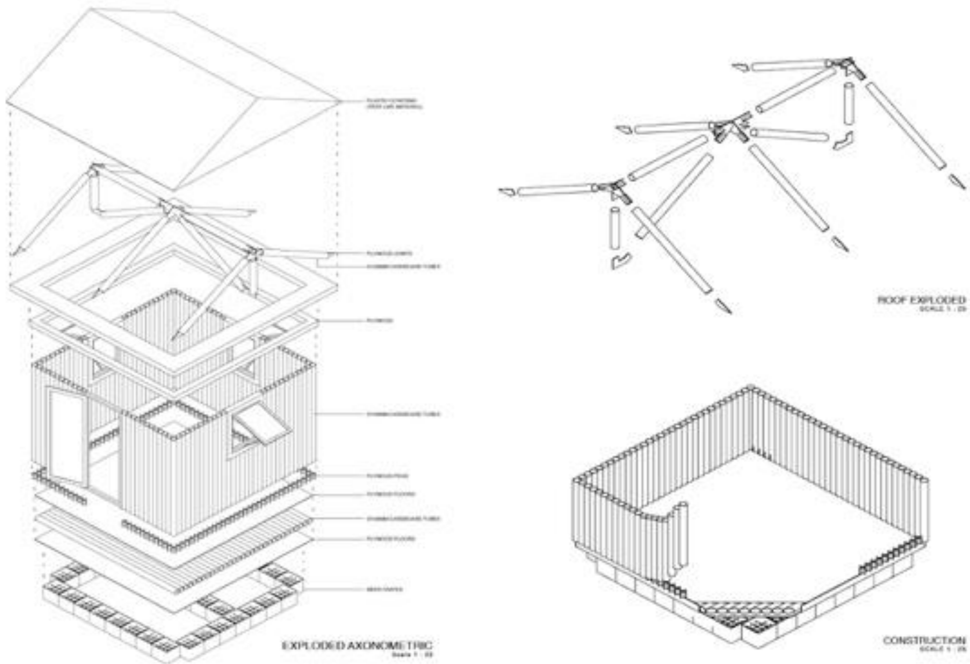


Figure 2.6. The *Paper Log House*

2.3.1.2. Portable Structures Dismantled into Fundamental Parts

Portable structures divided into basic parts can be transported in two groups as basic parts and auxiliary parts when they need to be moved from one place to another. For example, during the transportation of a stage composed of a scissors system, the structural mechanism is collected separately while the top cover is collected separately. The structure carried in this way are generally used in the field of social venues.

Designed and patented in 2006, the *Twinstage* is the largest mobile stage in Europe which is one of the well-known examples of the scissors system. With a length of 13.5m, a width of 24m and a height of 12m, the *Twinstage* is installed by six people in eight hours. Scissors are fixed to square steel profiles beneath the platform rotating pin on the central point **(Figure 2.7).** When the structure is assembled, it becomes stable. The flexibility and stability of the system allow using this structure for different events and functions.

Figure 2.7. Deployment Stages of the *Twinstage*

The *Carlos Moseley Music Pavilion* was designed by FTL Happold Group as a stage that can be used in various festivals during the summer (**Figure 2.8**). The structure is shaped like a 3.9mx13.5m sized pyramid which consists of four main parts: carrier elements, stretched top cover, a foldable stage and a foldable audience area. Hydraulic pistons are used during installation. When the structure is fully opened, it reaches 26m height.

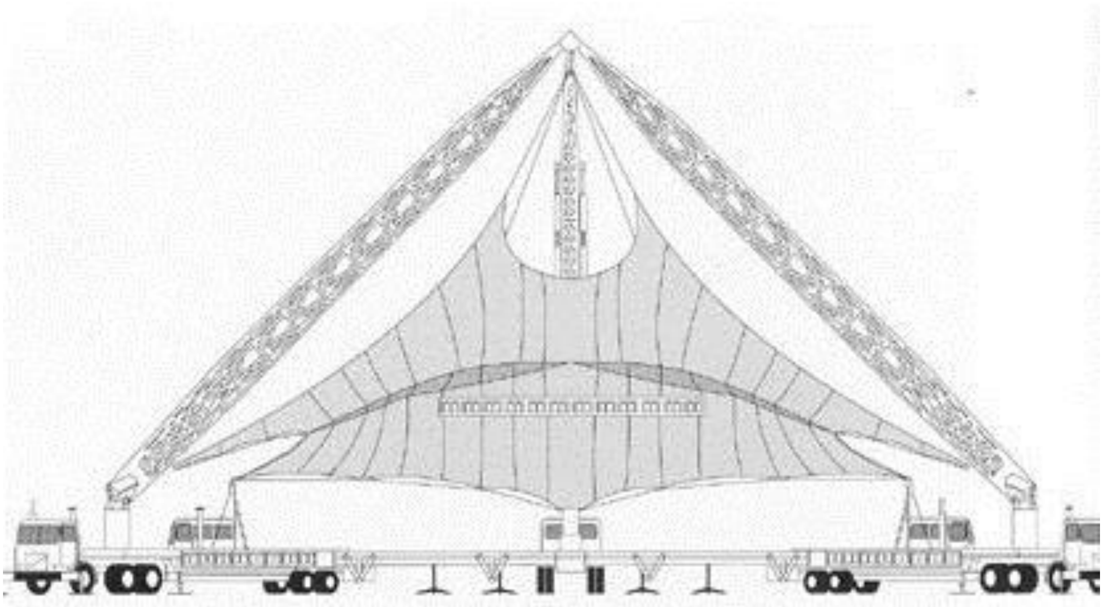


Figure 2.8. The *Carlos Moseley Music Pavilion*

Designed by Renzo Piano, the *IBM Travelling Pavilion* served as an exhibition space and toured European cities between 1982 and 1984. The structure is composed of a half vertex that is 85cm in length with a space of 480 square meters. The *IBM Travelling Pavilion* is made of 34 arch-shaped bar systems that are assembled on site. When installed, the structure is no longer movable. The *Museum of Moving Image Pavilion (MoMI)* was designed by Future Systems in 1992 as an auxiliary structure that hosts movie festivals. Having a capacity of 450 people, this pavilion was in connection with other structures in the cultural field of South Bank in London. Composed of arch-shaped elliptical elements, the structure can be installed manually by six people as first placing the arch-legs on steel ground and then covering the membrane (**Figure 2.9**).

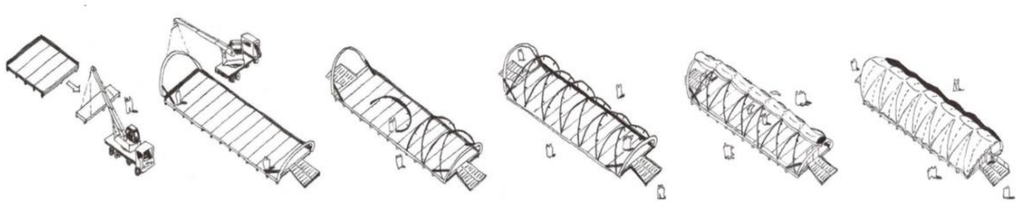


Figure 2.9. The *Museum of Moving Image Pavilion* (MoMI)

2.3.1.3. Fully Disassembled Portable Structures

The structures in this group are divided into special parts which must be connected to each other from the junction points. After the structural mechanism is combined at the junction points, the structure is completed by attaching the upper covers.

Designed by Architects Patricio Ortega and Claudio Vallejos, the *Pabellón Lebulense* is a temporary structure used as an exhibition corridor. The structure consists of two basic materials that are wooden sticks and plastic cloth. The plastic cloth is covered on the skeleton of the structure that is installed manually by screwing the connection points of wooden sticks. By this means, the structure provides protection from the rain.

The adjustable *Street Cinema* of Omri Revesz was designed in 2017. Located right next to the canal in Venice, the structure expands, contracts, open and closes according to the activity to be done inside. Used as a social meeting point during the day and as an open-air cinema at night, the structure is established by combining modular wooden structures with metal elements that hold them together. The connection of the building with the external environment is broken with the adjustable curtain mechanism.

The *Prefab Beach Bum* has the desired usage area with its transformable modular architectural system. It is a metal frame with multiple junction points that form triangles based on the geometry of the star-shaped octahedron, which makes full use of the lightweight structure provided by this geometry. The structure can be easily transported and mounted.

2.3.2. Portable Structures with VGoM

2.3.2.1. Scissors and Bar Systems

A scissor system is a simple mechanism that consists of bar elements connected by hinges allowing them to move freely against each other. These connected elements transfer energy to each other. Energy transfer creates expansion, contraction and various dimensional differences during the movement process (Zuk, &Clark, 1970). There are basically three types of scissors which are angulated, translational and polar units **(Figure 2.10).**

The translational units are composed of straight bars connected by revolute joints from their mid-nodes. Linear translational movement occurs when the bars start moving. The imaginary unit lines connecting the end nodes of the bars remain parallel in this movement. Like the translational units, the polar units consist of straight bars; but the main difference between these two types is that the bars are not connected at their mid-points. Rather, the scissor hinge is moved from the mid-points. Therefore, the system creates a curvature during the deployment. The system allows curvilinear movement. Unlike the polar and translational units, the angulated units are formed of identical angulated bars which allow retracting from center to perimeter or vice versa (Maden, Korkmaz and Akgün, 2011).

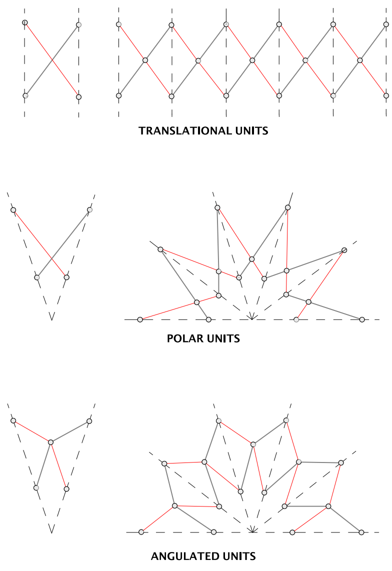


Figure 2.10. Types of Scissors Units

On the other hand, the bar systems consist of hinge bars that do not have to be generated by the identical units as in the scissor systems. Rather, various planar or spatial structural mechanisms can be used to construct the geometrical form. The generated system is similar to the lattice type structures (Zuk, &Clark, 1970).

Designed in 1961 by Emilio Pérez Piñero, *Movable Theater* **(Figure 2.11)** is the first example of scissor structures that is able to deploy. The structure is composed of scissor units having three joints that allow rotational motion around the joint axis. Pérez used pantographic scissors systems in this study which allow expanding the structure during the movement and changing the volumetric size for various purposes. The dimensions of the whole form change during the movement, but there is no permanent deformation. After the system is fully opened, it easily becomes its first state. While carrying out his design, Pérez aimed to create a structure that can not only change its shape but also carry its own load at the fully deployed configuration.

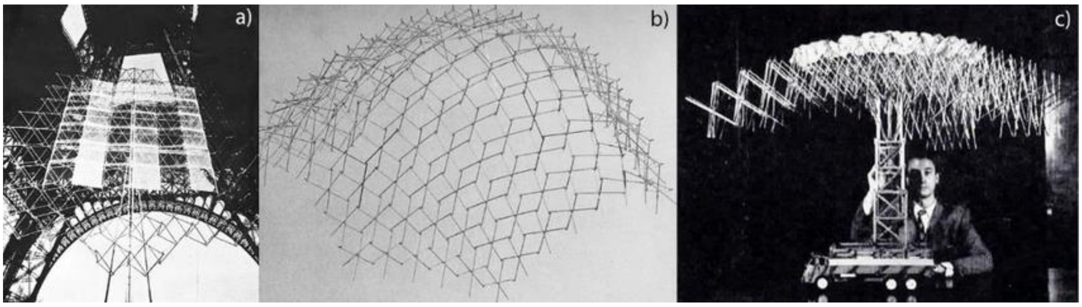


Figure 2.11. System Development Stages of Emilio Perez Pinero

Designed by Chuck Hoberman in 1990, the *Hoberman Dome* is a shelter structure that can increase the volume while keeping the shape of the dome fixed geometrically in its final configuration. When the structure is opened, it can cover an area that is three times of the closed structure. Having a kind of spherical polyhedral surface, the structure contains 20 triangles and 12 pentagonal shapes **(Figure 2.12)**. Each part in the structure moves from connection points that allow expansion. The loads are transferred from these points to each other and the whole structure can be fixed in a way that maintains its geometry.

The *Hoberman Arch* is a gigantic mechanical stage door composed of scissor units that was designed for the opening of the 2002 Olympic Winter Games in Salt Lake. It is 11m in length and 22m in width which can be opened and closed according to the performance. The structure is covered by rigid panels that slide over one another. The dimensions of 96 panels vary, but the largest one is 2.7m tall and 1.5m wide. The system creates an angular movement which is provided by rotational motions of the hinges. Thus, the desired visuality can be provided at the back during the performance **(Figure 2.13)**.

Figure 2.12. The *Hoberman Dome*

Figure 2.13. The *Hoberman Arch*

The *La Cheminambule* is a portable cafe moving on an electric bike that can adapt to the different conditions and spaces. Designed and built-in 2013 by Amandine Lagut and Charlotte Thon during their diplomas at the National School of Decorative Arts

(ENSAD) in Paris, the structure can be opened and closed according to the intended use. The tables, benches and a wood-burning stove are protected by a large fabric covering on the top like an umbrella. Since it allows the opening and closing of the covering at the desired level, it gives flexibility to the users. The system has rotational and translational motions which do not require an auxiliary equipment to move the structure since it is placed on a bicycle. When the designers established a company specializing in designing mobile structures for public space, the *La Cheminambule* was redesigned. The main idea of the structure is to create a mobile seating area and a café, which provides a place for social interaction. Because of the modularity, the structure can be constructed at any desired location. When the installation is completed, even a single person can open the umbrella manually to reveal the modular table **(Figure 2.14)**.

Figure 2.14. The *La Cheminambule*

The *Pabellon Xuê* is an open-air pavilion that was designed by Natalia Torres **(Figure 2.15)**. Built in a workshop with the students in the Department of Architecture in the Papal Catholic University of Minas Gerais, the *Pabellon Xuê* has an arch-shaped scissors structure functioning as a shelter. The aim was to create a public space where the people who may spend their time without rushing in the shadow of wooden arches. This structure is composed of translational scissor units. The movement of the arch structure is based on the rotational movement of the units.

Installation of the scissors structure can be carried out manually by combining them at their end nodes.

Figure 2.15. Opening stage of the *Pabellon Xuê*

2.3.2.2. Folded-Plate Systems

A folded plate system consists of flat plates that are joined along their edges in different directions. It can be formed in a linear, radial, or spatial arrangement. Folded-plate systems allow covering large spans since opposite sides can carry loads without requiring any intermediate support (Zuk, & Clark, 1970). They have a large load bearing capacity that depends on not only the material and connection but also the shape of the folding (Zuk, &Clark,1970). Due this structural property, various examples of folded-plate systems have been constructed for different functions including both static and kinetic ones.

The *Trestee Saving Bank* is a structure designed by Lorenza Apicelli in 1991 which is used for exhibitions and social events. When there is not an exhibition or event, it is used for the *Trestee Savin Bank*'s own events. Consisting of a standard container with a length of 13.5 meters, this structure can be installed manually by four people. This two-layer structure interlaces into each other during the transportation. During the installation, the second layer is raised with the help of hydraulic pistons within the first layer. It has the ability to open and close by performing rotational motion on side surfaces.

The *GucklHupf* is another example of the portable structures having a folded-plate system which was designed by Hans Peter Wörndl in 1993. Designed for a festival, the *GucklHupf* is a multi-purpose structure aiming to show the connection between settlement and temporariness and the relationships in the perception of openness and closeness. Composed of wooden plywood panels, the structure does not have any other openings than the movable panels that are opened manually. Depending on the climate, the panels are opened or closed to obtain the desired configuration. The system operates by performing rotational motion **(Figure 2.16)**.

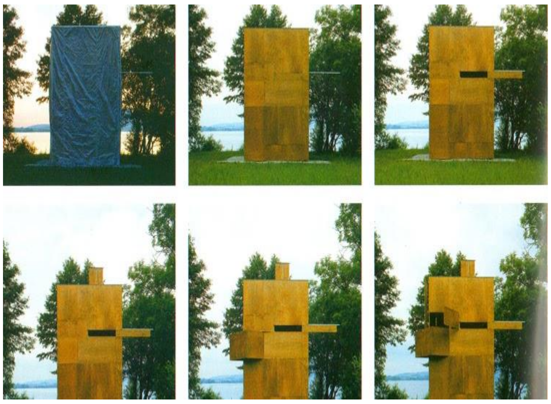


Figure 2.16. The *GucklHupf*

Designed by Markku Hedman in 2001, the *Kessa-Kontti* is a portable structure accommodating two people comfortably. This structure resembles a closed box when it is not being used. However, the living area can be pulled out when to be used. The *Kessa-Kontti* includes a kitchen, a living area, a convertible bedroom and a storage space. Cooking and toilet section are added to the structure when desired.

The *Dim Mobil Retail Unit* is a portable showroom designed by Lot-Ek, Giuseppe Lignano and Ado Tallo in 2005. 16m in length, the structure covers $90m^2$. When the structure is operated, it performs a rotational movement. Expansion of the structure is provided by the movement of side surfaces. When the system is fully opened, it reaches three times its normal size. All garment cabinets, accessory drawers, trial rooms, and waiting area seats are modularly removed from the central container. The structure has a mechanical operation system in which hydraulic pistons are controlled by computers.

The *Muv-box* is a portable structure functioning as a café that was transformed from an old shipping container **(Figure 2.17)**. Designed and prototyped by Daniel Noiseux in 2009, the *Muv-box* can deploy in two minutes. When closed, the structure with its container-looking shape measures 2.4m x 6.1m x 2.6m. However, the dimensions of the structure is 4.57m x 6.1m x 2.6m with the side faces when opened via electrical energy. This structure has a large kitchen and seating area with the opening of the side faces.

Figure 2.17. The *Muv-box*

Designed by Yasutaka Yoshimura in 2011, the capsule-shaped *EDV-01* structure is used as an emergency shelter. The *EDV-01* expands by doubling its size which is operated automatically. The ground floor has dimensions of 605cm×259cm×243cm while the first floor of 605cm x 451cm x 243cm. Performing translational movement, the structure has high lift hydraulic jacks for its operation **(Figure 2.18)**.

The *Nebula the Access Victoria Pod* was designed by Maynard Architects in 2012. It is a portable art space that can change its geometric form according to the needs of users. It provides various functions to the users such as a workshop area, performing space, meeting place or gallery. The structure resembles a box when the side wings are closed. It covers 14.8m^2 area with the dimensions of 279cm x 280cm x 509cm. In this way, it can easily be transported. On the other hand, the structure expands when the side surfaces are opened and covers an area of 62.4m^2. The opening of the side wings shows that the design is flexible, and form expansion is generated. The wings are folded or unfolded by means of the rotational motions between the main structure and the wing. The system works automatically using electrical energy **(Figure 2.19)**.

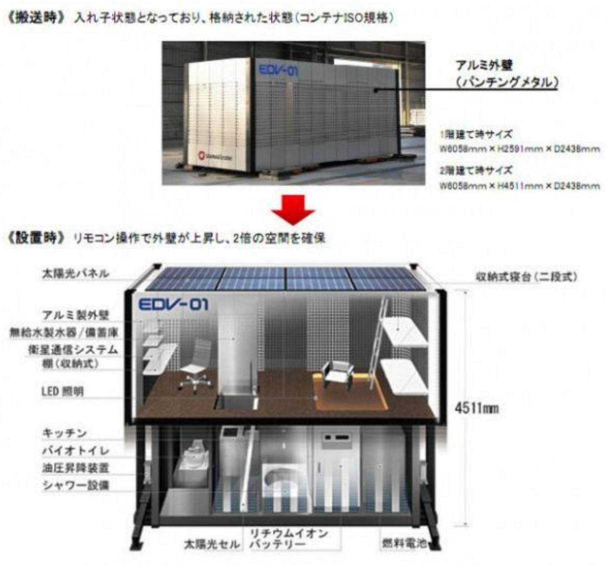


Figure 2.18. The *EDV-01*   **Figure 2.19.** *Nebula the Access Victoria Pod*

Constructed in one of the residential areas in the Netherlands, the *Mobile Artist Studio* was designed to be used for both accommodation and exhibition purposes. This moving structure operates by opening and closing side surfaces with the electric energy received from its engine. The panels on the side surfaces perform the rotational motion. During the opening, the structure comes into an outward-facing position. Since the whole system is in the size of a container when totally closed, it can easily be transported by a crane or truck.

The *Mobile Tree House* was designed by Ten-Fold Engineering which can expand up to three times its normal size in eight minutes. Covering approximately 64m^2 when folded, the structure consists of many foldable panels. The structure transforms into a house from a regular box shape by rotating its side surfaces. Since this structure does not require a foundation, it can be installed anywhere after being transported by a truck. Since the system allows many changes on the structure, it can be said that it is flexible enough in terms of form and space transformation **(Figure 2.20)**.

Figure 2.20. The *Mobile Tree House*

Designed by German architect Eduard Böhtlingk, the *De Markies* is used as a mobile holiday house that has a kitchen, living and sleeping areas and a bathroom. Covering almost 90m^2 when closed, the side surfaces of the structure can be folded or unfolded by means of a rotatory motor. The top of opening surfaces has a transparent cover that ensures the integration of the structure with the nature **(Figure 2.21)**.

Figure 2.21. The *De Markies*

Consisting of a small prefabricated structure that can easily be adapted to all kinds of terrain, the *All Terrain Cabin* is used as a dwelling. Designed by the Canadian Bark company, this small structure can be moved easily and quickly. Because of the opening of the side surfaces through rotational motion, the structure expands to accommodate a family of 4 people easily and comfortably.

The *M-House* was designed by Michal Jantzen in 2007 which serves for exhibitions and housing purposes. Multiple foldable panels that are in different sizes were used in the structure. The *M-House* provides different views with the panels opening and closing in different directions. The panels have both rotational and translational motions **(Figure 2.22)**.

Figure 2.22. The *M-House*

2.3.2.3. Pneumatic Systems

Pneumatic systems are supported by air pressure. It has natural transformation capacity due its property to control stiffness through pressure. The operating principle of the system is to compress the air absorbed by compressors to a certain pressure. Calibrated conditioned air pressure is diverted to the control point. Then, the compressed air entering the control point is diverted to the desired directions. This property provides greater saving and advantages than the other systems since the process is eventually re-mixed in the air. The air circulating in the system is used more intensively or rarely depending on the users. Thus, the pneumatic systems among all portable systems are economical, easy to install, simple to operate and have advantageous (Zuk, &Clark, 1970).

There are basically two types of pneumatic systems which are air supported and air-inflated pneumatic systems. The air supported systems consist of a single structural membrane supported by a small air pressure differential. However, there are two membrane layers in the air inflated systems which form inflated structural elements. The working principle of the pneumatic system is analogous to membrane structure. The tensile forces are transferred between the elements by means of the membrane plane. This is also effective in carrying loads.

Designed by Maurice Agis in 1980, the *Colorspace* is a site-specific installation work aiming to objectify spaces rather than producing objects for spaces. Installed in Kensington Garden in London, it contains many spaces for the exhibition which are connected to each other through tunnels. Different colors were used for those spaces to meet different purposes. The first *Colorspace* was exhibited in many cities of the UK. In 1985, Agis developed another structure for Berlin Festival which comprises more spaces. The repetition of the spaces made it easier to create patterns used for the production. Different variations of this structure were produced between 1985 and 1992 to operate the system better. The last *Colorspace* was produced for an exhibition at the North Sea Festival in 1992 which consists of 68 cubes of $3m^2$. The structure is laid down on the space where it is installed and then inflated by an electric air blower. When the installation is completed, it reaches 3.5m high **(Figure 2.23)**.

Figure 2.23. The *Colorspace*'s Setup Steps

The *Basic House* was designed by Martin Ruiz de Azua in 2000 for the utilization of homeless, casualties and participants of open-air concerts. This pocket-portable housing can also be used as two sides since it is made of a light and metallic polyester material. Both sides of the polyester material ensure heat insulation. A little breeze is enough to set it up. When the air is filled up inside of the structure, it swells, and the installation is completed **(Figure 2.24)**.

Figure 2.24. The *Basic House*

The *Küchenmonument* is one of the examples of the pneumatic structure serving as a temporary and extensive social space which was designed by Raumlabor Architecture in 2006. The structure is installed within three hours by two or three people. The membrane that is extracted out of the main box-shaped structure is expanded via strong fans to form a covered space. The box is 3m x 3.1m x 2m, and the volume of the balloon is 1.440 cubic meters. Installed manually, the structure can easily be carried to the desired locations **(Figure 2.25)**.

Figure 2.25. The *Küchenmonument*'s Setup Steps

2.4. Conclusion

In this chapter, the review of the portable structures have been carried out, and a new classification for the portable structures has been introduced. The existing examples of the portable structures have been examined according to their system types, transportability and usage areas. The characteristics, strengths and weaknesses of those structures have been presented. It has been investigated whether simple structural mechanisms were used for the opening and closing movements of the structures. It has been found that the systems are not mixed with each other and there is no complicated application. Even though they function well for the proposed applications, they cannot be used for another function. While some of the examples are easier to be carried or transported; the others have complicated systems to be moved. As a result, it can be said that each structure has deficiencies compared to the other structures. The main reason for this depends on the structural mechanisms used.

CHAPTER 3
TRANSITIONAL SHELTERS

Climate change causes all-natural events on earth to be affected by a chain reaction. As a result of these reactions, natural changes as well as human-originated changes cause natural disasters to be triggered. Disasters may cause permanent or temporary damage to the environment, and people's permanent shelters can be damaged. Due to the destruction of human settlements especially after natural disasters, a need for building temporary shelters emerges. Thus, practical design solutions should be developed to meet vital and functional requirements of the people after such disasters. In this chapter, existing examples of the temporary shelters are examined in terms of their design criteria, structural systems, functions and technical requirements.

3.1. The Concept of Shelter

Building shelter has been one of the basic requirements needed by the humankind throughout the history to protect themselves against negative environmental conditions **(Figure 3.1)**. It has been identified from the remains left from the First-Age societies that the shelters were built using the natural materials **(Figure 3.2)**. If they could not build shelters, they were found to have used caves and tree hollows as shelters for the protection **(Figure 3.3)**.

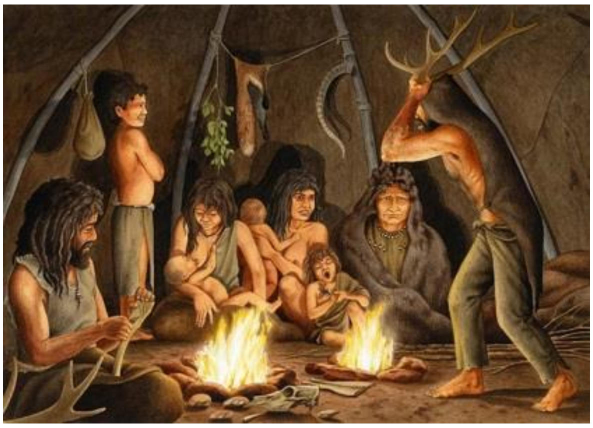


Figure 3.1. Collective Shelter in Ancient Times

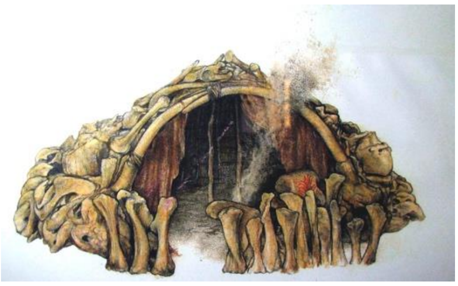


Figure 3.2. Shelter Remains from The First-Age

Figure 3.3. A Cave Used as a Shelter

With the change of living conditions and the development of communities, the concept of shelter used by previous communities has been replaced by the concept of housing over time. The concept of housing has become the living unit of the family, which is a part of the social life. Unlike emergency shelters, it has gained the status of a venue where the cultural and social activities are held. Currently, the shelters are only seen as temporary housing used for emergencies.

3.2. The Concept of Emergency

An emergency is defined as “unexpected or unforeseen sudden events” (Anon 1, 1997). However, different meanings of this concept can also be found in the literature. It can also be described as sudden serious events that require immediate intervention or reaction (Anon 2, 2003). The concept of emergency is also paired with the concept of disaster. According to the United Nations, the concept of disaster is described as “consequents stemming from natural, technological or human causes that affect societies by stopping or restricting human actions, normal life and causing physical, economic and social losses for human and that affected society cannot overcome by utilizing its own means and sources, are called the disaster” (Ergünay, 2005). Although the concept of emergency in our country had been used in the branch of medicine for many years, after the Izmit Bay earthquake occurred in

August 17th, 1999, it entered the architectural literature for the disasters upon the suggestion of the World Bank (Ergünay, 2005).

Disasters are the events that lead to destruction when communities lack their means and receive support from other communities and charities. Addis Abada (2002) classified hazards and disasters in two groups according to their source as natural and human-caused disasters. The natural and human-caused disasters can be classified according to whether the development process of the event is sudden or gradual, which can be reviewed as suddenly-occurring based on one cause and occurring gradually based on multiple causes. **(Figure 3.4)**.

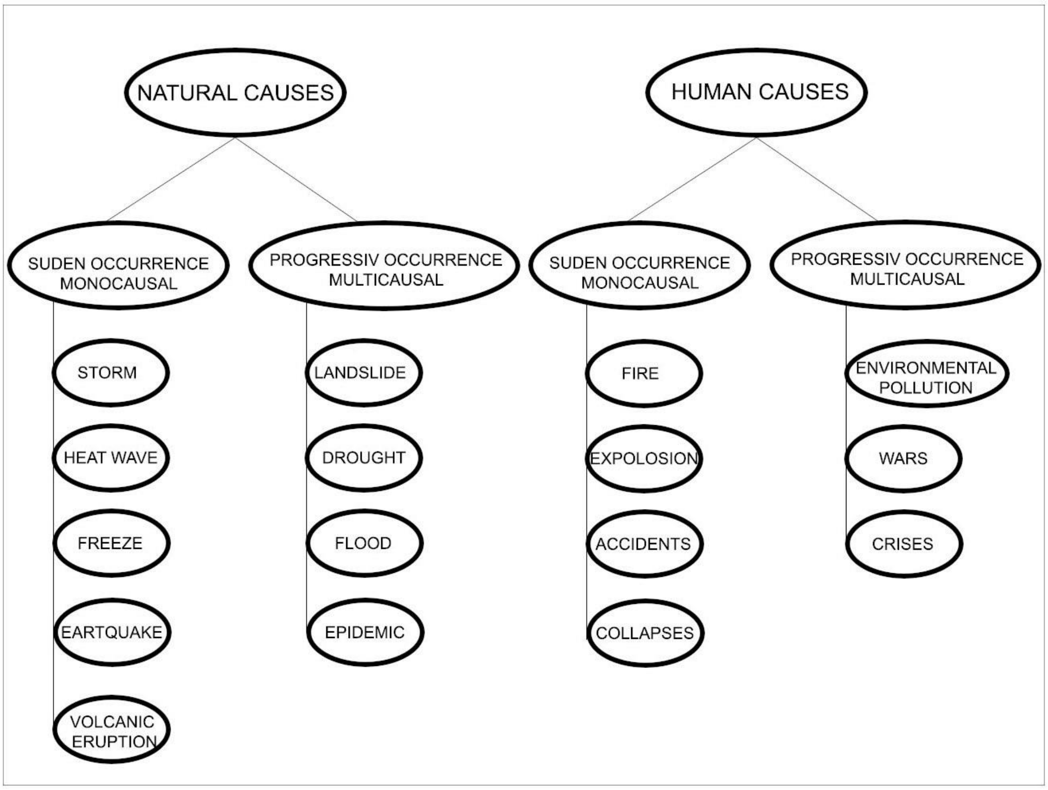


Figure 3.4. Classification of the Disasters

Natural events such as storms, heatwaves, freezing cold, earthquakes and volcanic eruption are the examples of sudden natural disasters. Examples of the gradual natural disasters include landslides, drought, flood and epidemics. The causes of sudden occurrence of human-caused disasters can be shown as fires, explosions, accidents and structural collapses while environmental pollution, wars and crises are the human-caused disasters that occur gradually.

Although there are differences between the natural and artificial disasters, there is actually no exact boundary between them. In general, the disasters develop by affecting other events such as the domino effect. For example, after a natural disaster such as an earthquake, there is a danger of the destruction of damaged electric poles in the region. While the electric arc generated during the destruction of the electric poles cause the surrounding trees and structures to burn, technological disasters may occur due to the power cut.

3.3. Emergency Architecture

Disasters cause physical, economic, social and environmental losses on humans and human settlements. This causes harm to people by stopping or restricting their normal life and daily activities (Ergünay, 2005). After the disaster, one of the primary problems is the need of housing.

Emergency architecture is a type of architecture aims at meeting the need for human housing on a temporary or semi-temporary basis. Temporary shelters established/built for the disaster victims provide protection from the negative environmental impacts and improve daily living conditions. These temporary shelters can meet the need for housing when an extraordinary situation occurs that people may encounter, but they are not suitable for long-term use (Songür,2000).

The natural disasters have a devastating effect on the human settlements, especially on the buildings. The force of the destruction varies according to the severity of the disaster. As a result of the destruction or heavy damage on the human settlements, especially after the disasters with high destructive power, many disaster victims need to be re-housed. For the disaster victims, as many shelters as necessary are provided to the region in the first place and then housing camps are established **(Figure 3.5).**

Figure 3.5. Container Housing Camp

Aid provided from the government funds to those in need through public or semipublic organizations in the aftermath of the disasters is called as social aid. The purpose of the social aid is to ensure the people in need can maintain a minimum level of living appropriate for the human dignity in their time of need (Hacımahmutoğlu, 2009). To ensure the social aid is provided in the best possible manner, the process can be examined in stages. This allow explaining in detail how the matters are arranged during and after a disaster:

1. Immediate relief period

2. Rehabilitation period

3. Reconstruction period

These stages are interconnected with each other and arranged to protect the life and safety of the disaster victims.

The first stage is the emergency aid. In the immediate relief stage, injured victims are provided with emergency medical service. In addition, medical treatment victims who are left homeless are provided with shelters. The immediate relief actions include search and rescue, first aid, treatment, evacuation, temporary shelter, communication and transport, determination of needs, provision of food, drink, clothing and fuel, security, environmental health and preventative medicine, determination of damages, removal of hazardous debris and prevention of the secondary disasters like fire, explosions and contagious diseases (Çakır, 2007).

The next stage is the rehabilitation period that includes the debris removal and the improvement of the situation by actions such as providing the necessary infrastructure and people’s needs. The measures needed to allow the victims to return to their normal flow of life are also taken in this stage. In this context, aims of this stage include the restructuring of socio-economic order in the disaster zone and the improvement of the ongoing situation. In the rehabilitation period, transitional shelters are used until the permanent dwellings are built for the disaster victims. The transitional shelters must have certain standards, and they must be produced in a large number, quickly. Besides, they should meet other needs of the disaster victims (hot water, plumbing, etc.). Thus, it should be aimed to bring the optimum standards to the people (Songür, 2000).

In the third and last stage is the reconstruction period in which final and permanent solutions are sought for sheltering. This stage involves the initiation of efforts to rebuild permanent dwellings with more suitable and healthier infrastructure for the disaster victims.

3.4. Design Criteria for the Transitional Shelters

The act of housing, which has been one of the indispensable basic needs of people since its existence, is not only a place where people will protect themselves from external factors but also a place where they form an emotional connection and call it “home”. When a disaster occurs, the search of home begins again in the post-disaster period and leads people to build transitional shelters.

The transitional shelters create a space for the affected families to move on with their daily lives until permanent solutions are found. They can be in the form of prefabricated houses, trailers, containers, tents and modular structures. The transitional shelters are generally be chosen according to the climate and other conditions of the region (**Figures 3.6, 3.7 and 3.8**).

Figure 3.6. Kızılay Tent **Figure 3.7.** Exo Shelter **Figure 3.8.** Ikea’s Better Shelter

The transitional shelters vary in cost, comfort level and services they provide. For example, the cost of materials used in the production phase of the modular transitional shelters is high while it can be lower if local materials are used. Nevertheless, the cost and comfort level of the transitional shelters are different than each other. A high-cost shelter can be uncomfortable. The most important criterion, regardless of the comfort and cost of the structures, is to provide people optimum comfort in the living environment until they find a permanent living space.

After the disasters, rebuilding the destroyed structures is a long process (Sey, 1987). The size of the affected population, the amount of damage to infrastructure, the difficulty of supply due to the demand for construction materials, the periods of obtaining construction licenses, urban planning problems and the provision of adequate financing are the factors affecting the prolongation of this process. For these reasons, the disaster victims cannot quickly return to their homes. As this process is expected to pass, it becomes important how the use and design of the transitional shelters will be.

After the earthquake of 17th August 1999 occurred in Turkey, many studies have been conducted which can be used as a guide in understanding the needs of the earthquake victims. Accordingly, it was appropriate to discuss the requirements of the earthquake victims under the following headings: emergency assistance, housing, education, transportation, common legislative area, work and health requirements (**Figure 3.9**).

Figure 3.9. Collapsed Buildings in the Earthquake 1999

In the emergency situations, temporary shelters such as tents are distributed to the people who lost their houses. These transitional shelters are camped in a certain number to make it easier for disaster victims to receive the aid. The tents can be a short-term solution and a potential refuge in such situations for the people who have become homeless. The tents are lightweight structures that can be easily transported to any location. Besides, they are very cost-effective. Even though they provide easy of store and set up, they have many disadvantages such as lack of privacy, insecurity and vulnerability, lack of durability, inadequate ventilation, lack of thermal insulation and inaccessibility to clean water and sanitary facilities. Moreover, these shelters are insufficient to provide comfortable living space indoor due to the material used to form the tents. In addition, they cannot respond to the changing weather conditions. As a short-term solution, the tents can be a lifesaver, but such shelters are not suitable for long-term use.

Due to the aforementioned disadvantages, the tent cannot be used for long term period. Thus, they cannot be considered as transitional shelters. On the other hand, container shelters are generally used as transitional shelters, but they are not flexible for expansion or functional change due to their structures, and some difficulties may arise in terms of their transportation and rapid delivery to the desired location. Moreover, there might be some problems due to ventilation, insulation and soundproofing

When designing the transitional shelters, many factors should be considered such as the material quality of the structures, transportability of the structures, isolation level and functions. The transitional shelter should be a safe place to live in, resistant enough to all weather conditions, have necessary spaces to carry out domestic activities such as sleeping, culinary activities, dressing, personal hygiene, storing, washing and drying as well as providing good heat and water insulation, and natural light and ventilation. Living in a secure and hygienic shelter is an essential need. Considering these requirements, it can be said that the transitional shelters should

1. provide protection from the external influences (durability),
2. be available for multiple disasters (re-use),
3. be lightweight and easy to move,
4. be rapidly assembled and disassembled,
5. be easy to store when not in use,
6. offer spaces where the disaster victims feel safe and protect their privacy (safety and privacy),
7. serve different functions as changing the form (extensibility),
8. be suitable for short and long use (temporary and permanent),
9. have all necessary spaces for the basic needs.

It is necessary to develop practical design solutions for the transitional shelters to meet vital and functional requirements. The necessary spaces to carry out domestic activities such as sleeping, culinary activities, personal hygiene, storing, washing and drying should be created. The most important criteria that should be considered while designing the transitional shelters are as follows: durability, safety and privacy, reusability, transportability, rapid assembly, easy to store, expandability and compactness, flexibility, thermal insulation and water resistance.

Durability

The temporary shelters should be durable during the intended period of use. Since the durability is related to the load bearing capacity of the structure and its resistance to the changing weather conditions, the materials to be used for such shelters should be selected considering the extreme weather conditions (IFRC, 2013). The shelter should withstand the wind loads acting different directions and not collapsed.

Reusability

Temporary shelters are generally used in a certain period of time ranging from several months to several years. The materials used to build these shelters should be reusable and upgradable since the structure can be relocated to a different site or re-used in another disaster (Arslan & Cosign, 2008; IOM, 2012).

Transportability

Rapid access of the shelters to the desired location is crucial. Therefore, these shelters should be small and lightweight to facilitate the transportation. This also reduces the logistics cost. Considering the capacity of vehicles used for the transportation, the shelters should be designed in a proper size. In this case, more shelters can be easily moved and delivered instantly at once.

Rapid Assembly

Because the disasters and their destructive impacts are unpredictable, it is not possible to plan beforehand how many temporary shelters are needed after the disaster. Therefore, it is necessary to find a quick and practical solution for such shelters. In fact, these shelters can be designed in such a way that they can be rapidly installed and assembled on site. This requires a kinetic design solution. If the shelter has a simple mechanism, it can be easily assembled by one or two persons in a short time.

Easy to Store

In the pre-disaster period, the shelters should be stored without having any damage and requiring much space. Since the number of shelters to be used after the disaster is unknown, it should be available as many as possible. Since the temporary shelters that cover large area cannot be stored conveniently in large numbers, it would be more convenient to avoid such shelters in design.

Safety and Privacy

One of the key factors when designing the temporary shelters is to provide people a safe place to live in. The shelter must ensure the protection of the ones live inside and their belongings. Thus, lockable doors and windows are required to protect against theft and attacks. Besides, the privacy of inhabitants is as important as the safety. Moreover, temporary shelters should have sound insulation since they are generally installed adjacent to each other. Furthermore, different compartments or separation walls are needed to control the access to the spaces such as sleeping area that is also used to change the clothes (Altman, 1975).

Expandability and Compactness

Expandability and compactness are significant factors in designing temporary shelters. The units can be reduced in size to be safely stored before using and be expanded when necessary. If the units are transformed into their compact states, more units can be transported once to the site. By this means, total transportation cost reduces.

Flexibility

Flexibility in the unit and settlement layout is important since it allows creating not only a multifunctional space within the unit but also variety of configurations in the settlement which facilitate modifications. The unit or the settlement may be changed in response to meet the changing functional or spatial needs of the users.

Thermal Insulation and Water Resistance

In order to provide a comfortable space inside the temporary shelters against constantly changing weather conditions, proper materials should be used not only for thermal insulation in cold winters and hot summers but also for water resistance in the rainy seasons (Sphere Association, 2018). The shelter should be sufficiently insulated and protected from the moist ground and the water on roof to prevent water leakage.

3.5. Evaluation of the Existing Transitional Shelters

Temporary shelters vary in type, size, cost, comfort level and services they provide. There are different types of shelters that can be used after the disasters such as tents, containers, prefabricated houses, trailers or modular structures (Farrokhsiar et al., 2000; Henrotay et al., 2006; Şener & Altun, 2009; IFRC, UN-Habitat & UNHCR, 2010, 2011, 2013, 2015; 2017, 2019; IOM, 2012; Asefi & Sirus, 2012; Lee et al., 2014; Kalkan, 2018; Valcarcel et al., 2021). The type of shelter should be chosen according to user requirements and climate conditions of the region. When the existing examples of the temporary shelters are investigated, it is seen that some of them are sufficient to provide optimum user comfort while the others are insufficient to meet the needs of occupants (Félix et al., 2013). To analyze the examples of temporary shelters in terms of the determined design criteria such as durability, safety and privacy, reusability, transportability, assembly time, form expansion and flexibility and to compare them based on their physical properties, spaces included, technical requirements and the disadvantages, 18 different examples have been selected as shown in **Table 4**.

The examples in the Table have been chosen to exemplify each category. The examples have been compared in terms of its capacity, durability, reusability, basic need area (kitchen-bathroom), portability, the time needed for assembly, safety-privacy, expansibility, power resources to be used for them to operate, natural lighting and natural ventilation. When the existing examples of the transitional shelters are investigated, it is seen that some of them are sufficient to provide optimum user comfort while the others are insufficient to meet the needs of occupants.

Among the design criteria of the transitional shelters, the most important one is the durability since the shelters must be robust enough to be used for several years. Thus, material selection is so crucial. The material used to construct the shelter should not be damaged even in extreme weather conditions. As seen in Table 1, different materials and structural systems are used to build the shelters which affect the durability. The most robust structure is the *SuperAdobe Eco-Dome*, but it is convenient for permanent usage rather than temporary due to its size and system type. Moreover, it requires land rights and construction permissions. The durability of the *Future Shack* is more than 2 years whereas the others are range from 6 months to a couple of years.

After the disasters, the temporary shelters should be quickly delivered to the disaster victims. Therefore, the structures should be light and compact so that multiple shelters can be transported at once. Transporting the container type shelters such as the *Future Shack* is more difficult than the other types, because they are heavy and need to be carried as one piece. It is also difficult to store such shelters since they occupy large spaces. On the other hand, demountable shelters such as the *U-Dome*, the *Habihut* and the *Shelterpack* are easy to store. Several structures can be transported simultaneously since they are carried in pieces.

Table 3.1. Transitional Shelters

	PHYSICAL PROPERTIES					DESIGN CRITERIA						SPACES INCLUDED			TECHNICAL REQUIREMENTS				DISADVANTAGES
Project Name	Form	Materials	Capacity	Covered Area	Number of Windows	Durability	Safety & Privacy	Reusability	Transportability	Assembly Time	Form Expansion & Flexibility	Kitchenette	Bathroom	Storage	Water Resistance	Thermal Insulation	Ventilation	Energy Supply	
EXO SHELTER		Proprietary blend of metal and plastic	up to 4 people	7.5 sqm	1	> 6 month	+	+	+	4 persons to build in 4-8 hours	-	-	-	-	+	-	Ceiling fans & Floor mounted vents	This shelter can only be operated on electric power. In case a destruction in infrastructure, there will be no electricity.	- No kitchen - No plumbing - Needs infrastructure - No warmth comfort - No storage
IKEA'S BETTER SHELTER		High-density polyethylene fibres and 5mm polyolefin panels	5	18.5 sqm	4	6 - 12 months	+	+	+	4 persons to build in 4-8 hours	-	-	-	-	+	-	Cross vent	Roof-mounted solar panels can only charge a mobile phone and a 4-hour LED lamp.	- No kitchen - No plumbing - No warmth comfort - No daylight or outdoor views - No storage space
SUPER ADOBE ECO-DOME		Log sandbags and barbed wire	4 or 5	37 sqm	8	> 10 years	+	-	-	1-4 persons to build 1 shelter in 5 days	-	An area is set for the kitchen, but the products to be used are not included.	An area is specified for bathrooms, but sinks, toilets or water heaters are not included.	+	+	+	Cross vent and roof vent	If electric power is not provided by the government, solar panels must be added otherwise users will not have access to electricity.	-Building permit required - Too big - Kitchen is not suitable for use - Bathroom is not suitable for use - Need infrastructure
PAPER LOG HOUSES		Recyclable paper tubes and fabric	4	16 sqm	3	6 - 12 months	+	+	-	10-20 people to build in 6 hours	-	-	-	+	+	-	Cross vent	The link to electric power should be managed by local residents.	- Building permit needed - No sanitary facilities - No kitchen - Needs infrastructure - No warmth comfort
FEMA TRAILER		Metal	4	23 sqm	3	> 6 months	+	+	+	4 or 5 people to build in 1 hour	-	+	+	-	+	-	-	This shelter can only be operated on electric power. In case a destruction in infrastructure, there will be no electricity.	- Very narrow living space - Needs infrastructure - No warmth comfort - Very expensive to build and install - No storage space
KIZILAY TENT		Fabric	3 or 6	32 sqm	-	1 - 3 months	-	+	+	3 or 4 people to build in 1 hours.	-	-	-	-	+	-	-	If electric power is not provided by the government, solar panels must be added otherwise users will not have access to electricity.	- No sanitary facilities - No kitchen - Needs infrastructure - No opening for natural lighting - No ventilation - No warmth comfort
ÜBER EMERGENCY SHELTER		Recyclable and reusable materials	3 or 6	Not specified	5	Not specified	+	+	+	Not specified	+	-	-	-	+	+	Cross vent	If electric power is not provided by the government, solar panels must be added otherwise users will not have access to electricity.	- No sanitary facilities - No kitchen - Needs infrastructure
FUTURE SHACK		Metal	3 or 6	14 sqm	2	> 2 years	+	+	+	Ready-made	-	+	+	-	+	+	2 openings for ventilation in the roof	Solar panels generating 12 volts	- Too large - Very expensive to manufacture - Transportation is difficult - No storage
TED EMERGENCY SHELTER (Transportable Emergency Dwelling)		Metal	3 or 6	28 sqm	8	Not specified	+	+	+	Not specified	+	+	+	-	+	+	Cross vent	Solar panels	- Too large - Very expensive to manufacture - Transportation is difficult - No storage

	PHYSICAL PROPERTIES					DESIGN CRITERIA						SPACES INCLUDED			TECHNICAL REQUIREMENTS				DISADVANTAGES
Project Name	Form	Material	Capacity	Covered Area	Number of Windows	Durability	Safety & Privacy	Reusability	Transportability	Assembly Time	Form Expansion & Flexibility	Kitchenette	Bathroom	Storage	Water Resistance	Thermal Insulation	Ventilation	Energy Supply	
MINIMUM MOBILE MODULE		Metal	4 or 5	14 sqm	Not specified	Not specified	+	+	+	Not specified	+	+	+	-	+	+	Cross vent	Not specified	- Too large - Very expensive to manufacture - Transportation is difficult - No storage
U-DOME		Membrane	4 or 5	Not specified	4	1 - 3 months	-	+	+	3 or 4 people to build in 1 hours.	-	-	-	-	+	-	With wall and roof vents	If electric power is not provided by the government, solar panels must be added otherwise users will not have access to electricity.	- No plumbing - No kitchen - Needs infrastructure - No warmth comfort - No storage
INTERSHELTER		Fiberglass	4 or 5	14 sqm	1	3 - 6 months	+	+	+	installed in a few hours with 2-3 people	-	An area is set for the kitchen, but the products to be used are not included.	An area is specified for bathrooms, but sinks, toilets or water heaters are not included.	-	+	+	-	If electric power is not provided by the government, solar panels must be added otherwise users will not have access to electricity.	- Kitchen is not suitable for use - Bathroom is not suitable for use - Needs infrastructure - Not enough natural lighting - No natural ventilation
PALLET HOUSES		Wooden pallets	4 or 5	18 sqm	Not specified	Not specified	-	-	+	10-20 people to build in 6 hours	-	An area is set for the kitchen, but the products to be used are not included.	An area is specified for bathrooms, but sinks, toilets or water heaters are not included.	-	+	-	Cross vent	Solar panels	- Kitchen is not suitable for use - Bathroom is not suitable for use - No warmth comfort
RED HOUSING		Wood and Fabric	4 or 5	Not specified	-	12 - 18 months	+	+	+	10-20 people to build in few hours.	+	An area is set for the kitchen, but the products to be used are not included.	-	-	+	Not specified	Not specified	Not specified	- Kitchen is not suitable for use
HABIHUT		High-density polypropylene panels	4 or 5	11 sqm	3	> 1 year	+	+	+	installed in a few hours with 2-3 people	-	-	-	-	+	-	Cross vent	Not specified	- No kitchen - No plumbing - No warmth comfort - No storage
LIINA TRANSITIONAL SHELTER		Wood-based materials	5	18 sqm	6	> 1 year	+	+	+	2 people to build in 6 hours	-	+	-	+	+	+	Cross vent	Not specified	- No plumbing
SHELTERPACK		Multiple layers of fire and waterproof materials	4	Not specified	1	> 1 year	+	+	+	installed in a few hours with 2 people	-	+	+	-	+	+	Roof window	Not specified	- Not enough natural lighting
TENTATIVE		Fibreglass shells and durable, weather-resistant thermal textiles	4	8 sqm	3	> 1 year	+	+	+	installed in a few hours with 2 people	-	-	-	-	+	+	Roof window and cross vent	Not specified	- No kitchen - No plumbing - No storage

Many temporary shelters are designed in compact form and the concept of expandability is generally ignored although it provides several advantages in terms of flexibility, transportability and storing. A few examples allow the shelter to expand. Only the *Über Emergency Shelter*, the *TED Emergency Shelter* and the *Minimum Mobile Module* have this feature. These structures not only increase the spaces to be used as unfolding their surfaces according to the spatial needs but also allow the combination of different units that can be added. On the other hand, the *Red Housing* allows cross partitions inside to be changed, therefore it provides different areas of use.

Even though there are many types of transitional shelters varying in shape and size, the overall capacity of such structures is up to 4 or 5 people. Covered area is range from $7.5m^2$ to $32\ m^2$. Apart from the sleeping area, the transitional shelters should include a small kitchenette, a bathroom and storage. However, sanitary installation is generally incomplete in many shelters. Therefore, the occupants do not have their own kitchen, shower or toilet. The lack of these areas lowers the standard of comfortable living of individuals. In the *Eco-Dome*, the *Inter Shelter*, the *Palet Houses* and the *Red Housing*, the spaces for kitchenette and bathroom are specified. However, culinary and sanitary fixtures are not included. The disaster victims having good economic conditions can purchase those fixtures whereas the ones who cannot buy them due to their economic condition are forced to use the common areas established in the camps. Sanitary fixtures and kitchen are available in the *Fema Trailler*, the *Future Shack*, the *TED Emergency Shelter*, the *Minimum Mobile Module* and the *Shelterpack*. *The Liina Transitional Shelter* has only a kitchen and its occupants have to use shared toilets and showers for the hygiene needs.

In addition to the required spaces for the domestic activities, there are also technical requirements that should be fulfilled while designing the temporary shelters. A sufficient level of natural light and ventilation should be provided in the shelter to have a comfortable living space. If the openings are created as opposite to each other, it allows cross ventilation naturally. Natural ventilation is provided in all the shelters except the *Red Crescent* tents.

The material affects thermal insulation and water resistance of the shelter. In all the examined examples, the used materials form a water barrier and protect the interior space. However, not all the shelters provide thermal insulation even though the thermal comfort is important for human satisfaction. Nevertheless, there are sufficient examples such as the *Super Adobe Eco-Dome*, the *Über Emergency Shelter*, the *Future Shack*, the *Ted Emergency Shelter*, the *Minimum Mobile Module*, the *Intershelter*, the *Liina Transitional Shelter*, the *Shelterpack* and the *Tentative*.

Temporary shelters are generally placed in remote areas in which there may be no connection to electric grid. Portable power distribution equipment can be used to supply electric power in the field. Even if the electrical infrastructure is installed, it can be destroyed due to the disasters. In this case, there will be no electricity that they can be utilized by the occupants. For this reason, it is important to consider alternative design solutions to minimize such problems. For instance, solar panels can be mounted on the structures as in the *Ikea's Better Shelter*, the *Future Shack*, the *TED Emergency Shelter* and the *Pallet Houses*.

Another point that should be taken into consideration in design is that the structures need a sufficient level of natural light and natural ventilation to provide a comfortable living space. Generally, gaps are left suitable for the used square meter as a solution for the natural ventilation and lighting. Because of the openings placed opposite to each other, fresh air can be easily taken inside through the cross-ventilation. This problem has been solved in the examined shelters except for the *Red Crescent* tents.

After the transitional shelters provided basic needs in the acute period, it is also important that it can provide a comfortable living space by expanding, as it may take time to transition to permanent structures in the post-disaster period. This problem has generally been ignored. Rather, the designs of the shelters focus on meeting the people's housing needs only. Moreover, additional spaces cannot be created by connecting the shelters each other. Only a few examples allow the shelter to expand which are the *Über Emergency Shelter*, the *TED Emergency Shelter* and the *Minimum Mobile Module*. These structures can increase the spaces to be used thanks to their surfaces that can be opened and closed by folding and allow the combination of different units that can be added. The *Red Housing* allows cross partitions inside to be changed, therefore it provides different areas for use.

When the aforementioned temporary shelters are evaluated, it can be said that most of them do not provide all the spatial and technical requirements for long term use. Although the temporary shelters should provide a comfortable living space to the victims during the period they live in since they are affected psychologically, socially and economically due to the devastation of disaster, they are generally not at the desired level to meet the user needs. Moreover, the units are not flexible enough to offer multi-purpose use within the space and to allow combinations of units to create more spaces that can be used for larger families. Since many of the temporary shelters are not expandable, the transportation and storing of such shelters are problematic. Thus, it is necessary to offer new design solutions. For this purpose, a new transformable unit is developed which can overcome the deficiencies that are inherent in the existing temporary shelters and provide a comfortable life for the occupants as meeting their need during the period of staying.

CHAPTER 4
TRANSITIONAL SHELTER PROPOSAL

The need for transitional shelters after the disasters is a common problem for all the countries all around the world regardless of their socioeconomic level. Due to the sudden nature of the disasters, countries never have adequate preparations. Until the permanent dwellings are built for the disaster-victims, transitional shelters should be offered to them. Architects and designers have developed many alternatives to improve the transitional shelters. However, when the proposed designs are evaluated, it is seen that they are not feasible enough in terms of flexibility, transportability and reusability. For example, the tents that are distributed to the disaster victims are easy to store and set up. However, they are neither safe nor have a private toilet or kitchen inside. For this reason, everyone in the tent camps have to use common toilets and kitchens. Since these shelters are also inadequate in terms of the used materials, they provide an uncomfortable and bad-conditioned living space for the users under cold climate conditions. On the other hand, container type structures have problems due to the transportation and rapid delivery to the disaster area. Moreover, they are not suitable for expansion and functional change due to their structure. Thus, it requires to develop a new design solution that can meet all user needs as well as the functional and technical requirements. In this chapter, a transformable transitional shelter that not only changes its shape but also allows different unit combinations such as supply unit, medical unit or activity unit, and a settlement layout is presented.

4.1. Objectives

Many designers have proposed temporary shelters having different features for the use in emergency situations. Even though the attempt in each project was to overcome the deficiencies in the previous designs, there are still some deficiencies in the shelter projects designed to be used temporarily. The model designed within the scope of this thesis has been created with the aim of eliminating the deficiencies found in the existing shelter projects to provide a comfortable life for the disaster victims.

Comfortable shelters are needed to protect the disaster victims from further stress for those who have already suffered from the disaster since they are most affected psychologically, socially and economically due to the post-disaster devastation. Poor living conditions increase the negative psychological interaction of these individuals. Inability to access individual hygiene and the collective living conditions may lead to health problems. Apart from this, the lack of privacy and security, and the poor insulation due to the material used in the structure of the shelter affects the lives of the victims adversely. Because of these reasons, the life in such shelters cannot be long-lasting.

After the short-term use of the tents in the first stage of the disaster, settlements consisting of prefabricated shelters are established until new permanent dwellings are built for the disaster victims, and the disaster victims are transferred to those prefabricated shelters. Even if the prefabricated shelters are slightly more secure and better than the tents in terms of the privacy, some of them do not provide basic needs such as private kitchen and toilet. In addition, two-stage transitional shelters system causes unnecessary financial expenses. Thus, new solutions should be developed.

The main objective of this thesis is to develop a transitional shelter that can change its shape from a closed configuration to an expanded form to meet all the design requirements. It is also intended to create different unit combinations that can be used either as housing units for larger families or as supply unit, health unit and activity unit. Another goal is to propose a settlement layout to ensure the creation of a healthy and comfortable living environment for the disaster victims. The proposed unit can be either used until the construction of permanent dwelling is completed or transformed into a permanent residence since can meet all needs of the users for long term period. In **Figure 4.1**, main concept diagram of the design proposal can be seen.

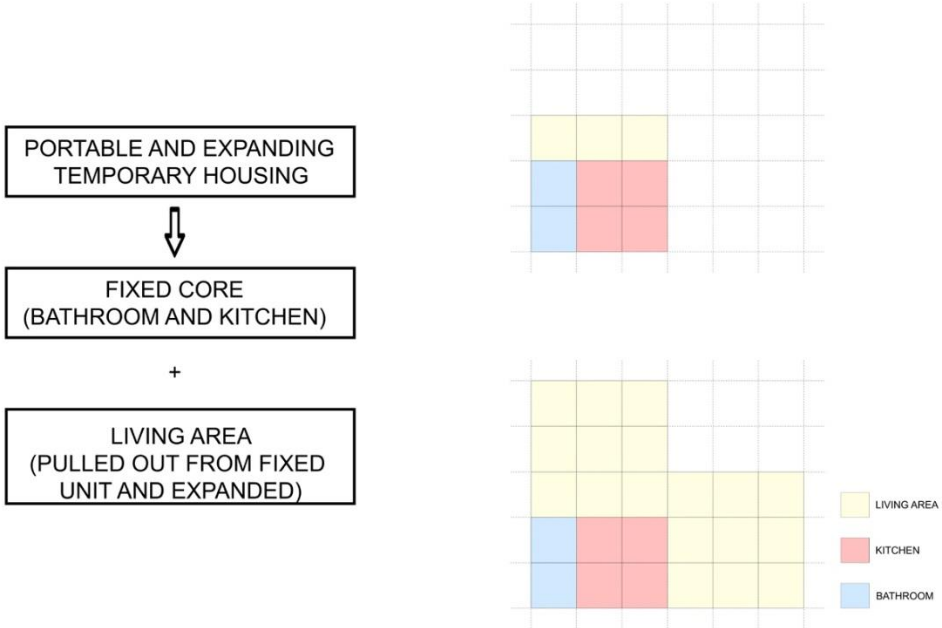


Figure 4.1. Main Concept Diagram

4.2. Design Strategies

The most important benefits that transitional shelters offer to the disaster victims can be classified in two groups: (1) functional and (2) economic/technical features. To provide comfortable living conditions to the victims of the disasters who lost their houses, the transitional shelter should have the functional features such as spatial requirements (toilet, kitchen etc.), climatic comfort, privacy, security, and the shelter must be self-sufficient. The economic and technical features including transportation of the structure, storage, materials, cost, re-usability and durability have importance. The transformable housing unit has been proposed considering these criteria. Having a cube shape in the compact configuration, the unit can meet all needs of the users since it has ability to transform itself into a new form to create larger spaces to be used for different functions. In **Figure 4.2**, the extension scheme of the unit is demonstrated.

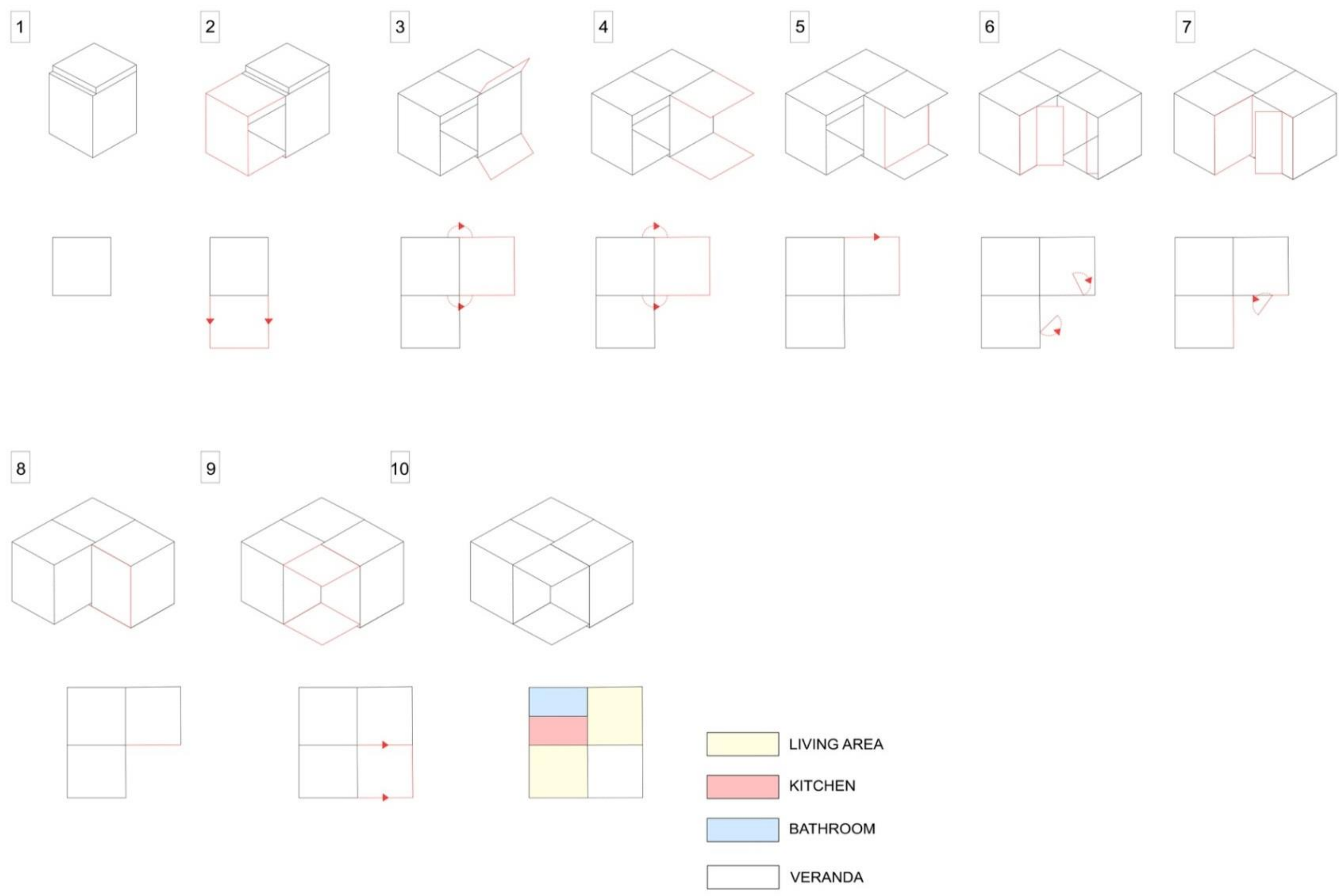


Figure 4.2. Extension Scheme of the Proposed Transitional Shelter

4.2.1. Functional Features

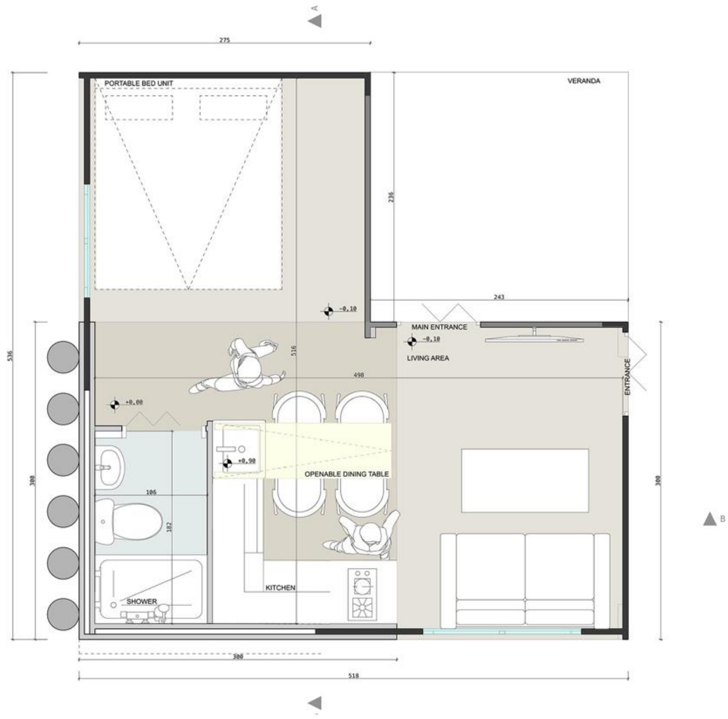
Right after the disasters, the disaster victims have experienced great difficulties in the tents or prefabricated shelters; therefore, the post-disaster life should be well designed. As the economic and technical features of the structure, its functional features have also importance for the users. For instance, the tents have many deficiencies due to its functionality in spite of being an economical type of shelter. The emergency shelters that are currently in use have low comfort levels and are only meet the sleeping needs of the disaster victims. In the proposed unit, the aim is to create a comfortable living space for the disaster victims and to meet all their needs.

Having a covered area of $21m^2$, the unit accommodates both a common living space of a family with four members and the spaces for fundamental functions such as sleeping, cooking, dining and bathing (**Figures 4.3-4.7**). The unit has two entrances: one is used as the main entrance that connects the common living space to the veranda while the other entrance is located on the left side of the living area which can serve as a transition interconnecting two units. A larger living space can be created for more crowded families by connecting two units side by side from the junction points. Maximum eight people can easily live in the living space created by combining the two units. While the bathroom and kitchen inside the unit is fixed, the bed and table are movable. The table located in the kitchen can be easily laid when needed and folded back on the washbasin. Likewise, the bed can be opened or closed according to the usage status of the area depending on the number of people living in the unit.

The privacy required for the occupants inside the unit is provided by separating the spaces. The sleeping area is not directly visible form the entrance and the veranda. The unit provide the users not only a visual privacy at the maximum level but also an auditory privacy. In addition, the insulation material used inside the walls prevent unwanted noise transferring.

The model meets all the spatial needs of the disaster victims. The living, cooking, eating, bathing, and sleeping needs of the victims are satisfied. In the shelter camps established after the 1999 Marmara earthquake, cooking and bathing needs of the disaster victims were met communally. A common use of wet volumes has posed many problems. In the proposed design, kitchen and bathroom are equipped for each family. Since the proposed unit can be combined, more bathrooms and kitchens can be provided to the of the large families.

a)



b)

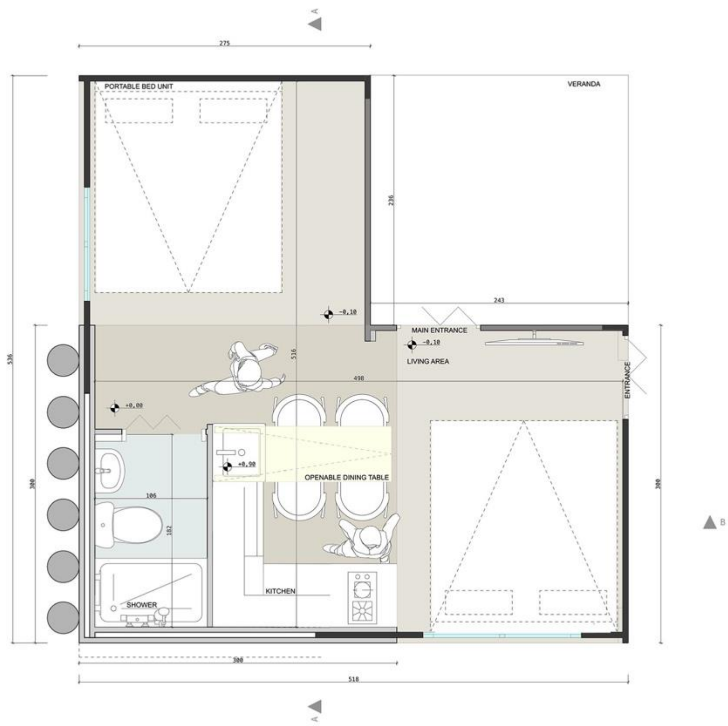


Figure 4.3. Fully Opened State of the Proposed Transitional Unit a) Alternative 1; b) Alternative 2

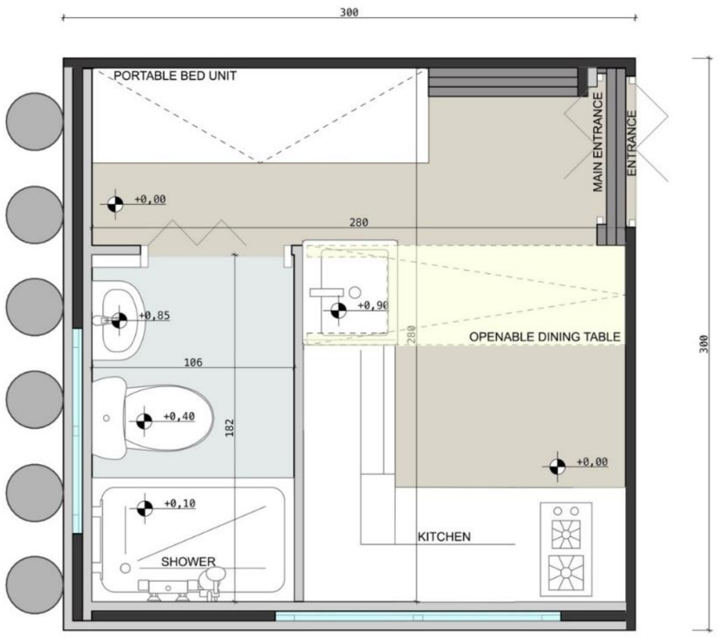


Figure 4.4. Closed State of the Unit

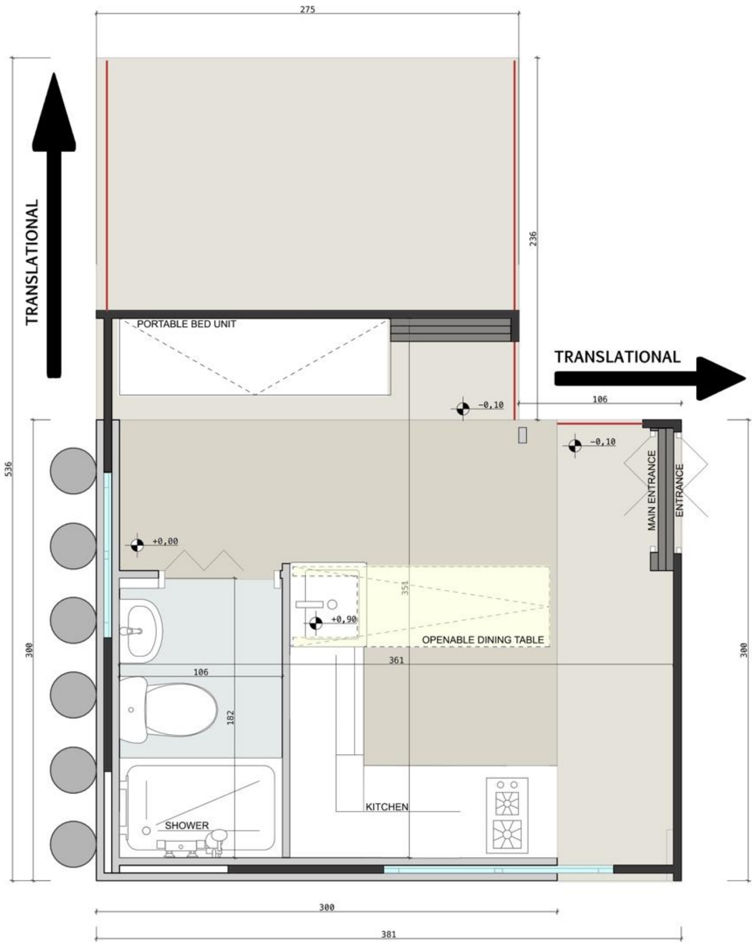


Figure 4.5. Opening State 1

Figure 4.6. Opening State 2

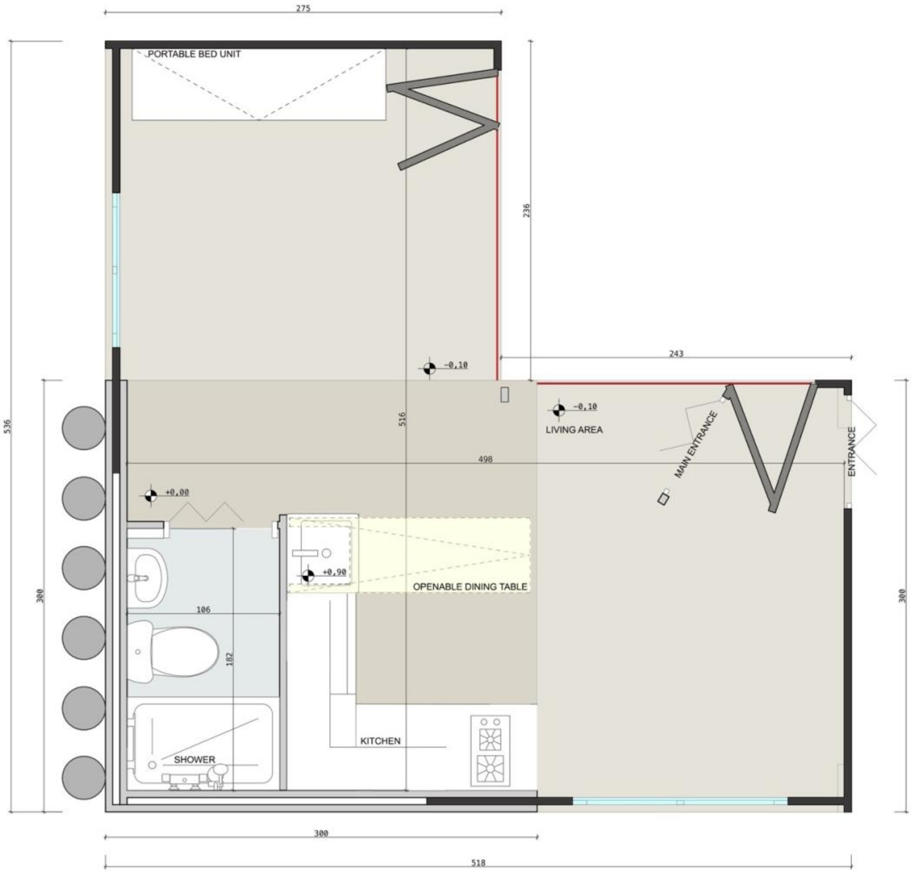


Figure 4.7. Opening State 3

4.2.2. Economic and Technical Features

The production and stocking of the transitional shelters before the disaster plays an important role in providing a quick solution to the damage that will arise because of the disaster. Before starting the shelter production, the economic and technical features of the shelter should be well considered and examined. It is necessary to carry out enough production and storage operations along with calculation of the cost.

Since the proposed unit is transformable, it meets not only the design criteria of form expansion and flexibility but also of storing and transportability. The unit can be stored in one piece in its closed configuration like a small container. By this means, the units can be easily placed side by side and on top of each other without occupying much space in the warehouse. They can be directly transferred to the desired location immediately after the disaster without wasting any time. Four units can be transported by a truck at once since the length of a truck is 13.6m and its width is 2.45m (**Figure 4.8**).

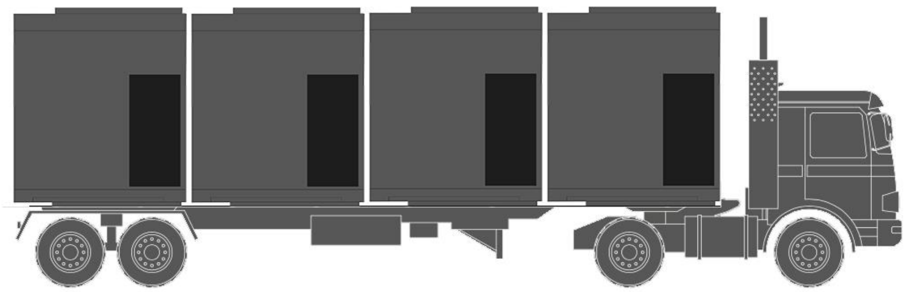


Figure 4.8. The Layout of the Units Transported on a Truck

The disaster victims must be settled within 13 days to the transitional shelters (Sey, et al., 1987). Once the shelters reach the disaster zone, they must be unloaded by a crane. The unloaded shelters should be installed quickly in maximum two hours by only two people after reaching the disaster zone. When the proposed units are delivered, they can be easily installed in a short time by only rotating and pulling the parts needed to move since they have a very simple system not requiring any parts to assemble. No electrical energy is needed for the installation of the units. The advantage of keeping the system so simple is that the units can be installed in the disaster zone without the need of any technical support. Thus, the victims can easily establish their own temporary shelters which can be re-used.

The proposed unit meets the important technical requirements such as thermal insulation, water resistance, ventilation, electricity and clean water. The proposed unit consists of sheet metal, inspired from the container, for the purpose of protecting the unit. The sheet metal on the outer surface provides durability and protection against changing climate conditions. While the outer surfaces are made of sheet metal having sound barrier, the inner surfaces are covered with plywood. Rock wool is used between these two layers to provide insulation. The plywood layers used in the interior make the disaster victims feel psychologically that they are in a warm environment. To avoid the negative effect due to the plywood used in the bathroom, it is necessary to use PVC panels on the wall located in that area (**Figures 4.9** and **Figure 4.10**).

The thermal comfort is provided by the insulated surfaces on floors, walls and ceilings. By this means, the temperature of the interior space is always kept at the desired level to create an optimum indoor environment. Moreover, the unit is elevated on the telescopic legs which stands 30cm high above the ground level to provide water resistance. The sliding windows on the movable walls of the unit ensure that natural light enters the interior at a sufficient level and natural ventilation is provided. The natural illumination I provided by the glazed main entrance door and large windows located at two different sides of the unit. Natural air flow can be achieved easily inside the unit by allowing cross-ventilation. The outdoor environment and interior space can be interconnected through large windows.

In addition to the aforementioned features, the proposed unit meets other important requirements such as electricity and water. In normal conditions, transitional shelters to be used after the disasters should be placed in areas where they can be connected to the water and electricity networks in the region established by the state. However, in cases where there is an interruption in the connection with these networks, the structure will not be self-sufficient. Thus, a photovoltaic (PV) system has been used at top of the proposed transitional shelter to generate electrical energy for the actions of heating and lighting. Under normal conditions, the daily electricity need of a house is 4-5 kilowatt-hours which means $10m^2$ solar panel. Correspondingly, two 300x200mm PV panels are planned to be installed on the unit. On the other hand, six water tanks are equipped to provide clean water. Four of the tanks are planned to be connected to the water supply network of the city while two remaining tanks can collect and store rainwater by means of the channels on the roof.

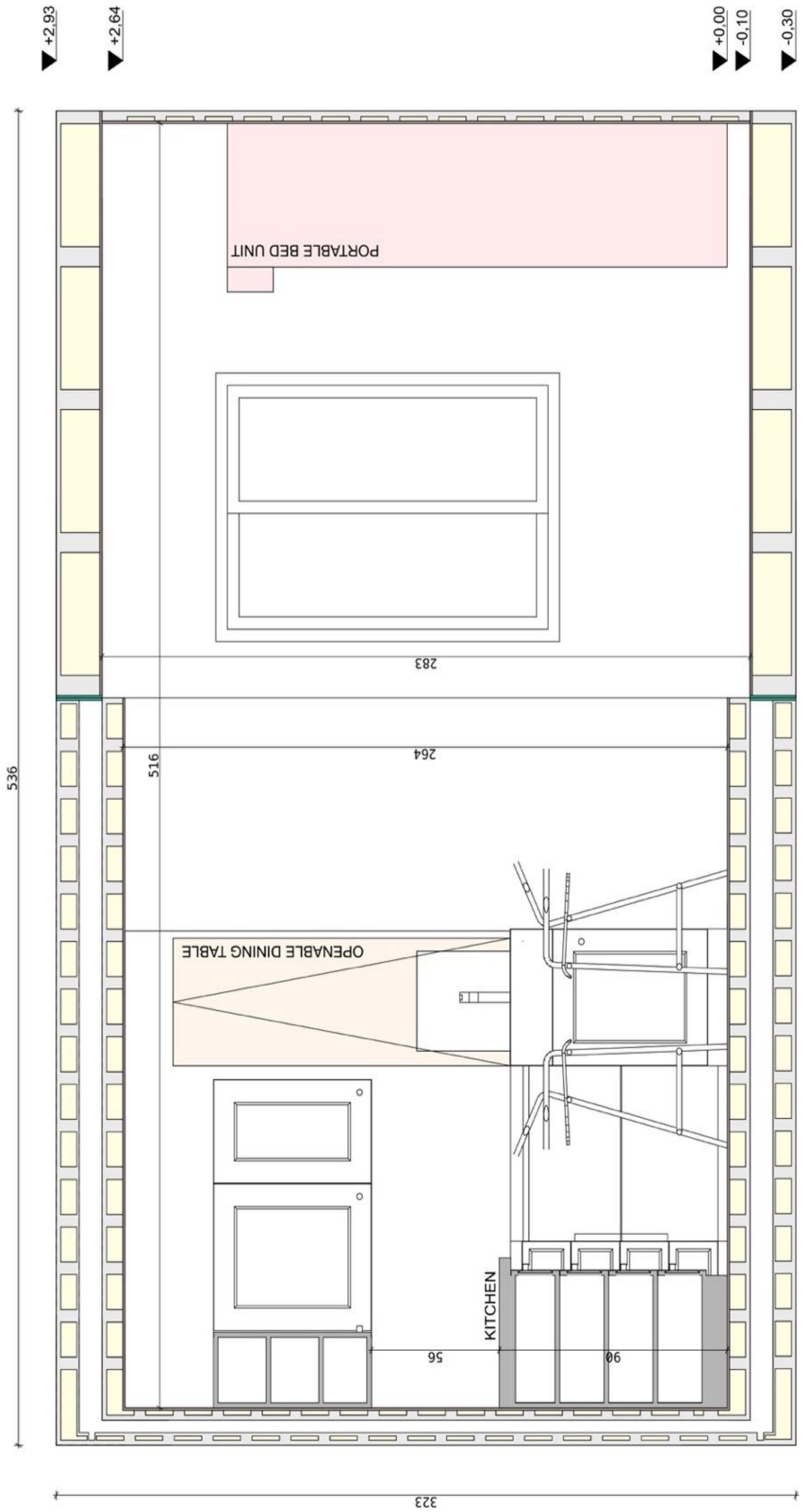


Figure 4.9. Section A-A

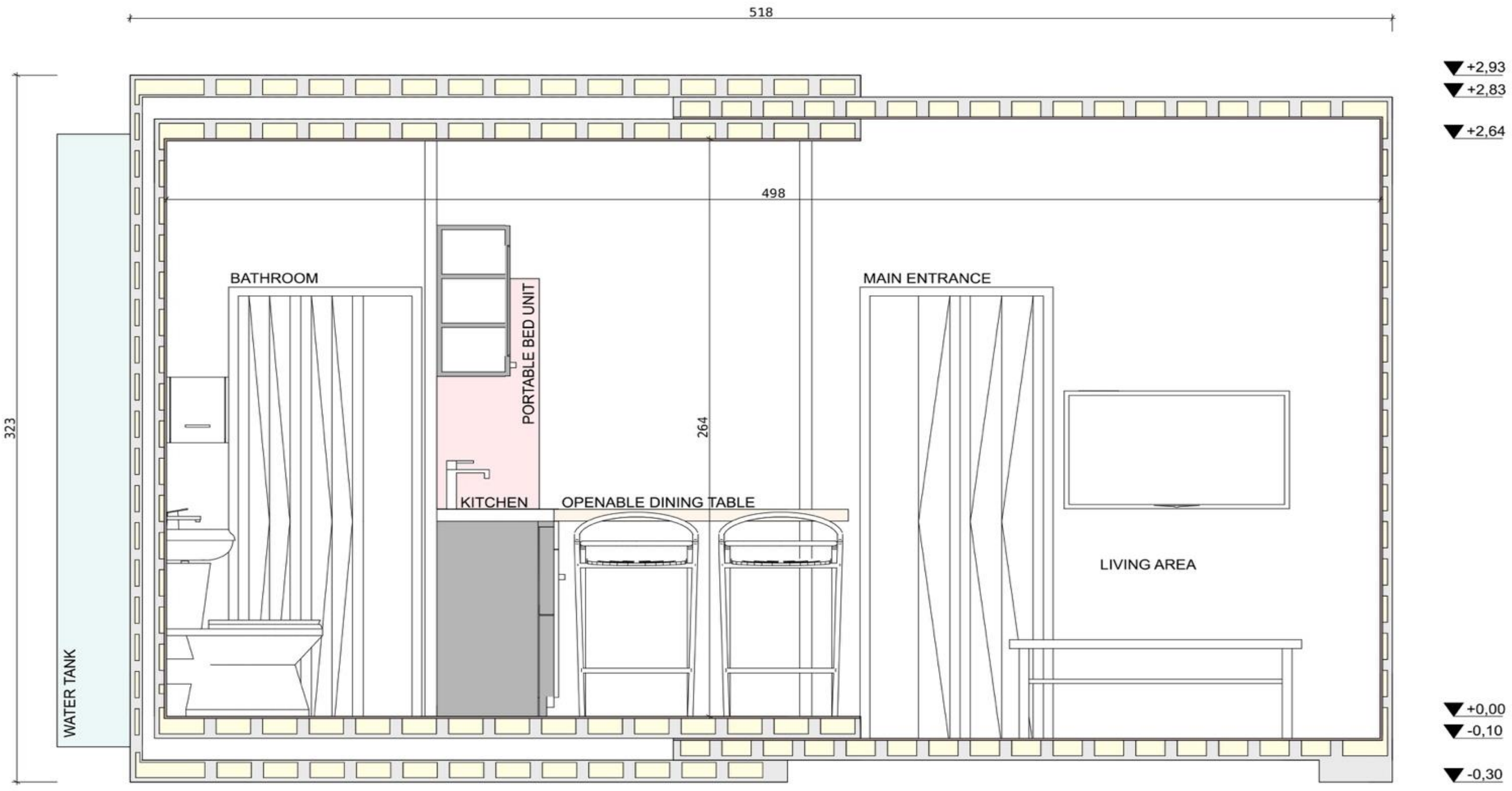


Figure 4.10. Section B-B

When compared to the transitional shelters that are currently being used, it can be thought that the designed unit is expensive because of the manufacturing and the materials used. However, when considered that the unit will be used for a long time after the disaster until the construction of permanent dwellings are finished, it is more economical than the two-stage shelter. Moreover, considering that the unit will be able to be used again and most of the used materials have recycling properties, the need for continuous shelter production will be also prevented. In addition, with the water tanks and solar panels included in the unit, this self-sufficient structure will provide energy savings and reduce the economic burden that is faced by the government.

4.2.3. Spatial Organization of the Proposed Unit

The proposed transitional shelter is cube-shaped when closed. The size of the unit in the closed state is 300x300cm. When the system is moved, it transforms from a cube shape to a L shape prism having dimensions of 518x538x333cm in its the fully opened position (**Figures 4.11 and 4.12**). Having a total area of 21m^2, the unit accommodates a common living space for a family with four members and contains basic vital functions such as dining, cooking, sleeping and bathing. If portable furniture is used in the unit, it allows users to re-design the space according to their preferences. When the life begins in the unit, the users will have the opportunity for creating their own plan schemes

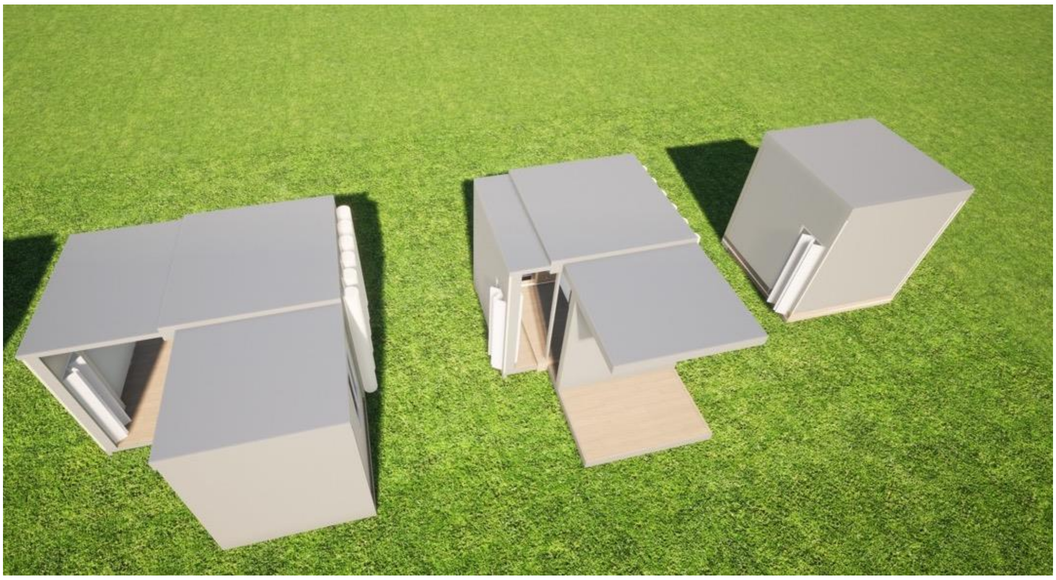


Figure 4.11. Shape Transformation Process the Proposed Unit

Figure 4.12. Opening Stages of the Unit

The proposed unit consists of four main spaces: common area, kitchen, bathroom and sleeping area (**Figures 4.13 and 4.14**). The unit has two entrances: one is used as the main entrance that connects the common living space to the veranda while the other entrance is located on the left side of the living area which can serve as a transition interconnecting two units. Due to the location of the main entrance, the distance to the sleeping area, bathroom, kitchen, and common living area is equal.

Figure 4.13. Closed State of the Unit

Figure 4.14. Fully Open State of the Unit

The kitchen and bathroom are located side by side in the fixed part of the unit. The bathroom has an area of 1.98m^2 that meets the needs of a person for a shower, toilet and washbasin. In the bathroom, there is a shower tray with a dimension of 650mm x 1060mm and a small washbasin with a dimension of 280mm x 410 mm.

The kitchen has 3.35m^2 in the open position. Cooker, refrigerator and oven are equipped in the kitchen as fixed appliances. The foldable dining table in the kitchen can be easily opened when needed by turning it at an angle of 90° towards the inner space and folded back on the washbasin when not in used so that it does not occupy much space (**Figure 4.15 and 4.16**). Its foldable nature provides a great advantage in terms of the flexibility of the usable space.

On the other hand, the sleeping area is 6 m^2 in which there is a folding bed (**Figure 4.17 and 4.18**). The double bed can be easily pulled out of the wall cabinet when needed or stored in the vertical position when not used. Because it can be folded or unfolded according to the user preference, the space can be used for different functions when it is closed. The common living space has a combined area with the kitchen. The common living area is 9m^2 which can be also transformed into a sleeping space depending on the number of people living in the unit. If portable furniture is used in this space, it allows users to re-design the space according to their preferences.

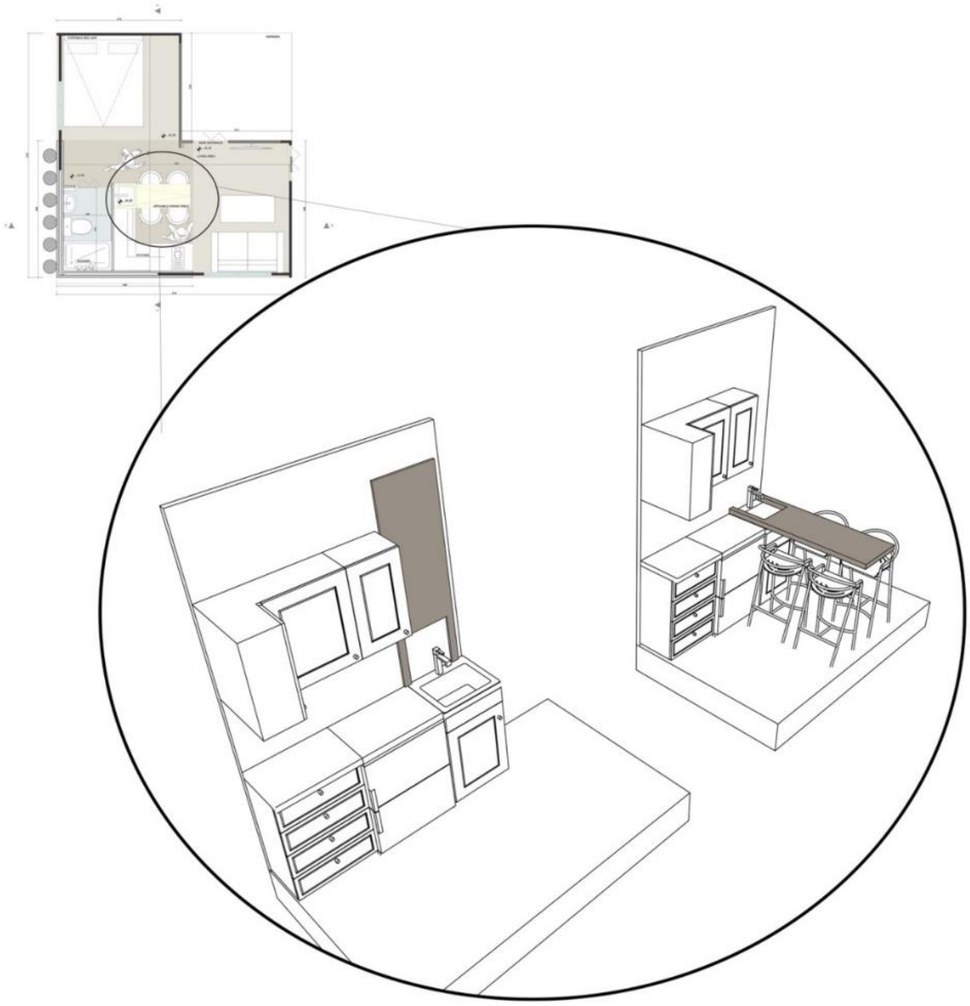


Figure 4.15. Folding Table Detail

Figure 4.16. Kitchen Interior View

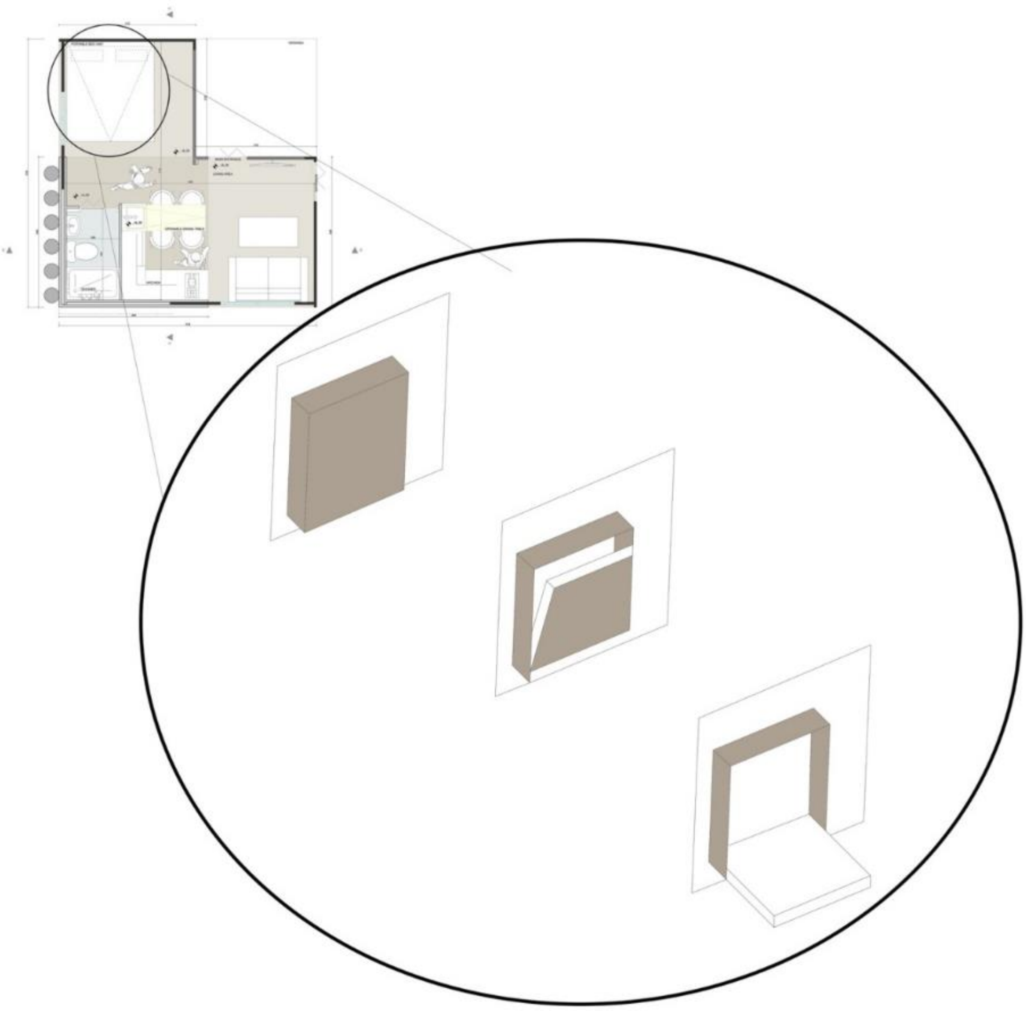


Figure 4.17. Folding Bed Detail

Figure 4.18. Bedroom Interior View

When the system is fully opened, the veranda is created as pulling out the floor and roof plates from the main structure. Serving as not only an outdoor living space but also an entrance to the unit, it covers an area of 5.74m^2 and is made of a sheet metal that can be easily opened and closed when desired.

In addition, blankets, cleaning kits, pots, cutlery sets (for 6 people), wooden spoons, glasses, laundry tubs, dustpans, bed linen, chairs, quilts, pillows, carpets, sofa beds, brooms, dinnerware, clothes dryer hanger and TV are available in the unit (Sphere Project, 2000).

4.2.4. Transformation Capability of the Proposed Unit

The proposed unit has both a fixed part and a movable structure. Due to the light structure of the materials that are used in the inner and outer parts of the proposed unit, the pulling process is easy.

The main structure is located in the fixed part of the unit where the kitchen and bathroom are placed. The surrounding structure can be easily moved by pulling out of it from the fixed part by means of the sliding mechanism. Then, the floor and roof plates are unfolded to create the sleeping area. Those plates are connected to the structure by continuous hinges allowing rotational movement. Once the installation of the structure is completed, the folding walls on the side faces are pulled on rail and fixed in their places.

The unit consists of walls and floor panels that fold around the main core and interlocked with each other. This system gives a kinetic dimension to the unit. The kinetic feature provides many advantages to the unit. With such moving parts, the unit in the form of a cube in the closed state grows by expanding its space. The unit can be unfolded when needed. This provides a great advantage in terms of the transportation.

There are two basic movements in the unit which are translational movement and rotational movement (**Figures 4.19-4.21**). The translational movement allows the walls of the unit slide into each other. By this means, the system can be opened and closed. The rotational movement allows folding the floor, side and roof panels.

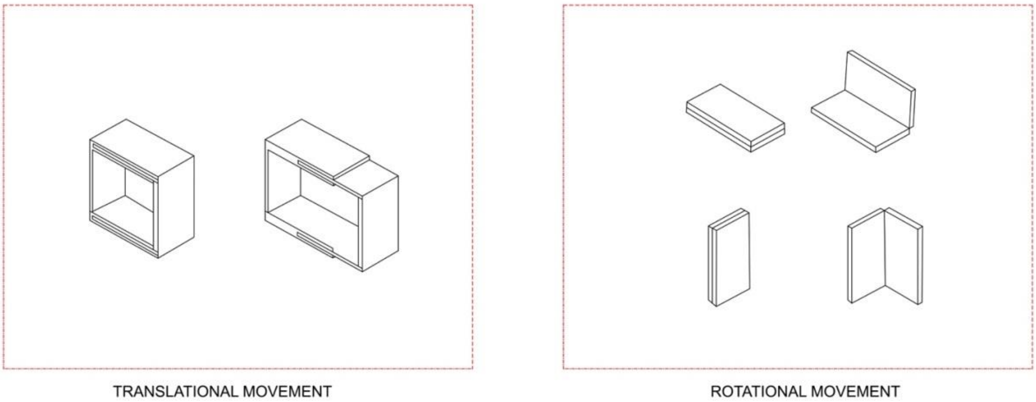


Figure 4.19. Representation of the Movements

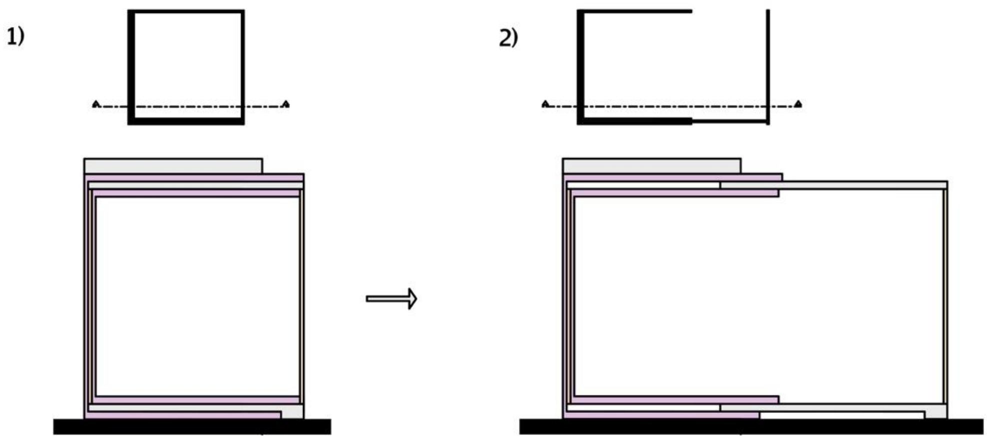


Figure 4.20. Motion Scheme 1

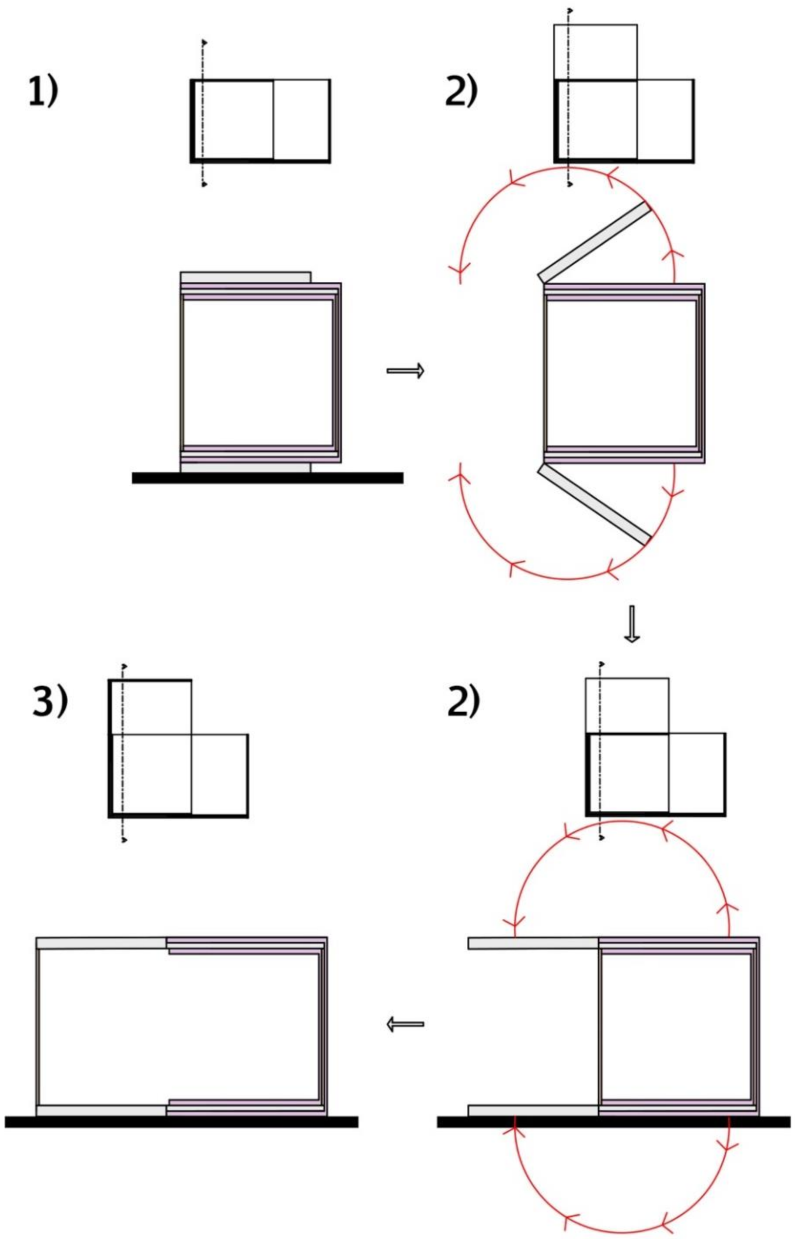


Figure 4.21. Motion Scheme 2

The part where the kitchen and bathroom are located can be defined as the core of the unit. The walls located in this part have a thickness of 15cm while the floor and roof panels have a thickness of 30cm. The part where the living space is located performs a translational movement. Wall, floor and roof panels are moved by pulling them from the core section simultaneously. The walls have a thickness of 5cm whereas the floor and roof panels have a thickness of 10cm. The main structure located in the core part is removed by pulling out the structure which can be easily pulled by the wheel and rail system located at the connecting points. The presence of wheels also ensures that the weight is evenly distributed; thus, the structure is established in a balanced way (**Figure 4.22**).

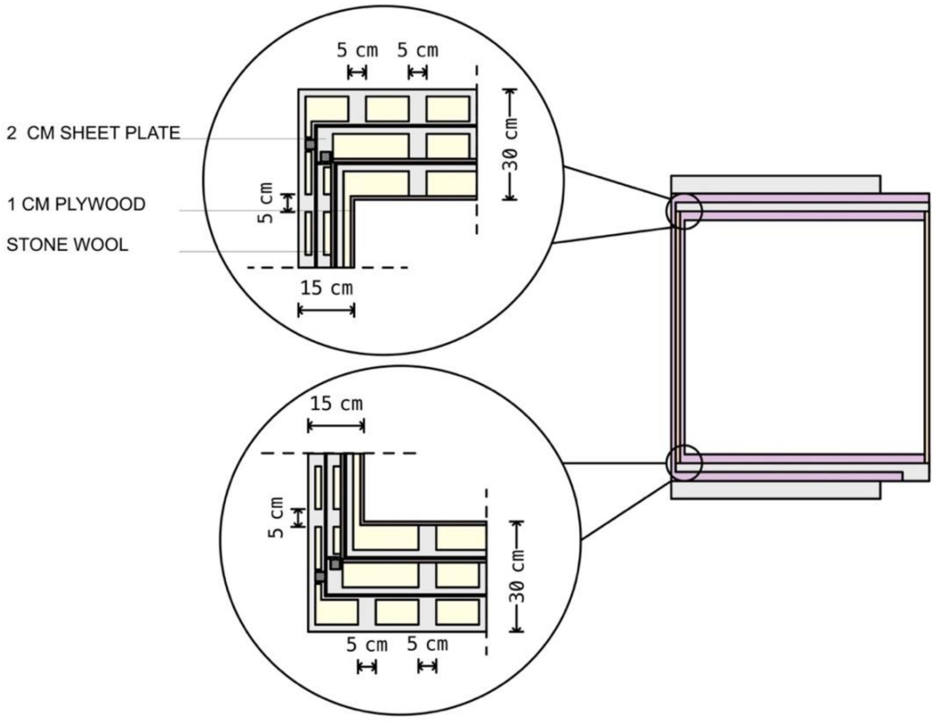


Figure 4.22. Sliding Rail and Floor Detail

Since this part is 10cm above the core section, it is pulled together with a floor covering through the legs. When the installation is completed, the entire unit will be ready as balanced on a flat surface **(Figure 4.23)**.

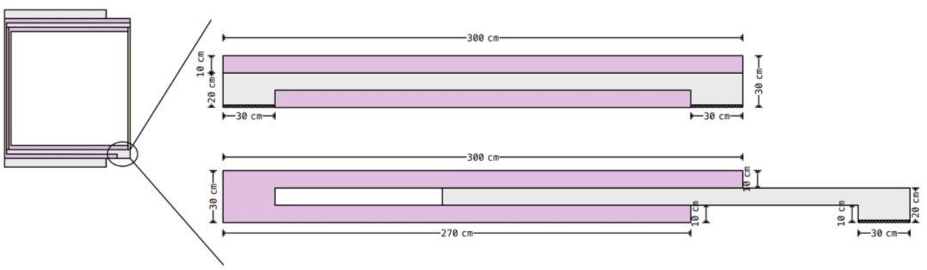


Figure 4.23. Supporting Foot Detail

Locking parts are equipped between the layers to prevent the movement of the walls, floor and roof after the installation. **(Figure 4.24)**

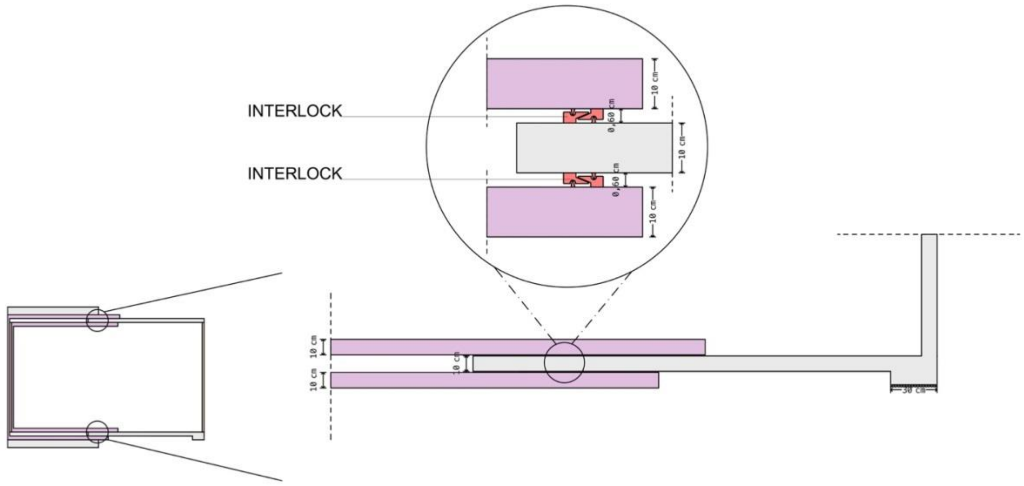


Figure 4.24. Interlock Detail

While the floor and roof make a rotational movement in the part where the sleeping area is located, the walls make a translational movement. The walls have a thickness of 5cm while the floor and roof panels are 20cm. The elements that are connected by continuous hinges are easily rotated **(Figure 4.25).** The wall is easily pulled and placed in its place on the rail system located at the floor and roof **(Figure 4.26).**

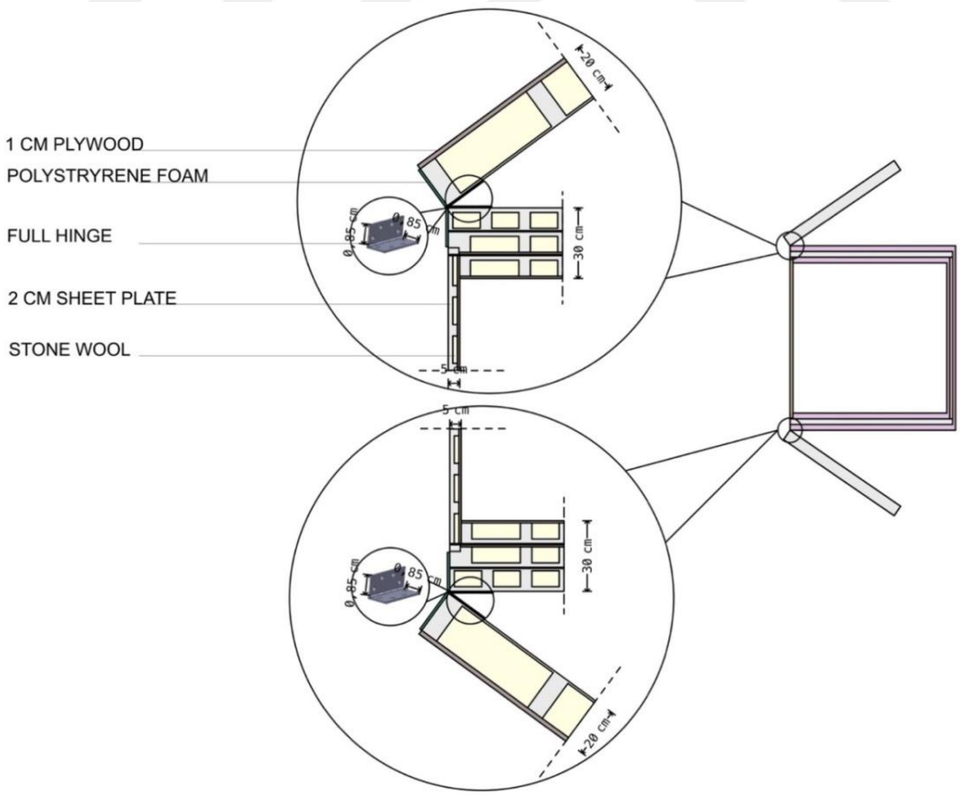


Figure 4.25. Folding Panel Detail

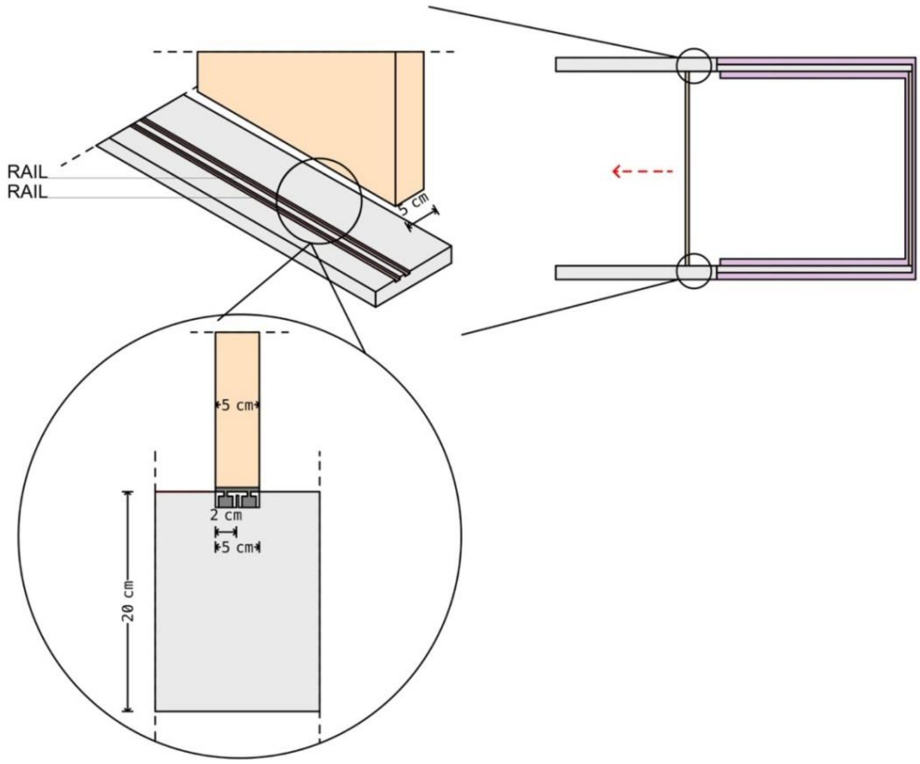


Figure 4.26. Rail Detail

Once the installation of the main structure is completed, the wall components folded on the side faces are pulled on rail system and fixed in their places. The veranda that is attached to the module is located at the main entrance. The veranda is made of sheet metal with a dimension of 24.3 x 23.5 x 33.3 cm which can be easily opened and closed according to the user preference. For the veranda to be installed, the installation of the entire unit must be completed first. Floor covering and canopy sections that are pulled out from the main structure can be fixed in a balanced way because of the portable mast.

On the movable walls of the unit, there are sliding windows with the dimension of 150cm x 150cm. They are placed to ensure that natural light and natural ventilation enter the interior at a sufficient level. Profile sections of the windows are made of fine wood while the glass section is made of mica material to prevent it from breaking during the transportation **(Figure 4.27).**

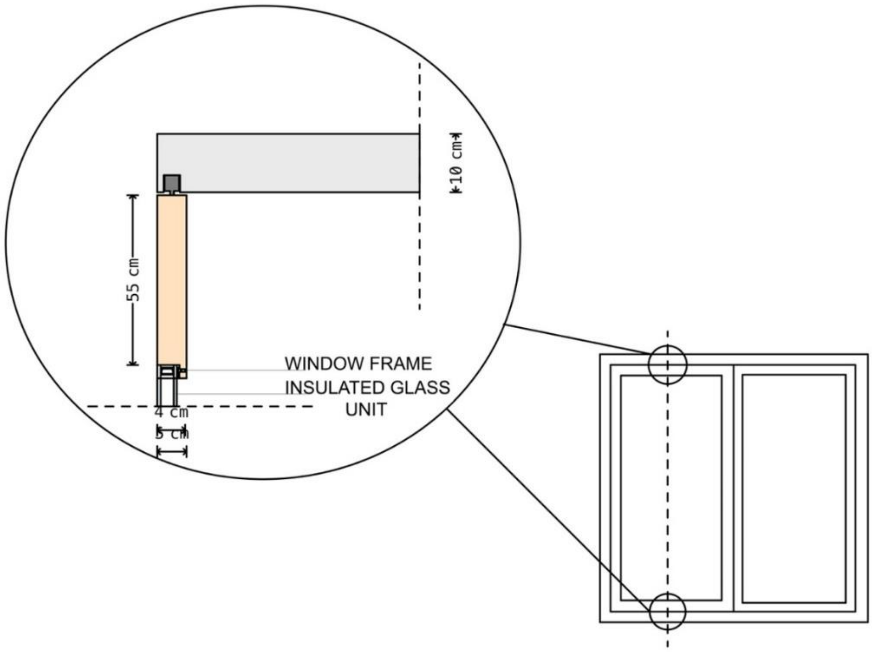


Figure 4.27. Windows Frame Detail

4.3. Alternative Unit Combinations

In the immediate relief stage, the first thing to do is to determine the number of victims. Accordingly, emergency shelters should be erected and assigned to the victims as soon as possible. Deployment of the transitional shelters may occupy the time of the relief workers involved in emergency response, whose numbers are likely to be already limited, thus causing loss of time. Therefore, the proposed unit in this thesis is deliberately made to be simple in order to allow the victims to deploy them on their own. This way, the relief workers can spare more time for injured people and control the delivery of shelters to the disaster zone more rapidly.

The proposed unit can meet the needs of a family composed of four people and provide a comfortable living inside for a long-term use. Its kinetic structure allows using the unit for different family types or demographic structures. Since the unit has a secondary gate and foldable walls at the veranda side, various combinations and arrangements can be created for larger families without requiring to move the occupants to another unit (**Figure 4.28**). By this means, larger living space, bathroom, kitchen and veranda can be created according to the number of users who would like to stay together or live separately but close to each other (**Figure 4.29**). The units can also be configured in a way that they are combined side by side, but they can be used as separate units.

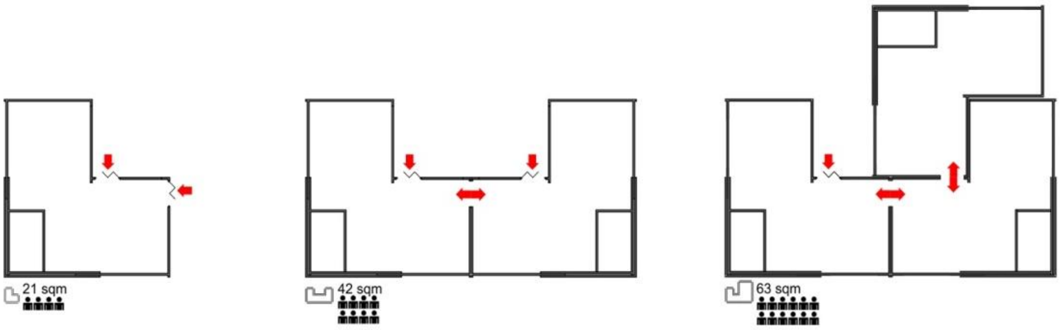


Figure 4.28. The Expansion of the Units by Combining them According to the Number of Users

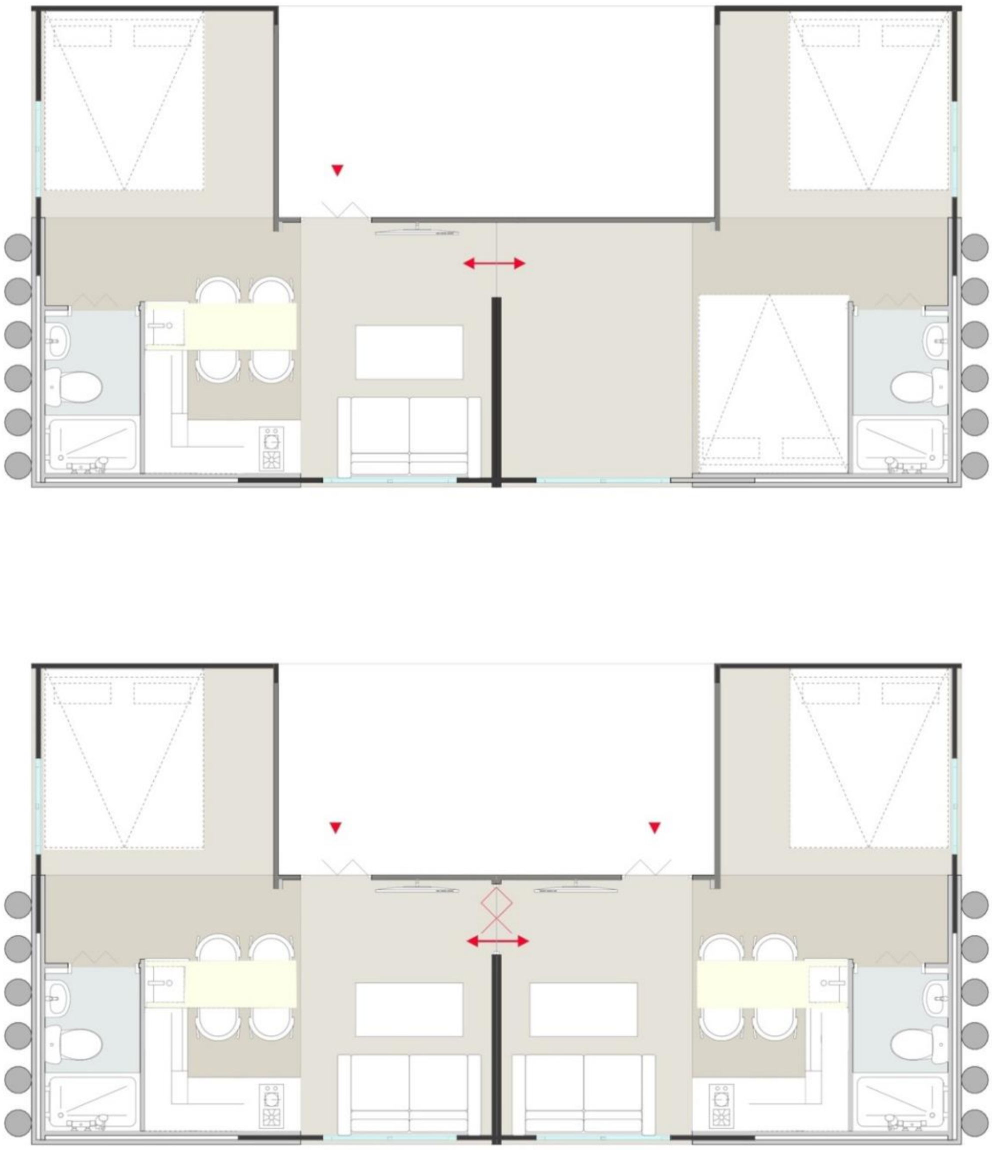


Figure 4.29. Two Alternative Unified Modules for Large Families

The advantages provided by the mobile parts of the unit allow the creation of different unit configurations according to the number of people who wish to stay together. Some families may wish to live separately but close to each other. Therefore, the units can also be configured to connect to each other but remain as separate units.

The rock wool used on the walls for thermal insulation in units is a product with A2 class fire resistance. A2 class fire resistant materials are considered as difficult flammable building materials. But after combining the two life units, the units need to be better protected. For this reason, slag wool is added to the areas where the units join. Slag wool is a non-combustible insulation material. It can withstand up to 1038 ° C. Thus, the heat insulation and fire insulation to be formed between the two units will be provided. (İZODER, 2021)

After the victims are placed in the emergency shelters, other modules which are required at the disaster zone are brought to the zone. This stage is the rehabilitation stage. Until their permanent dwellings are built, the victims stay in these shelters. Therefore, social living spaces must be improved. The units must be installed at the zone as soon as possible.

In addition to the housing units, it is required to provide communal spaces for socializing and medial support for the disaster victims until their permanent dwellings are built. For this purpose, a supply unit where they can fulfill their needs, a medical unit and an activity unit where they can socialize and feel better in the aftermath of a disaster are created by connecting the transformable units to each other (**Figure 4.30**).

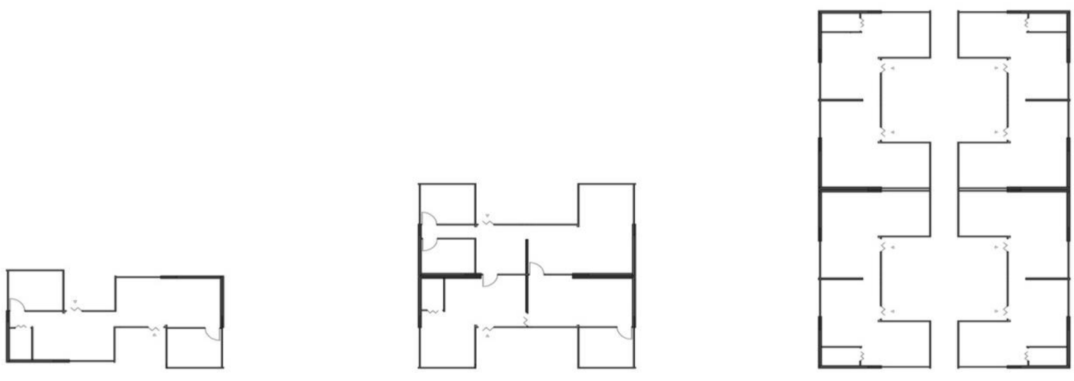


Figure 4.30. a) Supply Unit Plan; b) Medical Unit Plan; c) Activity Unit Plan

Covering an area of $42m^2$, the supply unit has been formed by connecting two units conversely side by side (**Figure 4.31**). While the operating principles are same as in the housing unit, new arrangements have been made in the internal space for the functional purposes. The unit has been divided into two parts to store the foods and the other stuffs such as clothing, blankets, sleeping mats, household items and hygiene materials. The unit has also an office of $6m^2$ and a bathroom.

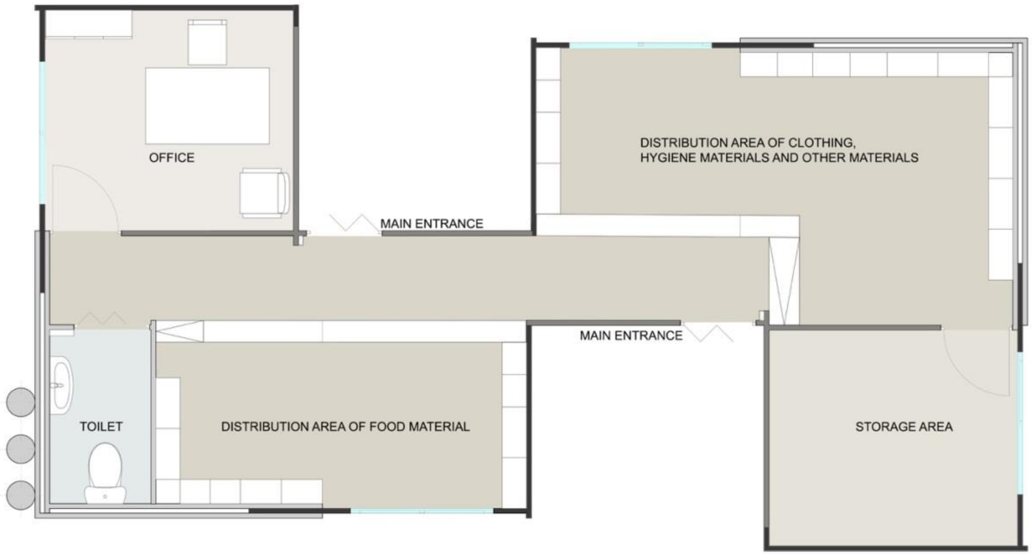


Figure 4.31. Supply Unit Plan

Having vertical and horizontal mirror symmetries, the medical unit of $80m^2$ has been created by placing four modules side by side and back-to-back (**Figure 4.32**). This unit provides the victims not only basic health services and first aid in case of emergencies but also psychological support. It has been designed as an open unit with the idea that the victims may need medical support at any time. Therefore, an area where the doctors and nurses may rest during the day and night has been also included in the unit as well as bathroom, kitchen, and storage space. The medical unit also includes $14m^2$ space for the treatment of the patients, $6m^2$ patient room where the patients can be kept under observation in emergency cases and a rehabilitation area of $20m^2$ for the patients who has difficulty in their movements. In addition, there are two doctor rooms where the patients can receive psychological support and a common room of $9m^2$ where the patients can wait.

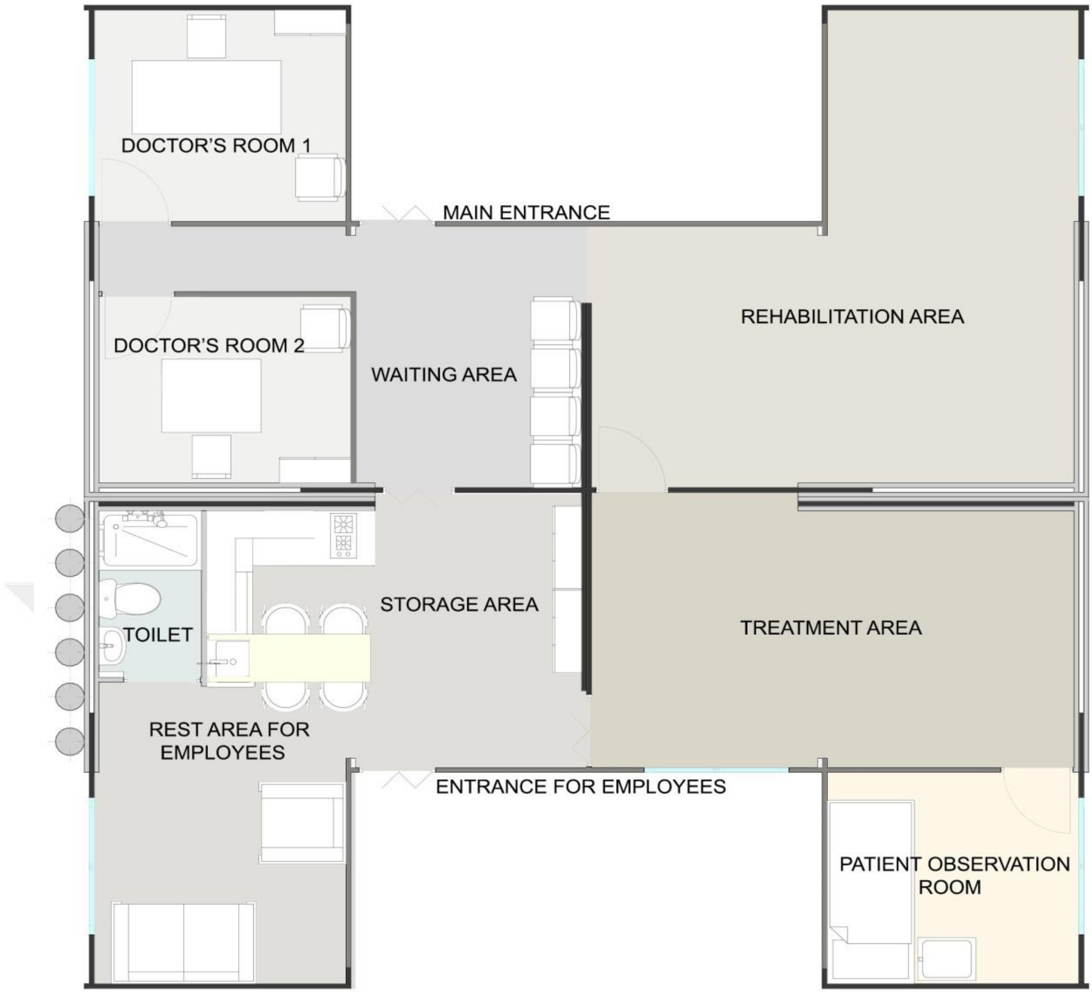


Figure 4.32. Medical Unit Plan

On the other hand, the activity unit of 152m^2 is intended for the disaster victims to engage in activities and socialize. This unit has been created by combining eight modules in the principle of vertical and horizontal mirror operations (**Figure 4.33**). The activity spaces inside are flexible and suitable for day-long or time allotted use by any age group. Different activities can be taken place in the activity unit for the children such as reading, painting, dancing, hand crafts or many workshops including science, game, drama and music. Some of the studios can also be used by the adults for handcraft or different purposes. There are two courtyards shaped by the combined units, which can be either used as open spaces when needed or turned into closed spaces by unfolding their top covers.

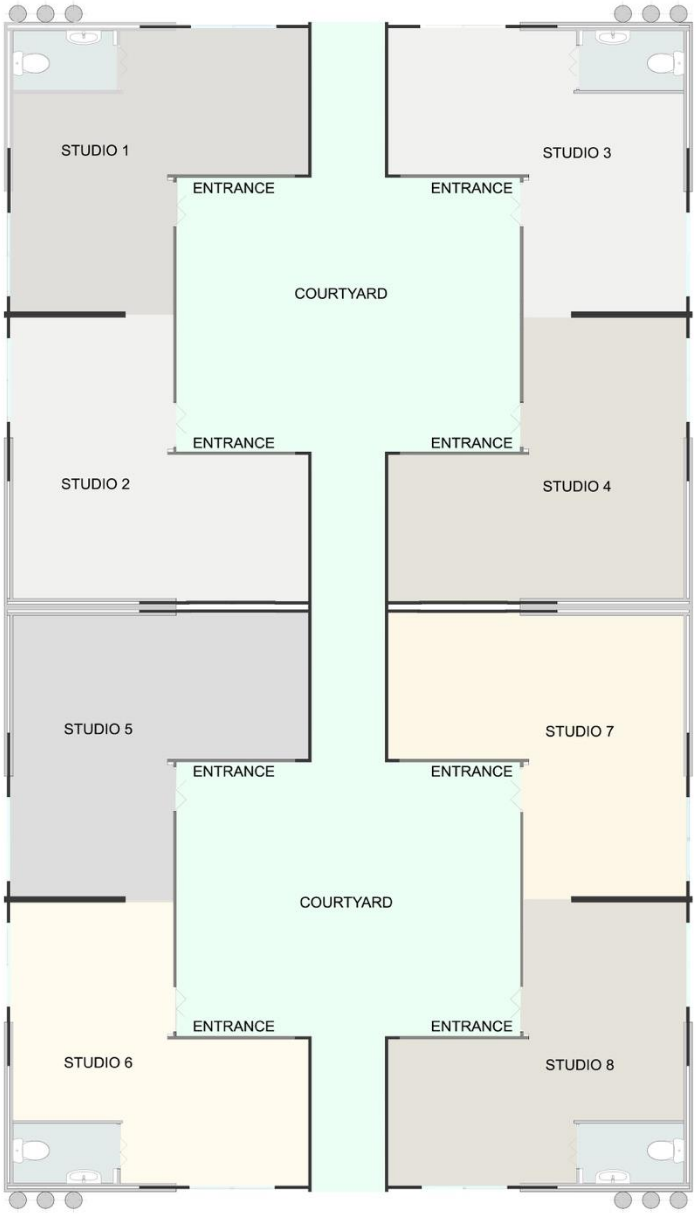


Figure 4.33. Activity Unit Plan

4.4. Settlement Layout

Dealing with the transitional shelters requires developing not only a proper unit design but also a settlement layout. Areas selected for the disaster should comply with the following criteria (G.A.B.A, 2021):

- Shelter area should be as close as possible to the settlements.
- The size of the area should be a minimum of 35.000 m^2.
- If possible, the area should be in the public land.
- The area should be surrounded by wire mesh in order to avoid any security problems and to protect the area from external dangers.
- The slope of the area should be between 2% and 4%, but not exceeding 7%.
- Sufficient water must be available in the area.
- There must be a place that can connect water, sewage and electricity to the city network.
- Heavy vehicles must be able to reach in all weather conditions, and if not, the soil must be suitable for paving.
- The services and internal transportation to the accommodation area should be smooth.
- The appropriate area should be away from the risks such as floods, landslides and avalanches.
- It should be at least 3 meters above the rainwater basin that will accumulate during the rainy season.
- Care should be taken that the selected area is not an agricultural area.
- Soil type should be suitable for the water permeability.
- The vegetation should not be dense enough to prevent the establishment of the shelter area.

In accordance with these criteria, it is aimed that the units can create various common areas between them when placed in certain configurations. By this means, it will be possible to provide richer common closed and open spaces for the victims.

The courtyards created between the modules will provide small or large gathering spaces where people can meet and strengthen their neighborhood relationships, improve and strengthen the social structure.

Considering the aforementioned criteria, a site has been selected located in the south of Doğançay Cemetery to create the settlement layout plan. This area is one of the 3 areas to be established as a tent city by AFAD after the disaster in the Bayraklı region **(Figure 4.34)**. This selected area is close to the residential areas, easy to reach by car, not densely wooded, slope is less than 7%. However, the fact that the area is 30.150m^2 and it is an area suitable for expansion.

Figure 4.34. The Selected Site Located in the South of Doğançay Cemetery

(Sources: https://parselsorgu.tkgm.gov.tr)

This site has been selected due to the ease of access. It is surrounded by low buildings and warehouses. The ground is levelled and prepared for the deployment of the transitional shelters for the disaster victims. Since the site is already prepared for the deployment of the transitional shelters, first, it is planned to create a compact layout. This compact layout will allow both the separation by neighborhoods and the organization of supply, medical and activity units according to the number of people in each neighborhood. According to this arrangement, one medical unit, two supply units and one activity unit will be sufficient for each neighborhood comprised of up to a maximum of 416 people **(Figure 4.35)**.

Figure 4.35. Neighborhood Settlement

Based on the proposed neighborhood settlement, a larger settlement plan for the site has been created. The units have been placed across each other to allow people to easily access any area. In the case of the unit is too crowded; the user can be easily directed to another unit. The users can easily access any area on the site since the paths between the clusters are wide enough not only for the pedestrian access but also for the vehicle access in case of emergencies **(Figure 4.36).**

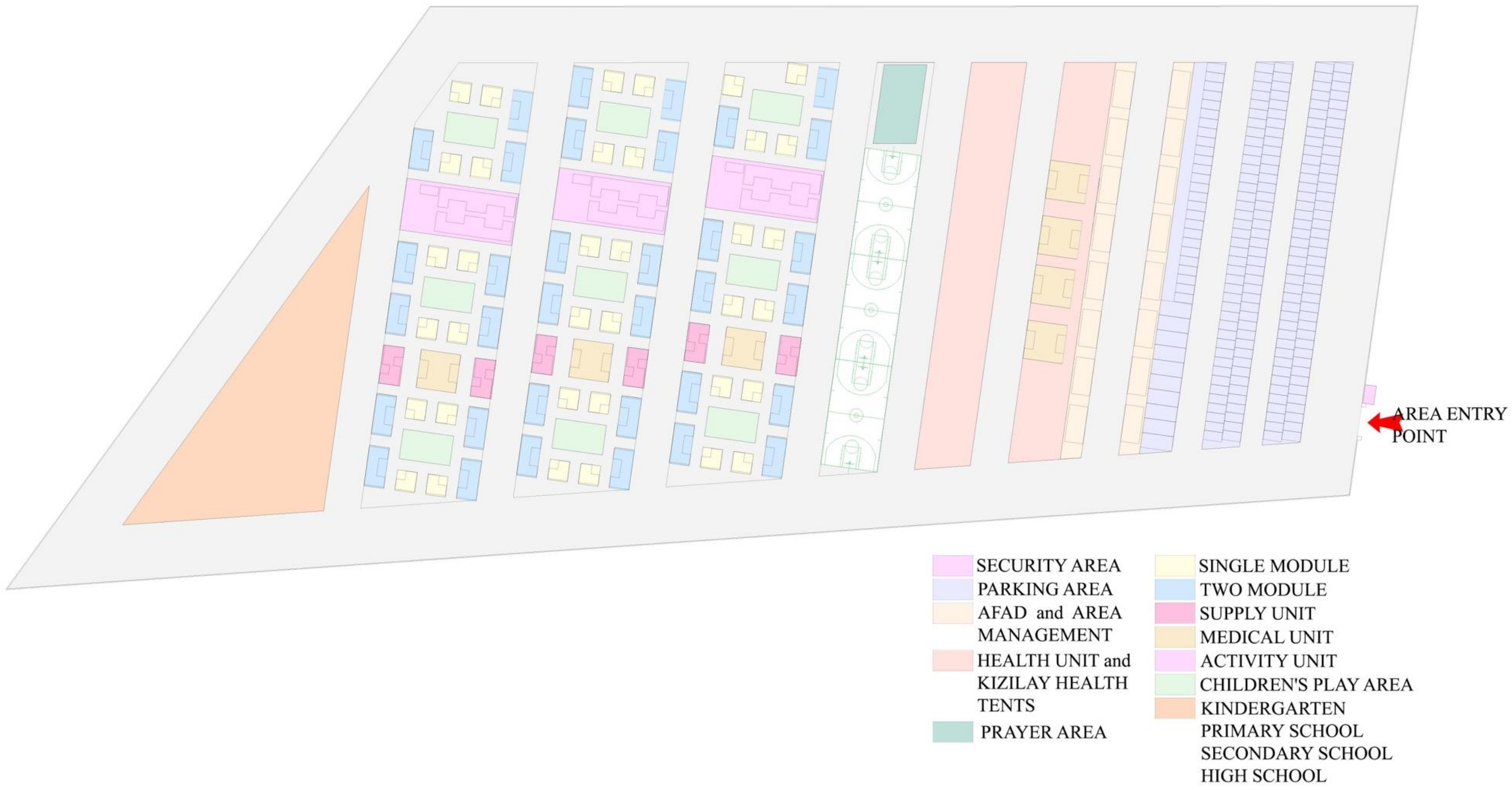


Figure 4.36. Placement of the Neighborhood Layout in the Existing Residential Area

The site chosen is surrounded by a wire fence for security. On its façade to the main street, there is an 8-meter-wide entrance in which there will be security guards. The main roads in the land are 15m and the roads between the quarters are 10m. A distance of 3m between the units is sufficient. After passing the entrance, a parking lot has been created for parking the vehicles that provide access to the accommodation center (4.500m^2). The car park has been reserved for 110 vehicles for the use of disaster victims and shelter center employees. A private parking lot for 10 vehicles has been allocated for the trucks to provide the necessary products to the units. There is a parking lot for 120 cars in total. The area after the car park, an area of 9.000 m^2 has been reserved for the settlement of the AFAD's personnel and the management of the region. The tents to be used in this area are minimum 50m^2.

After the area reserved for the AFAD, there is an area of 3.000 m2 reserved for the proposed medical units and the Kızılay health tents. The reason for placing a health unit at the entrance is to be close to the car park in order to facilitate the procurement of the needed materials and to ensure that the patients who need to be transferred can carry out their procedures. In addition, health units outside this area are located at different points on the land. The other health units have been located in the middle of the created areas, at the points that are equidistant from everywhere and have intensive use.

In the proposed settlement, there is a prayer area of 800m^2 of which 400 m^2 has been reserved for men and 400 m^2 for women. In addition, there are sport fields between the main entrance and the residential units so that people can continue their social lives (total 2.000 m^2). In order to reduce the density in the created neighborhoods, there are supply units, activity units and children's playgrounds. At the very end of the area, 500m^2 kindergarten, 1.500m^2 primary school, 1.500m^2 secondary school and 1.500m^2 high school area are allocated in a more isolated part.

CHAPTER 5
CONCLUSION

Being unexpectedly occurring events, the disasters cause adverse effects on people. Foremost among these effects is the destruction of permanent dwellings and the deprivation of shelters which provide security, a most fundamental need of people. Immediate sheltering after a disaster is the deployment of transitional shelters for the victims until they can move into more permanent dwellings. The tent-type shelters that are widely used in emergencies fail to fulfill all human needs since they are not convenient for long-term use. The victims forced to live in such shelters for extended periods of time are deprived of the humanitarian comforts of life. The widespread use of such shelters is due to their low cost allowing easy replacement or excess production.

Many relief organizations, architects and engineers have conducted many researches on the transitional shelters. The main purpose of such research efforts is to design a shelter that can provide a living standard suitable for human dignity for the victims in need of shelter after a disaster, while also providing an economic solution. Even though there are many types of the transitional shelters varying in shape, size and structure, most of them do not provide all spatial and technical requirements for long term use.

In this thesis, first, portable structures have been investigated which form the background of the transitional shelters since such structures provide flexible transformable design solutions. Then, the transitional shelters designed to date have been examined, and their inadequate and positive/negative sides have been evaluated. As a result of the evaluation, the questions about the problems related to the subject have been emerged.

To provide comfortable living conditions to the victims of the disasters who lost their houses, a transitional shelter unit has been proposed in this study which can be used by them until they move to their permanent dwellings. The proposed unit meets not only the design criteria of the transitional shelters such as durability, re-usability, transportability, storing, privacy and safety, rapid assembly, form expansion and flexibility, but also the technical requirements such as thermal comfort, water resistance and ventilation. Compared to the existing proposals, it can be said that the proposed unit is flexible enough to create different alternatives and unit combinations while the existing ones have limited configurations. Two or more units can be combined to provide extended living space for larger families. Its flexibility and modularity allow using the units for different purposes or other needs of the victims like social interaction and medical services. By this means, the same structure can be easily used for different functions without requiring building new structures for those spatial needs. Moreover, thanks to its transformability, the unit can be easily expanded when necessary or folded into its compact configuration when transported. Even though most of the existing design proposals occupy much space and only one module can be transported on a truck, the proposed unit occupy less space in its compact state. Thus, four units can be transported at once to the site and this reduces the total transportation cost. Furthermore, the unit has been designed in the consideration of the aspects of self-sufficiency and recyclability. Unlike the other shelter designs, the proposed unit can fulfill all needs of the disaster victims during the period they live in it. In this thesis, the most suitable one of the temporary accommodation areas in the Bornova region determined by AFAD was selected and a settlement plan was proposed. Housing and service modules have been placed in a certain layout.

The study conducted in this thesis not only contribute to the literature but also provide a practical design solution that can respond to the needs of the victims for long-term use. It has been thought that the proposed unit can also be used for different functions since it allows shape transformation and unit combinations. Different application areas can be investigated for the future study. The module can be produced with higher insulation, but a study should be carried out to build the module with lighter materials for easier transportation. In addition, a future study should focus on reducing the production cost of the unit.

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