Self- Help Housing for Rohingya Refugees in Bangladesh

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Abstract

In the 21st Century, a predominant worldwide issue is the enormous refugee crisis. Notably, Bangladesh is also hosting Rohingya refugees coming from Myanmar for more than three years. Though the refugees tend to live in Bangladesh for an unknown period, the shelters provided by the humanitarian organizations are hardly suitable for living. Moreover, since a huge number of children are being born in the camp, they require facilities for health, education and self-employment in addition to houses. Although self-help housing strategies are already being implemented to house Rohingya refugees, the shelters that were built on an immediate basis are not in usable condition now.

This research gathers information on self-help housing, evaluates the pros and cons, and the potentials of aided self-help housing as a mid-term solution. The author also identifies the existing conditions of the shelters in the Rohingya camps, household sizes and their needs for their long-term stay. After a thorough case study analysis, this research recognizes the design factors of camp master planning, guidelines for more efficient and long-lasting self-help shelters and the planning process to reduce construction time.

Finally, the key findings of this research demonstrate that the design of the self-help shelter for the Rohingya refugees is needed to be adaptable and flexible considering their future needs. Also, while considering construction time and ease of self-help construction process, this research recommends the prefabrication of shelter units. In conclusion, despite being focused on the context of Rohingya refugees of Bangladesh, this research findings can be an efficient tool for the designers of refugee housing all over the world.

Résumé

Un des problèmes mondiaux prédominant du 21eme siècle est la crise démesurée des réfugiés. Le Bangladesh continue notamment d'accueillir des réfugiés Rohingyas en provenance du Myanmar depuis plus de trois ans. Malgré le fait que les réfugiés restent pour une période indéterminée, les abris fournis par les organisations humanitaires ne conviennent pas à la réalité de vie dans cette zone. De plus, comme un grand nombre d'enfants naissent dans les abris et camps, ils ont besoin d'installations de santé, d'éducation, et de travail indépendant en plus de l'abris des camps. Bien que des stratégies d'auto-assistance en matière de logement soient déjà mises en œuvre pour héberger les réfugiés Rohingyas, les abris qui ont été construits sur une base immédiate ne sont pas en état actuellement de fonctionner.

La recherche produite dans ce rapport a recueilli des informations sur le logement autonome, analyse ses avantages et inconvénients, ainsi que le potentiel du logement autonome assisté comme solution à moyen terme. L'auteur identifie aussi les conditions préexistantes des abris dans les camps des Rohingyas, ainsi que la taille des ménages et leurs besoins pour un séjour de longue durée. Après une analyse approfondie des études de cas, cette recherche désigne les facteurs de conception de la planification générale des camps, les lignes directrices pour des abris d'auto-assistance plus efficaces et durables, et le processus de planification pour réduire les temps de construction.

Pour terminer, les conclusions principales de cette recherche démontrent que les conceptions d'abri d'auto-assistance pour les réfugiés Rohingyas doivent être adaptables et flexibles compte tenu de leurs futurs besoins. De plus, en tenant compte des temps de constructions et de la facilité du processus de construction d'auto-assistance, cette recherche recommande la préfabrication d'unité d'abri. En conclusion, bien que cette recherche soit centrée sur les contextes

des réfugiés Rohingyas du Bangladesh, les résultats peuvent être un outil efficace pour les concepteurs de logements pour les réfugiés du monde entier.

Keywords:

Self-help Construction, Refugee Housing, Refugee Crisis, Rohingya Refugee Crisis in Bangladesh.

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List of Abbreviations

IDP	Internally Displaced People
IOM	International Organization for Migration
OCHA	Office for the Coordination of Humanitarian Affairs
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNHCR	United Nations High Commissioner for Refugees
WHO	World Health Organization
RSG	Rakhine State Government
CCCM	Camp Coordination and Camp Management
NFI	Non-Food Item(s)
CGI	Corrugated Galvanized Iron
GSC	Global Shelter Cluster
ToTs	Training of Trainers
TDKs	Tie Down Kits
USKs	Upgrade Shelter Kits

Chapter 1: Introduction

1.1 Rationale of the Study

Every year millions of people are forced to leave their homes due to war, environmental disaster or persecution. According to the forced displacement report by the United Nations High Commissioner for Refugees (UNHCR), in 2018, 25 people were forced to flee in every minute ("Global Trends - Forced Displacement in 2018 - UNHCR, the UN Refugee Agency," n.d.). The report also stated that the number of refugees is increasing every year (figure 1.1).

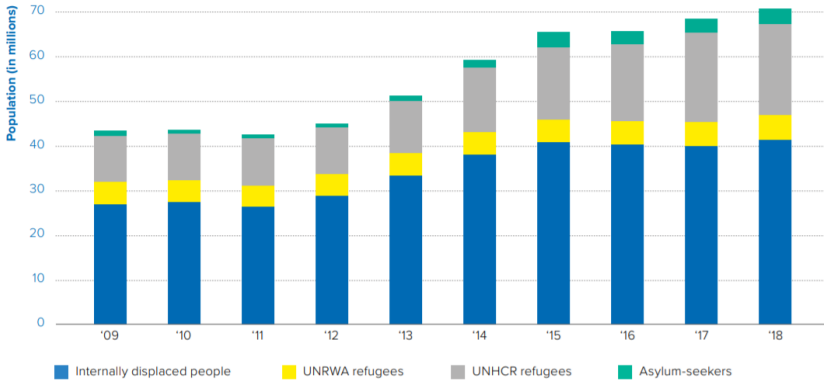


Figure 1.1: Global forced displacement (2009-2018)

Source: ("Global Trends - Forced Displacement in 2018 - UNHCR, the UN Refugee Agency," n.d.)

The primary source countries of refugees are from all over the world; whereas the Syrian Arab Republic constitutes the largest number of refugees (figure 1.2). Moreover, among 4 out of 5 refugees stayed in neighbouring countries of their country of origin; resulting in a crisis of refugees for many nations ("Global Trends - Forced Displacement in 2018 - UNHCR, the UN Refugee Agency," n.d.). However, in 2018, among 25.9 million forcibly displaced people, only 2.9 million returned their home. The study revealed that, at the end of 2015, the average duration of their exile was 10.3 years (Devictor & Do, 2017). This means that the refugees start living permanently in the host countries as the crisis is almost never-ending.

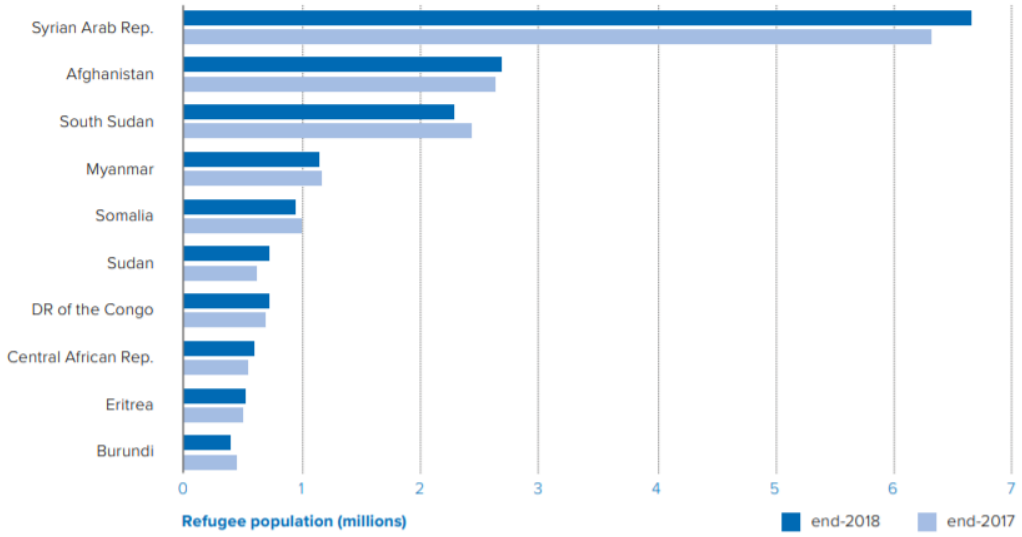


Figure 1.2: Major source countries of refugees; from end-2017 to end-2018

Source: ("Global Trends - Forced Displacement in 2018 - UNHCR, the UN Refugee Agency," n.d.)

In Myanmar, the Rohingya Muslims faced several decades of discrimination, statelessness and violence in their state, Rakhine. Such oppression has forced them to flee to different countries; such as Bangladesh, Thailand, Philippines, Malaysia, Indonesia, and India ("Rohingya Refugee Crisis in Myanmar - What to Know | Mercy Corps," n.d.). During major attacks in 1978, 1991-1992 and again in 2016, Bangladesh has housed the highest number of refugees ("Rohingya Refugee Crisis | OCHA," n.d.). In 2016, the Rohingyas faced severe attacks which led them to flee to nearby countries. It was reported in world media that, their villages were burnt, people were killed, and women were raped indiscriminately by Myanmar Military. About 65,000 Rohingya refugees had come across the border of Bangladesh from Myanmar in 2016 to save their life from the threat of genocide and the number kept growing till now. As of March 2019, the number of refugees coming to Bangladesh increased to 909,000 ("Rohingya Refugee Crisis | OCHA," n.d.).

Figure 1.3: Drone image showing the area covering the Rohingya Camp in Cox's Bazar
Source: ("Drone shows huge Rohingya camps - BBC News," n.d.)

Kutupalong and Nayapara are two registered Rohingya camps in Cox's Bazar. Kutupalong is the largest refugee camp that is expanding to shelter the increasing number of Rohingyas ("Rohingya Refugee Crisis in Myanmar - What to Know | Mercy Corps," n.d.). Figure 1.3 shows the extent of Rohingya camps in the hilly region of Cox's Bazar. There is not only a lack of houses but also very few of them have the quality of life inside the shelters (figure 1.4). As Cox's Bazar is very prone to natural calamities such as storms, cyclones, and tidal surge, during the rainy season in July 2018, minimum 10 people died, and 5,000 houses were destroyed due to landslide and heavy monsoon rains ("Building Rohingya Housing - Jewish World Watch | Jewish World Watch," n.d.). Besides, according to a survey conducted by UNICEF, more than 60 babies were born every day in the camp; who hardly get an adequate standard of living, health care, education, and recreational facilities. Hence, the refugee camps need other facilities for human life to live in the host country.

Figure 1.4: Shelters for Rohingyas in Kutupalong camp

Source: ("Rohingyas reach paradise with stories of tragedy - Concern Worldwide," 2017)

Most of the Rohingya refugees have been living in Bangladesh for about three years. However, the number of refugees who returned to their own country is very low. Although Bangladesh Government had made a list of people to send back to Myanmar, the candidate refugees had denied going ("Opinion - The Rohingya's Right of No Return - The New York Times," n.d.). A survey of 214 families showed that most of them refused to return to Myanmar because Myanmar government do not want them back and they are unsure about their safety ("Rohingya refugees refuse to return to Myanmar without rights guarantee | World news | The Guardian," n.d.). As safe returns for the refugees are not predictable shortly, it is required to improve the living condition of the camps.

The low-income people transforming and building their low-cost housing units during the emergency by self-help appears to be very common in the developing countries. In a different emergency condition, such as; climatic emergency, after the war, refugee crisis; self-help housing strategies have been used as an immediate, fast and inexpensive solution throughout the world. Even the UNHCR supported the refugees in Bangladesh with the building material kit to build

houses on their own (UNHCR, 2019). However, there are very little researches on self-help housing solutions for refugees in developing countries. This research report is focused on self-help housing for Rohingya refugees living in Bangladesh. Additionally, self- built refugee housing that can be built very fast for permanent use is the priority of this research.

1.2 Research Question

The evidence, concerns and interests discussed in the previous sections contributed to the following question of research:

> **What strategies can be adopted for the self-help housing design for the Rohingya refugees that can be built immediately for long term stay?**

Stem questions derived from this research question are:

1.How to develop a master plan of refugee housing considering their long-term needs?

2.What type of structures and materials can be used to build self-help shelters instantly but can be used permanently?

3.What are the construction methods and skills required for self-help housing?

1.3 Goals and Objective

The main goal of this research is to study self-help housing as the most appropriate solution to house the refugees immediately, at the same time in a way that they can live for a longer period in the host countries if needed. Moreover, the successful outcome of this research will provide design guidelines that will help the designers to design permanent or semi-permanent houses efficiently and sustainably. These design guidelines will include; site plan, shelter structure types, building materials, sanitation, sources of energy, construction techniques and skills, flexible design strategies and construction guidelines. Moreover, the guidelines will be helpful for not only the refugees in Bangladesh but also for the other countries facing crises in a different climatic context.

Ultimately, this research will give high priority to self-help houses that will be simultaneously easy to construct in a short period and durable.

The objectives of this research are as follows:

- Explore Bangladesh's current status of refugee camps and describe the issues they face there.
- Identify the family sizes of the refugees and understand existing building methods in that context.
- Familiarity with existing situations.
- Analyze building materials and construction technologies for self-built homes.
- Explore how ordinary people can build houses quickly and permanently, at the same time.
- Study the basic facilities refugees might need to live in the host countries for their long-term stay.
- Develop design guidelines for self-help housing for the refugees.

1.4 Intended Audience

The intended audiences for this report are the architects, engineers and the directors of the housing sector of government or non-profit organizations for the refugees; who plays a direct or indirect role to design and build a shelter for refugees in different countries. Practitioners involved in designing housing for refugees may also use the findings in this study and apply them in practice. Also, this work may be helpful to the researchers interested in refugee housing, emergency housing, and other related issues.

1.5 Methodology

The methodology for this research report consists of two phases; literature review and case study analysis. For exploring self-help housing for urgent needs; major data is collected from secondary resources such as books, journals, articles and previous researches. “Housing by People” by Ar. Turner, J. (1977) and “Self- Help Housing a Critique” by Ward, P.M. (1983) is a good source to understand the scope of self-help affordable housing in developing countries. Then a comprehensive review of the Rohingya refugee crisis is given. This information is collected from the reports on existing refugee shelters by the humanitarian organization that are working for them; such as, IOM, JWW and UNHCR. Moreover, “Strategic Recommendations for Shelter Upgrade in Response to the Rohingya Humanitarian Crisis” written by Martin, W. (2017) “and “Handbook for Emergencies United Nations High Commissioner for Refugees” by UNHCR, (2007) are a good source of information on the building materials and technologies currently using for the shelter of the refugees.

The third chapter of this research is focused on case study analysis. Ten case studies are analyzed which were selected based on a self-help housing prototype for long term use. Then, these cases are studied using an analytical framework to develop design strategies. Six categories are selected as a part of the analytical framework to evaluate the cases and thus derive the results applying these six categories. The categories of the framework are; background of the project, shelter details, construction, implementation, strengths and weaknesses. In the analysis, techniques used in the self- help housing are identified for further results.

From the analysis of the cases, design guidelines are suggested in Chapter 4. This chapter consists of the final result of the research that is useful to design houses for the refugees quickly

considering durability, quality of space and long-lasting use in the particular context of Bangladesh.

1.6 Scope and Limitations

This research would discuss self-help housing issues for the refugees living in Bangladesh. This study in the particular country of Bangladesh can narrow down the size of the household, building materials and characteristics of structures for refugee housing in the global refugee background. At the same time, it will provide the solutions based on comparative studies which can be used in different context around the world for refugee housing.

1.7 Research Outline

The research is divided into four chapters:

Chapter 1 consists of an introduction that addresses the rationale of the study, the objective of this research and the overall structure of the report.

Chapter 2 of this report is an extensive literature review on the self–help to the house for emergency cases; current approaches to accommodate refugees in Bangladesh and the prevailing state of the refugee camps in Cox's Bazar. In addition to the situation of Rohingya shelters; their family size, problems and need for basic conveniences are discussed in detail.

Chapter 3 consists of a case study analysis. In this chapter, the strategies applied in selected refugee housing projects that are built by self-help are studied and evaluated based on their effectiveness for long term use.

Finally, Chapter 4 provides the design strategies that can be applied to design self-help housing for refugees in Bangladesh as well as other countries of the world.

Chapter 2: Self-Help Emergency Housing and Rohingya Refugee Crisis

2.1 Self Help Emergency Housing: State of the Art

With the increasing incidence of natural calamities and civil wars, one of the vital concerns for architects and planners is the effort to establish a logical and immediate response to emergency shelters. As a rapid response during the emergency period, the materials and aid for shelter seekers are provided by the government or humanitarian organizations, and the displaced people using the shelter kit, build houses on their own. Thus, in different circumstances, such community-led housing initiatives are widely studied topic in both developing and developed countries.

In the past, the role of architects for aided and humanitarian architecture was more operational and technical rather than design thinking. Strategic spatial problem solving and architecture driven approaches for long-term recovery in devastated communities were missing in that time. The necessity of architects to contribute to the self-help housing challenges following a disaster or war has thus become an evolving issue. Although the refugees and disastrous people build houses by their effort, the design ideas and contribution of architects for emergency housing can rebuild local culture, environment and economy of damaged communities as well as their houses can be more long-lasting and better performative.

2.1.1 What is Self-Help Housing

Self-help is a practice of housing construction, that emerged long before Ar. John Turner articulated his theory (Harms, 1992; Parnell & Hart, 1999; Ward, 1982). A revolutionary idea arose in the late 1950s in the area of housing which has changed the whole view on housing for the poor (Kapur, 1989). Turner demonstrated his fieldwork in Lima and Peru that how people used their resources and ingenuity to build 50,000 residential units over the seven years (Turner, 1963). The key factor of this initiative was to fulfill their own needs, especially regarding housing which in

all societies is not exempt from anyone (Ward et al.,1982). Self-help housing currently continues to be successful in reducing costs as well as improving neighbourhoods, increasing family satisfaction, and bonding with their own home.

According to a definition given by Self-help Organization, "Self-help housing involves groups of local people bringing back into use empty properties that are in limbo, awaiting decisions about their future use, or their redevelopment"("What is self help housing? | Self Help Housing," 2009). The people with low income employ self-help mostly because they have no other choice. But in more developed countries and those with higher income, self-help is a strategic approach that offers certain advantages and motivates for moving in that direction (Ghandehari, 2000).

2.1.2 Aided Self-Help Housing

When the government and main international donor agencies sponsor the poor for self-construction of houses, mostly under the official supervision with technical or material help are considered as 'aided self-help' (Ntema, 2011). Therefore, by enabling individual or collective household initiatives to house themselves, the responsibility of the government or the donors is to support these initiatives through the provision of inexpensive land, tenure protection and basic services such as water, sewerage, and electricity. From these perspectives, the site-and-services concept was generated (Payne, 1984). Most of the time 'aided self-help' is initiated by local authorities and then funded by the government or international agencies such as- World Bank and USAID (Mayo & Gross, 1987). Poor and homeless people are selected for allocated plots with varying levels of facilities based on their income and duration of stay in the city, where they can build houses by 'self-help'.

The idea of government-aided self-built housing for the low-income group of people developed in stages. This was first implied in policy in 1904 by the Swedish Government and then

various ranges of programs were arranged throughout Europe and the Soviet Union in the 1920s (Harris, 1999). Such interventions and programs were proactive responses to specific historical situations, and most of them were for a short duration. The only lasting plan was the one launched in 1926 by the City of Stockholm (Harris, 1999). It did not appear in this era that any of those who supported such programs had any broader idea of the role of aided self-help within a continuing housing policy. It also remained the same in the 1930s, when many governments including Europe and North America introduced self-help into homestead schemes due to their economic depression (Harris, 1999). Consistent policy and the associated theory of aided self-help emerged during the 1940s. The first significant initiative as an aided self-help housing project was completed in Puerto Rico, in the U.S. From then, aided self-help has been practised in the developing and developed nations as a successful way to provide housing for the homeless, refugees and low-income group (Harris, 1999).

Aided self-help housing has two main advantages, for which it has become a very useful and popular kind of self-help housing. Firstly, it has the potential to spread the limited fund as widely as possible, making the best use of it for large-scale investments, where the individuals are free to do what they can do for the betterment of their houses (O'Connor, 1983). This makes aided self-help housing appealing not only to governments but also to NGOs such as the World Bank and other humanitarian organizations (O'Connor, 1983). Moreover, it has also significant advantages to governments of under-developed and developing countries, by providing freedom from severe and unsustainable financial commitments to fund housing for the poor (Payne, 1984). Through endorsing self-help housing, governments and organizations in the developing countries can save a huge amount of public funds through supplying serviced packages and leaving the rest to the offered people themselves to be finished (Soliman, 2004). Moreover, admittedly Ar.

Turner's ideas and initiatives on aided self-help housing have been embraced by both experts and the state in developing countries, primarily because they seem practical, realistic, and include the prospect of large-scale savings on public housing budgets (Soliman, 2004).In another study, Mukhija (2004) denoted that aided self-help housing is not only a cost and time-effective process but also allows the donors to assume the housing is constructed before it is finished.

Despite these benefits, aided self-help housing is not beyond criticism. Several authors indicated that self-help by site and service schemes was generally ineffective as a low-income housing strategy (Burgess, 1992; Keivani & Werna, 2001; Werlin, 1999). Cost-recovery across the history of low-income housing remains a major problem and aided self-help housing was no exception in this regard (Robertson, 1978). Although the goal was to make housing distribution at an affordable price for both governments and humanitarian agencies through site and service schemes, repayments were beyond the reach of many households (Payne, 1984). Moreover, the governments of the developed and under-developed countries typically failed to fulfil the basic administrative functions associated with assisted self-help. This leads to poor maintenance of infrastructure, failure to deliver some planned services, lack of continuing community education, and other basic amenities of housing (Payne, 1984). Despite government flaws, aided self-help housing projects have often many cons for both the target communities and the beneficiaries.

To sum up, although aided self-help projects were essentially the product of the ideas and works of Ar. Turner, they still could not avoid the intervention of both the state and other agencies in their operations (Gugler, 1997). It is argued that the inability to provide housing to target populations is a direct and intentional deviation from Turner's initial fundamental concept of site-and-services (Skinner & Rodell, 1983). Despite criticism, aided self-help housing has been using as an appropriate tool to house the displaced, poor and refugees in many countries.

Following are some of the examples of self-help housing as an affordable solution for housing for the low-income group:

Canopy and Giroscope in Hull, Uk

Canopy and Giroscope are pioneers in the movement of “Self-Help Housing" in the UK, which has gained popularity in recent years and has expanded significantly. They provided a framework that has influenced others. Today in the UK, more than 100 groups are adopting their model of self-help housing. They achieved the World Habitat Award 2015 for promoting self-help housing in the North of England (World Habitat, 2016).

Figure 2.1: Giroscope housing after reconstruction
Source: (World Habitat, 2016)

The housing charities teach homeless and disabled people to renovate and re-use abandoned homes. They built houses that provided shelter for local homeless and poor people who required houses.

Canopy and Giroscope, both organizations initiated in response to collapsed housing markets and a willingness to use empty homes with the help of people in housing need. The models they used are known as Self-Help Housing and are often replicated and adapted. The model

includes organizations acquiring long-term vacant buildings, renovating them using free labor, and letting them stay. Both organizations focused on broader benefits for individuals and societies, including enhancement of skills, capacity building and social inclusion (World Habitat, 2016).

Figure 2.2: Before and after picture of a renovated house

Source: (World Habitat, 2016)

Canopy and Giroscope supported the campaign to advocate for the Empty Homes Community Grants Program for the UK government. The funding saw a major rise in the self-help movement from about 30 organizations to over 100 in England now following a similar model (World Habitat, 2016)

Aided Self-Help Community Development Project in Bhutan

Tarayana foundation's comprehensive self-help housing project was among the finalists in the World habitat Award 2015. This project focused on the Olep ethnic group living in Bhutan's western-central region, who was a nomadic hunter-gatherer community. This project, directed by the Tarayana Foundation, has developed skills and fostered a culture of self-help that has helped the community to recover and prosper. Their philosophy of the project was to stimulate the community to lead its development. The project used the Rural Participatory Appraisal Approach

to include the entire community in project development, as participants were not expected to be literate. Through this, the community formed a committee that drew up the priorities and plans for the project ("Comprehensive Community Development for Poverty Alleviation - World Habitat," 2015).

Figure 2.3: Self-help construction process
Source: https://www.world-habitat.org/world-habitat-awards/winners-and-finalists/comprehensive-community-development-for-poverty-alleviation/

The priority was given to improve housing, considering that better shelter was an absolute necessity and a first step towards feeling safe and comfortable. Through pursuing training on carpentry, masonry, rammed earth and laying stone walls, the committee mobilized the appropriate community leaders. A master builder brought in from a nearby village who provided training and necessary instruction. After receiving knowledge from the training, the community people gave adequate labour to build their houses. Within two years, all the village's bamboo houses were replaced by two-story timber and mud houses and constructed in traditional construction style. Tarayana supplied materials (corrugated sheets of roofing, timber and nails) for construction and the whole community was involved in the building process. The community provided labour, while Tarayana contributed to project facilitation, staff management, and support from the administration. For two years, the United Nations Volunteers / United Nations Development

Program (UNV / UNDP) provided $50,000US to begin the project in 2006 (“Comprehensive Community Development for Poverty Alleviation - World Habitat,” 2015).

Figure 2.4: Houses after built by the community people
Source: https://www.world-habitat.org/world-habitat-awards/winners-and-finalists/comprehensive-community-development-for-poverty-alleviation/

Although much remains to be achieved, they are on a road of sustainable growth that can only bring more mutual wealth and stability to them. This model was implemented in 150 villages throughout Bhutan in 15 out of the 20 districts in total (“Comprehensive Community Development for Poverty Alleviation - World Habitat,” 2015).

2.1.3 Self-help Housing Advantages and Disadvantages

Self-help housing policies have different types of advantages and disadvantages offering for different types of projects. There are financial, physical and social advantages in self-help housing. Although financial advantages are the most alluring reason for doing self-help, other advantages should not be ignored.

According to Ward et al., (1982), the following are the financial advantages of self-help:

- The most significant benefit of self-help housing is that it saves the construction cost of housing by using sweat equity and enterprise equity.
- The self-helpers can enjoy the independence to work according to their budget and time.

- Collective support can shift a significant part of low-income housing's public expense to the private sector, which means the common people can get the benefit in return.
- For personally-owned houses, the self-helpers sweat equity would turn into added value for their home.
- People can invest according to their afford and ability in their own homes. They don’t have any pressure for mortgage payments.

According to the research by Teasdale, Jones, & Mullins (2009) on self-help housing, apart from financial advantages, self-help offers physical and social advantages which are as follows:

- It contributes to additional housing services to address homelessness and meet the needs of local housing.
- It provides affordable housing for those who are unable to access other housing options, such as displaced, poor and refugees.
- The self-helpers can have the opportunity to acquire construction skills and qualifications through on-site experience.
- It offers benefits of active participation, increased self-confidence and control over key aspects of their lives.
- The local authority can help to address empty properties and build harmony within the community. By addressing negligence and integration through "street-level programmes", it can lead to broader community regeneration.
- It engages people through wider policy goals and offers better control of the local communities.

- Self-help is helpful for owners of empty properties, such as private owners, local authorities and housing associations, who are safe from squatting, crime prevention and antisocial behaviour, without incurring private security costs.

Although having these advantages, self-help housing strategies have some disadvantages as well. Following are some of the disadvantages (Ghandehari, 2000):

- Building houses by self-help requires more time than usual.
- Self-help in-group organizations can give rise to some difficulties in accommodating the point of view of everyone.
- As the houses are not built by trained masons, it can be argued that the quality of the houses produced by self-help is questionable.
- It may lead to a waste of materials and thereby increase construction costs due to inefficient use of the building materials by non-professionals. Faults made by non-professionals can result in the self-help projects less effective and lead to loss of capital.
- It can be very difficult to manage a team consisting of non-paid, inexpert and non-professionals.
- Building by self-help can be unsafe. Injuries arising from inappropriate use of equipment can be unavoidable on some occasions.

Like many other housing schemes, self-help has both pros and cons. The designers and the decision-makers considering the advantages and disadvantages choose self-help schemes for housing the poor.

2.1.4 The Potential of Self-Help Refugee Housing as Mid- Term Solution

Despite ranging from informal community housing projects to social enterprises, self-help housing strategies can be used as a holistic approach for housing and employment provision for the refugees by incorporating their labour and skills without having any professional training (Teasdale et al., 2009). After providing immediate shelter for the refugees, they are transferred to transitional houses with an expectation of staying there for the long term. These houses provide amenities and facilities as a mid-term housing solution until the refugees return to their origin country or resettle. Housing by self-help is popular for providing mid-term housing solutions in the host country.

Self-help schemes have been using for refugee housing since the 1920s. In 1922-23, Greece began receiving thousands of refugees following its defeat by Turkey in Asia Minor. A Refugee Settlement Commission, formed by the Greek Government under the guidance of the League of Nations, implemented several policies to address the housing crisis (Eddy, 1931). One of the policies included offering individual family sites and basic public infrastructure, as well as land and mortgage loans to self-help cooperatives, which was aided self-help strategies (League of Nations, 1924; Leontidou, 1992). Such a pragmatic approach was directed at refugees; at a time when tens of thousands of Greek families were constructing their own homes. Although national and local governments gave more of a hesitant approval, the approach of self-help proved to be a successful strategy for refugee housing on an immediate basis (Leontidou, 1992). Another organization, the Tamil Community Housing Association was founded in response to the mass refugee movement that was followed immediately after the refugee crisis in Sri Lanka during the early 1980s (Teasdale et al., 2009). Eventually, the association focused on the settled families for developing their houses permanently and expanding their goal to make the refugee community as

an asset (Teasdale et al., 2009). Although the Tamil Community Housing Group has shifted their focus from refugee settlement, still they are providing housing in the empty land using self-help housing strategies (Teasdale et al., 2009).

The UNHCR works for refugees from the year 1950s. During the crisis, they provide adequate shelters to the refugees ("UNHCR - History of UNHCR," n.d.). They incorporate self-help strategies and involve the refugees in the building process by providing the building materials, tools and guidelines. Generally, they distribute the emergency shelter kits from three of their centres in Dubai, Copenhagen and Durban ("UNHCR - Shelter," n.d.). In the primary phase, they provide shelter kits with tents, plastic sheeting and matting so that the refugees can build very quickly, easily and thereby they do not need to spend a night under the sky. In longer-term circumstances, they fund the renovation of community shelters or the production of new homes and provide refugees with the resources they need to build their own homes under self-help schemes ("UNHCR - Shelter," n.d.). Besides, they also monitor the distribution and construction of the houses and manage water supply from surface water, rainwater, groundwater, natural reservoirs or municipal or private systems if it is allowed (United & High Commissioner for, 1982). Additionally, for human excreta disposal, they arrange different systems according to their need. A well laid-out camp protects the environment and helps to prevent fires and disease outbreaks. Although they arrange housing for emergency needs, many of the outbreaks of the disease appeared when the refugees start living in the host countries for several years. Therefore, there is a serious need to design and build the camp not only for an immediate response but also as a preventive measure for the future to ensure in case of their long term stay their home can be a safe place. As self-help has been proved as an effective scheme for sheltering refugees, a well-designed house self-built by the people can hinder the other problems of emergency housing too.

2.2 The Rohingya Refugee Crisis

2.2.1 Existing Living Conditions of the Refugee Camps in Cox's Bazar

The number of Rohingya refugee families living in Bangladesh has increased to 211,044 as of 15 September 2019 (UNHCR, 2019). Most of the refugees live in Ukhia Upazila, which comprises 81% of their total households and 80% of individuals. The second largest group exists in Teknaf, which comprises 19% of households (Global Shelter Clusters, 2018). Among the total number of refugees, only 34,665 individuals and 6,318 families are registered refugees, which constitutes only 4% of the total number. Kutupalong RC comprises 14,277 registered refugees from 2,617 families and 19,895 registered refugees from 3,704 families from Nayapara RC. Figure 2.5 shows the refugee population density in different registered and unregistered camps (UNHCR, 2019).

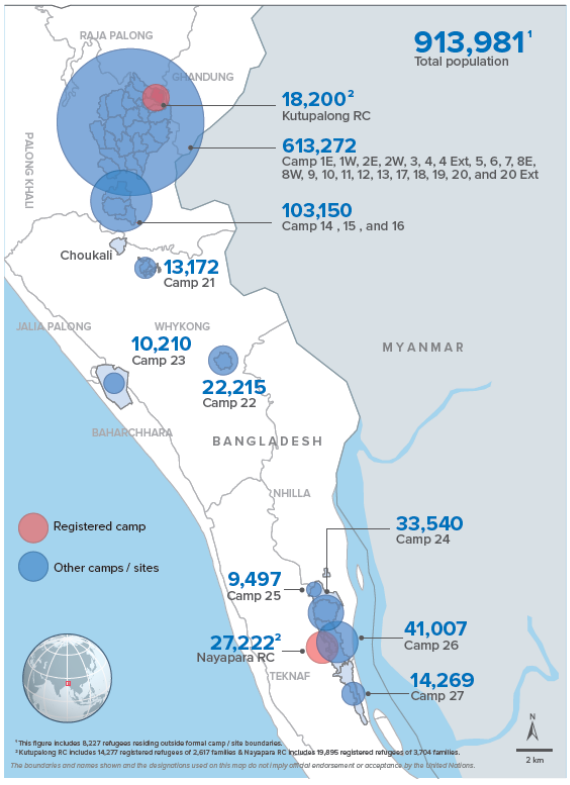


Figure 2.5: Rohingya refugee population density in Cox's Bazar.

Source: (UNHCR, 2019)

- **Problems Regarding Existing Shelters:**

The hilly site of Cox's Bazar is very prone to flooding and landslides during the monsoon season. When the refugees arrived in 2017, the site planning teams from leading agencies started drawing masterplan. But they faced extremely unregulated camps where the refugees led decision-making on where to live, where to pave new footpaths and bridges, and how to build a shelter for their families. The vulnerable site was worsened as there was a need to quickly settle the refugees. This resulted in impoverishing the hills, removing natural drainage and infiltration capacities, and increasing the likelihood of severe flooding. With the annual monsoon season, this becomes especially important. Figure 2.6 demonstrates the condition of Rohingya camps during rainy seasons. The complexity of the context emphasizes the value of site planning for the refugees' long-term protection. It highlights the need to enhance the position of site planners and lift their voices within the planning process. Their early decisions would improve the communication system within the site and the lives of people impacted by forced displacement (Global Shelter Clusters, 2018).

Figure 2.6: Condition of Rohingya camps during the monsoon.
Source: https://www.hrw.org/news/2018/08/05/bangladesh-rohingya-endure-floods-landslides

Due to the heavy influx of people that came in 2017-18, the structure of the houses was not durable and the quality of the environment inside the houses was very poor. The density of less than $10m^2$ per person created conditions comparable to the worst urban slums in Dhaka, and because of inadequate access to life-saving facilities in many areas, alerts from the health sector were becoming increasingly vociferous (Global Shelter Clusters, 2018). As of November 2019, some of the most commonly reported safety concerns by male and female key informants were unstable structure, shelter deterioration and no adequate lighting in the houses (IOM Bangladesh, 2019). Table 2.1 below demonstrates the evaluation of the shelter condition by the key informants.

	Male KI			Female KI		
	1st shelter safety concern	2nd shelter safety concern	3rd shelter safety concern	1st shelter safety concern	2nd shelter safety concern	3rd shelter safety concern
Unstable structure	31%	8%	8%	31%	13%	10%
Shelter Deterioration	30%	25%	10%	30%	27%	12%
No adequate lighting in	11%	29%	27%	8%	22%	29%

Table 2.1: Shelter concerns by the percentage of assessed locations and gender of KI
Source: (IOM Bangladesh, 2019)

- **Problems Regarding Accessible Water:**

The main sources of drinkable water in all Rohingya camps are tube wells and hand pumps (Figure 2.7). Both male and female key informants raised questions about their access to drinkable water during the interviews. Long wait times (male KI: 55%; female KI: 62%), lack of adequate water points (male KI: 44 %; female KI: 39%), and distance to water points (male KI: 38%; female KI: 48%) were the most frequently identified water access issues. To cope with these challenges, they used to go further away to fetch water (male KI: 50%; female KI: 59%), which resulted in unhygienic water consumption (male KI: 31%; female KI: 41%) (IOM Bangladesh, 2019).

Figure 2.7: Deep tube wells in the refugee camp for drinkable water

Source: https://medium.com/friendship-ngo/4-steps-towards-effective-wash-for-the-rohingya-4e57ab9615d6

- **Problems Regarding Sanitation:**

Generally, the Rohingya camps have 4 types of latrines and bathing practices; they are, public toilet facilities, private toilets in their shelters, showering outdoor and no bathing and toilet facilities. Figure 2.8 and figure 2.9 illustrates the usual scenario of toilets in the refugee camps. Lack of segregation between female and male facilities was the most frequently recorded problem about accessing latrines and bathing facilities and a higher percentage of female KIs reported the problem than the male KIs. The second most frequently recorded problem with male KIs was inadequate lighting in toilet areas (48%), whereas the female KI recorded unhygienic latrines (54%). The third most widely identified problem with both male KIs (42%) and female KIs (46%) was toilets being completely or partially non-functional. A substantial gap could be found between male KI and female KI responses on the issues regarding the toilet and bathing facilities located in too far away distances. The explanation for this may be that females are more likely to have

limits on movement compared to males due to cultural factors as well as safety purposes (IOM Bangladesh, 2019).

Figure 2.8: A common type of toilet in the refugee camp.
Image retrieved from: https://www.flickr.com/photos/unwomen/28521353237

Figure 2.9: Condition inside the public toilet of refugee camps
Image retrieved from: https://www.npr.org/sections/goatsandsoda/2019/10/08/768242295/a-simple-way-to-make-toilets-friendlier-for-women-in-refugee-camps

Unlike the issue of accessible latrines, the lack of gender separation in bathing facilities was also identified as problems most frequently by female KIs (69%) compared to male KIs (57%). The second most common issue recorded was that bathing facilities lack adequate lighting (male KI: 46%; female KI: 41%) followed by inadequate water supply (male KI: 35%; female KI: 35%).

2.2.2 Housing Challenges Faced by Refugees

The refugees arrived in Bangladesh with very few belongings from their country. They were dependent on humanitarian shelter aid and other lifesaving needs. Many families had lost members that disrupted the family structure. Most of the new refugees (578,000 people) stayed in temporary shelters or new organic settlements, whereas 46,000 people live with host communities. In the beginning, the temporary settlements were widespread and crowded, lacking the adequate facilities and infrastructure required to sustain such a huge, vulnerable populations' critical living needs. To improve the situation and monitor the refugee movement, the Bangladesh Government designated areas for the settlement of new refugees. To promote this process, the UNHCR and the IOM facilitated the process (Martin, 2017). Figure 2.10 below shows the condition of the area before and after the Rohingya Settlement.

Figure 2.10: Image of Kutupalong area before and after Rohingya Crisis

Source: P. Hübner, UNHCR, SDC

With the arrival of shelter kits, the organizations formulated their strategies consisted of three phases. They are as follows (Martin, 2017):

1. Provide emergency shelters and NFIs for refugee households living in informal, spontaneous and formal refugee settlements.

2. Promote complimentary support to allow refugee households to build and upgrade shelters to better resist cyclones and to promote safer living conditions in settlements.

3. Provide shelters and NFIs help to host families in Bangladesh to encourage healthier living conditions according to their needs.

For executing these strategies, the humanitarian organizations had faced many challenges. Lack of available land comparing to the number of refugees was one of the biggest challenges. Earthworks and road-building did not proceed as the rain continued for a longer period than usual. Though bamboo acquisition, supply, and quality challenges were recognized early on, the limited local shelter options exacerbated the need for rapid shelter responses. Additionally, the camps and sites remained congested, causing severe impact on the refugees' physical and psychological well-being, especially for children, women, and people with disabilities (Global Shelter Clusters, 2018).

The organizations had utilized self-help housing strategies to build 43,000 households in about four months. A series of Training of Trainers (ToTs) were performed on the knowledge and facilitation skills for shelter field workers and community mobilizers (both from the organization and partners). The ToTs covered key messages on reinforcing the shelter's roofs, walls, foundations and drainage through presentations and practical examples to allow participants to learn by doing (Figure 2.11). More than 100 Rohingya carpenters were identified and trained on key messages and then mobilized throughout the refugee communities. The organization also appointed community members who acted as sources of information and contact between the refugees and the organization to provide updated information, input and ongoing technical advice (Global Shelter Clusters, 2018).

Figure 2.11: Training sessions for constructing houses by their own

Source: IOM Bangladesh

Despite having training, they faced several challenges, such as limited durability of material and insufficient quantities of shelter kits. The organizations suggested that bamboo can be a durable building material if properly picked and handled (Martin, 2017). Therefore, bamboo posts were used by inserting directly into the earth. Additionally, the refugees did not provide support using bracings. It was primarily due to cultural preference, limitation of the number of bamboos, as well as the small covered space (since bracing decreases internal space if bamboos are mounted within the frame). Additionally, the language barrier was also a problem to understand the construction materials and process properly. But the high involvement of the refugees in the building process created a sense of ownership over their shelters (Global Shelter Clusters, 2018). Figure 2.12 below demonstrates the refugees building their own houses with bamboo.

Figure 2.12: Self-help shelter construction process by the refugees.
Source: (IOM Bangladesh, 2019)

2.2.3 Basic Supporting Amenities Needed for Refugee Shelters

As the refugees have been living in Bangladesh for about more than three years, they need other supporting amenities to live. The children are growing up in the camps lacking educational facilities. The elderly population also faces problems regarding access to health care facilities. Additionally, the barrier to access nutritious food causes many diseases to the people, especially the children and elderly generation.

- **Access to Health Facilities:**

According to the Needs and Population mentoring Report by IOM Bangladesh, elderly persons (male KI: 68 %; female KI: 67 %) are the most widely identified group of people having difficulties to access health care services. The second most reported group of people facing challenges were females (reported by male KIs), and children (reported by the female KIs). Furthermore, people with disabilities are also reported to face challenges to access healthcare facilities (IOM Bangladesh, 2019). Figure 2.13 illustrates the percentage of different gender and group of people facing problems accessing healthcare facilities.

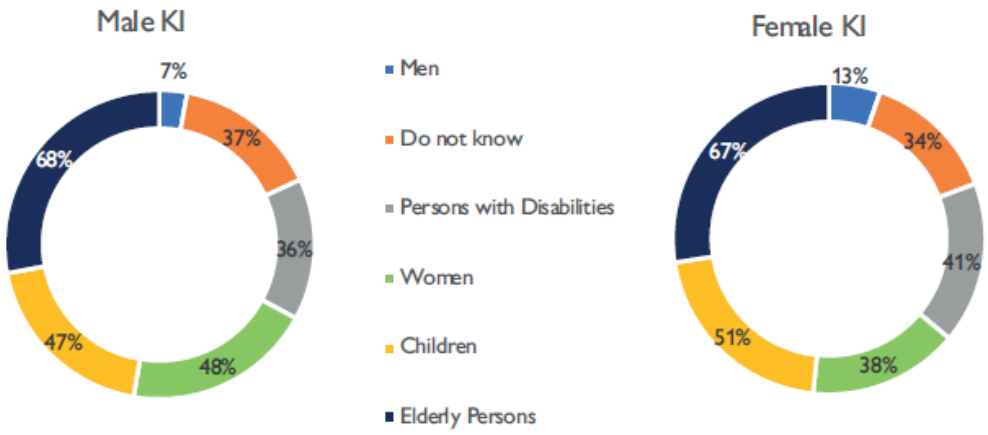


Figure 2.13: Percentage of different gender groups facing problems to access health services
Source: (IOM Bangladesh, 2019)

The Key Informants have reported many problems they face to access health care facilities. Long wait time in facilities was the most common health access problem recorded (male KI: 58 percent; female KI: 74 percent). The second most frequently recorded problem was an inadequate form of health services, such as no medicines, long distance between healthcare facilities and shelters, problems with incapable healthcare staff and their behaviour, lack of female healthcare staff and lack of emergency transports or ambulances (IOM Bangladesh, 2019). Figure 2.14 shows a typical healthcare center in the refugee camps.

Figure 2.14: Healthcare centre for the refugees.
Source: https://www.emergency-live.com/of-interest/rohingya-un-says-thousands-lives-saved-challenges-remain/

- **Barriers to Accessing Education:**

Although there is an arrangement of elementary education for children, they face barriers to access education. As there are almost no facilities for secondary level education, challenges arise to teach the boys and girls aged between 10 to 18 years. The table below (Table 2.2) shows the percentage of boys and girls facing barriers to accessing educational facilities reported by the male and female KIs (IOM Bangladesh, 2019).

		Face barrier	Do not face barrier
Girls aged 3-5	Male KI	3%	97%
	Female KI	2%	98%
Boys ages 3-5	Male KI	3%	97%
	Female KI	2%	98%
Girls aged 6-14	Male KI	29%	71%
	Female KI	32%	68%
Boys ages 6-14	Male KI	22%	78%
	Female KI	24%	76%
Girls aged 15-18	Male KI	95%	5%
	Female KI	99%	1%
Boys ages 15-18	Male KI	89%	11%
	Female KI	99%	1%

Table 2.2: Boys and girls of different age groups facing barriers accessing education by the percentage of accessed location and gender of KI.

Source: (IOM Bangladesh, 2019)

The common barriers identified for boys and girls aged 3-5 years were distance, lack of transport, lack of adequate education programme and safety and security. Some specific types of barriers identified for boys aged 6-14 years were lack of enough educational programme, what is taught is not useful or appropriate for their age. Among girls aged 6-14 years, some common types of obstacles were lack of adequate education system, social norms and values like family or community restrictions. Among boys between the ages of 15 and 18 years, there is a lack of adequate education system and other vocational training opportunities. For girls between the ages

of 15 and 18 years, social norms and family constraints, lack of adequate education system are the most recorded problems. The following figure (Figure 2.15) shows an elementary school for the refugee children in the camp (IOM Bangladesh, 2019).

Figure 2.15: An elementary school for refugee children.
Source: https://theirworld.org/news/rohingya-refugee-children-new-learning-centres-bangladesh-to-provide-education

Besides access to educational and healthcare facilities, the refugees also face problems regarding food security and livelihoods. Almost half of the refugees have no income source due to limited work opportunities inside the camps. Incompetent wage labour was the most widely recorded main source of income, followed by small business, street vendor, humanitarian aid and casual day labour. Most of the time, they access to food from the food distribution centres. The key informants reported that they face problems accessing food due to the long distance of the distribution points, long wait time and problems to carry the food items (IOM Bangladesh, 2019).

2.2.4 Household Sizes and Space Analysis Needed by Refugee Families

According to the UNHCR Population Factsheet of Rohingya Refugees as of 15 September 2019, about 211,044 Rohingya families are living in the refugee camps. Among all of these

families, 39% of the families have a standard family size of 4-5 persons, 37% have 1-3 persons, 21% have 6-8 persons and 3% have more than 8 persons in their families (UNHCR, 2019). Women and girls make up 52% of the refugee population arriving before September 2019. Approximately 19 % of families are thought to be residing in female-headed households before the increase in August 2017. Such families are especially vulnerable and face significant safety issues due to security and cultural limitations including access to life-saving assistance. Access to shelter kits requires both labour and money to move shelter materials to their shelters from the distribution sites, often deep within a sprawling camp through a rugged landscape. They need construction knowledge to build the shelter structure, which is usually done by the men. Over half of the population of Rohingya are children. Additionally, unaccompanied and separated children were identified at all sites assessed according to the Multi Sector Rapid Assessment. Individuals with physical disabilities are unable to obtain help due to barriers, protection and health threats. Often, facilities and shelters are not adapted to their needs, which puts them at risk (Martin, 2017). Major threats are also faced by elderly households, which before 15 September 2019 represented 3% of all households (UNHCR, 2019).

In the upgraded shelters, the average area per house is 14 square metres and the average area of shelter per person is 3.4 square metres. Moreover, most of these houses have no attached toilet. The cost of material of these upgraded shelters is $155US per household, where $103US for materials, $12US for tools and $40US for supporting cost. The total cost per project is $208US per household (Global Shelter Clusters, 2018). Most of these shelters do not provide any privacy and people live within a very congested room. Figure 2.16 demonstrates the unhealthy living environment inside the shelters.

Figure 2.16: Unhygienic living conditions inside a Rohingya shelter.

Source: https://www.aljazeera.com/indepth/features/2017/03/fight-survive-rohingya-refugees-bangladesh-170313091106782.html

2.2.5 Local Materials and Techniques for Low-Cost Housing

During the beginning of heavy influx in 2017, the Shelter / NFI Sector has carried out extensive distributions of emergency shelter kits (primarily tarpaulins and rope) and with these materials, the refugees have established their shelter using materials either obtained or procured from the local market. Figure 2.17 shows emergency houses built with Tarpaulins. The purpose of Tarpaulin was to provide protection from water, wind, sand and to give privacy and dignity (Martin, 2017). Shelter-grade Tarpaulins were procured from numerous sources, including regional stockpiles of the agency, foreign procurement and in-kind donations (Global Shelter Clusters, 2018).

Figure 2.17: Emergency Rohingya shelters.

Source: https://www.iom.int/news/over-1000-new-shelters-built-rohingya-refugees-threatened-landslides

Two months after the initial flux it became clear that bamboo was the only viable building material if procured from the local markets. Bamboo was economically feasible and accessible to the Rohingyas and was familiar as well. This was used as shelter materials, for projects of community buildings, facilities and other accessible infrastructures (bridges, stairs, paths). As an acknowledgement of this, a study was commissioned by the Shelter-NFI Sector to understand the market capacity to supply bamboo. The study reported that the construction needs of the world's largest refugee camp could not be met without sufficient and high-quality supply of bamboo. About 23 million pieces of bamboo were distributed via the shelter kits. Following the emergency process, the focus was on reinforcing and stabilizing the existing shelters, which were constructed in direct contact with the ground with untreated bamboo, creating the ideal conditions for pests and rot, resulting in failure during heavy winds and rains. Significant measures have been taken to resolve those problems by the end of 2018 (Global Shelter Clusters, 2018). A technical note and report on the durability and treatment of bamboo were prepared. Technical requirements were accepted for bamboo treatment, and Sector Partners gained a deeper understanding of the entire bamboo supply chain and key recommendations for sourcing, processing, handling, treatment and design (Hodgkin & Prideaux, 2018). Figure 2.18 illustrates the upgraded shelters for the refugees. The Sector developed key messages and diagrams about shelter improvements, such as bamboo ties and connections, to support training activities (Figure 2.19).

Figure 2.18: Upgraded shelter made of bamboo structure and tarpaulin.

Source:(Global Shelter Clusters, 2018)

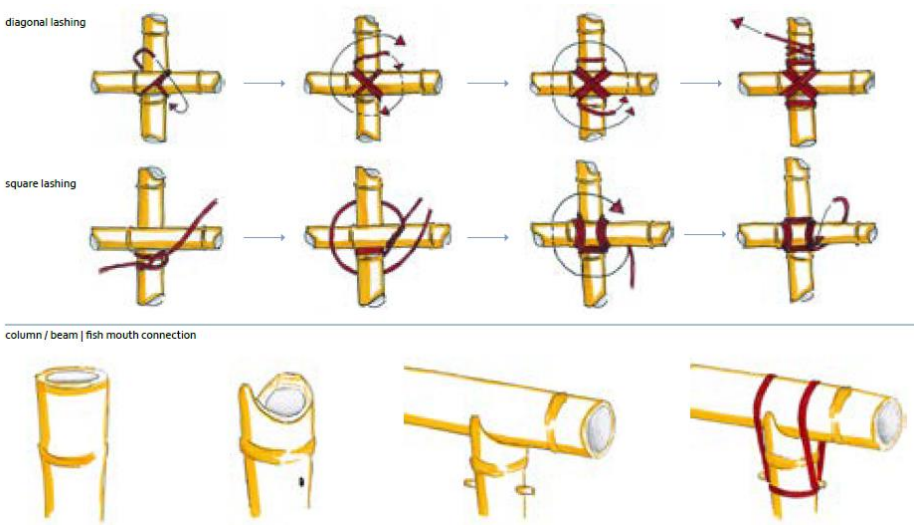


Figure 2.19: Bamboo tie connections.

Source: (Global Shelter Clusters, 2018)

At the beginning of 2018, attention was given to the upcoming monsoons season and cyclones, and how the shelters built by the Rohingya themselves could be strengthened. Together with the USKs, it was decided in April 2018 to supply all households with TDKs to improve the shelter's capacity to withstand high winds. The Sector utilized the idea of using ropes to tie the shelter down and bind it to the ground. One choice used steel pegs driven into the ground to withstand the lifting forces, while the other used filled sandbag weights. Both methods worked well, but post-distribution testing revealed that metal pegs were positioned perpendicular to the ground rather than at the angle in some cases, reducing their importance. As indicated, the sandbags were not buried, and their lifetime was shorter than that of the metal pegs. Nearly 80% of households received TDKs as of 31 August 2018 (Global Shelter Clusters, 2018). The following table 2.3 shows the contents of shelter kits for houses and neighbourhood construction.

CONTENTS OF THE UPGRADE SHELTER KIT				
Items	Qty	Unit cost (BDT)	Unit cost (USD)	Total cost (USD)
Shelter Materials				
Tarpaulin (4x6m)	2	2,014	24.00	48.00
Bamboo (large)	4	300	3.58	14.30
Bamboo (small)	60	40	0.48	28.61
Sand bag (polyprop.)	30	20	0.24	7.15
Tie wire	1	40	0.48	0.48
Rope (thick), 25m	1	120	1.43	1.43
Rope (thin), 30m	1	72	0.85	0.85
Nails, 3', 0.25kg	1	45	0.54	0.54

Items	Qty	Unit cost (BDT)	Unit cost (USD)	Total cost (USD)
Household Toolkit (1 kit for 5 HH)				
Claw hammer	2	150	1.79	3.58
Hand saw	2	120	1.43	2.86
Pliers	2	180	2.15	4.29
Machete	2	220	2.62	5.24
Shovel	2	200	2.38	4.77
Hoe	2	300	3.58	7.15
Digging post	2	340	4.05	8.10
Bamboo Basket	5	120	1.43	7.15
Neighbourhood Toolkit (1 kit for 100 HH)				
Wheelbarrow	2	2,850	33.97	67.94
Sand bag (polyprop.)	500	20	0.24	119.19
Shovel	5	200	2.38	11.92
Hoe	5	300	3.58	17.88
Digging post	5	340	4.05	20.26
Bamboo basket	10	120	1.43	14.30
Steel pan	10	250	2.98	29.80

Table 2.3: Contents of upgrade shelter kits

Source: (Global Shelter Clusters, 2018)

2.3 Conclusion

This chapter sets the context for a wider understanding of self-help housing, aided self-help housing, its advantages and disadvantages. Hence, it is possible to say that self-help housing provides an effective solution for aided housing construction for the refugees. Furthermore, this chapter also finds out the context of Rohingyas in Bangladesh and their condition of housing, Considering the numerous benefits of self-help housing, this chapter reveals its potentials for eradicating numerous housing problems that the Rohingyas are facing in their current shelters. Finally, the following chapters will find out design guidelines after a thorough case study analysis.

Chapter 3: Case Studies

3.1 Introduction

Based on the theoretical aspects discussed in chapter 2, this chapter develops analytical tools by investigating successful existing self- help refugee housing projects around the globe. This chapter consists of ten refugee housing cases in different countries built in different years. The case studies are chosen according to the following parameters:

- Shelters for refugees
- Self- help construction
- Short construction time
- Semi-permanent shelter type

The goal of this analysis is to observe the self-help refugee housing cases, identify the construction process, construction time, design parameters and analyze the strengths and weaknesses of each project.

3.2 Methodology

A comprehensive literature review-based methodology is followed to identify and analyze the cases. By researching ten refugee shelter projects, this chapter provides an overview of how to make a master plan of a refugee housing, design shelters for refugees that can be built by the refugees or the host community, space needed for different households, construction process, affordability and other infrastructure needs for the refugee housing. The case studies are analyzed under the following outline:

- **Background**

Background discusses several aspects of the refugee crisis including primary reason, year and how long the crisis prolonged. Moreover, under which circumstances the shelters were designed are also described here.

- **Shelter Details**

This category includes all aspects of a self-help refugee shelter initiative related to design, space, materials and costs. The role of designers in self-help housing for the displaced people is different than the traditional self-built shelter design. They need to consider a range of things while designing. This category finds out how the shelter design in the cases was laid out so that it became a successful self-help project. Following four criteria are described under the shelter design:

- Shelter design

- Structure and materials

- Space analysis

- Cost

- **Construction and Implementation**

In this category, the process of a self-help construction for refugee housing is covered. This category also describes the timeline of the construction process and skills required for the projects and how the displaced people can be trained for construction. Following are the essential considerations that are identified for construction of self-help shelters by the displaced people:

- Short construction time

- Self-help construction process

- Needed skills

- **Other facilities**

This category encompasses the infrastructure necessary in the refugee camps other than the shelters. For instance: schools, clinics, water fountains, and religious structures are fundamental components as these provide mental, physical and spiritual wellness to the refugees.

- **Strengths & Weaknesses**

This category identifies all the strengths and weaknesses of the project described by the Global Shelter Cluster organization. Here, the pros and cons are described that helped to make a concluding remark of the cases and identify the design guidelines.

3.3 Case Studies

3.3.1 Case 1: Housing for the Displaced People in the Democratic Republic of Congo

Project Location: Two villages in Kamuesha health zone, Kasa province.

Crisis: Kasai Conflict.

Year of Crisis: From January 2017- onwards.

The number of Displaced People: 83,740 in the Kamuesha health zone. 4.7 million in the whole country.

Beneficiaries: 630 households with Non-Food Item (NFI) (3,150 individuals, 60% female and 158 individuals with disabilities, including 40% returnees and 10% host families) and 200 households with shelters.

Source of Information: (Global Shelter Cluster, 2019).

1. Background:

In the context of instability and prolonged displacement in the Democratic Republic of the Congo, tensions rose due to the recognition of traditional leaders in 2016, which led to a conflict in the Kasai region between the national army and local militias. About 1.4 million people were displaced across the region during the first half of 2017. A six-month system-wide Level-3 emergency was declared in October 2017 to respond to the severity of the country's crisis.

2. Shelter Details:

- **Shelter Design:**

The shelters were designed based on local building techniques using accessible local materials and were constructed by the beneficiaries. This process brought about two advantages: firstly, because of a simpler execution, target households could buy the materials from local markets which ensured cash flow into the local economy. Secondly, it also reduced the possibility

of conflicts with neighbouring host populations as they worked in a group that developed unity among them. Aside from these, vernacular building techniques also made these structures usable for many years.

Figure 3.1: Shelters built by the communities

Source: (Global Shelter Cluster, 2019)

- **Structure & Materials:**

The materials used for the construction were mostly a wattle and daub or mud-brick structure with a thatched roof. The shelter kit included; for walls: sticks, reeds, ropes, mud, and mud mortar; for structure frames: sticks, reeds, rope, and bamboo, for the roof: thatch, palm leaves, rope, and plastic sheet; for doors and windows: tin, hinges, padlock, and lock. Lastly, for construction of the house, a tool kit consisting of measuring tape, handsaw, string, mason square, spade, and hoe was also provided to the beneficiaries.

- **Space Analysis:**

The basic plan of each shelter included a shaded cooking and storage veranda, connecting to a living area and an additional sleeping space accessible only from the living room. The average size of these shelters was 20 square meters, where the average area per person was 4 square meters. Figure 3.3 illustrates the plan of the shelters.

Figure 3.2: A typical refugee shelter designed by the community

Source: (Global Shelter Cluster, 2019)

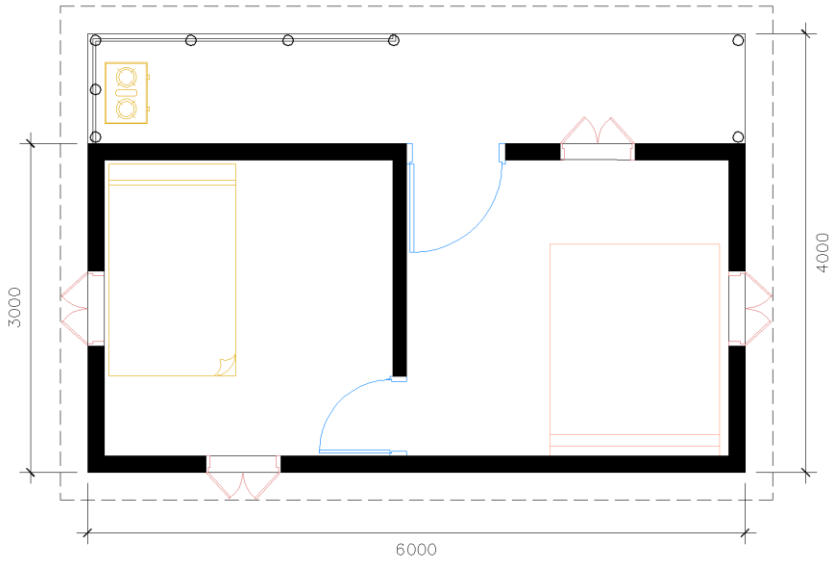


Figure 3.3: A schematic plan of the shelter for the displaced people

Source: Drawn by the author

- **Cost:**

The material cost for shelters was $140US and $120US for the NFI kit. The total project cost per household was $360US (shelter + NFI kit). Table 3.1 below shows the distribution of total material cost:

	Items	Total Cost $US
Walls	Sticks and reeds	15.00
	Ropes	
	Mud and mud mortar	
Frames	Sticks and reeds	5.00
	rope	
	bamboo	
Roof	Thatch or straw	5.00
	Palm leaves	
	Rope	
	Plastic Sheet	15.00
Door & Windows	Door, 86 X 90 cm	52.00
	Windows, 40 X 40cm, 40X50cm	
	Hinges	
	Padlock and lock	
Shared Community Toolkit (two for every 20 households)	Measuring Tape	48.00
	Handsaw	
	Mason square	
	Spade	
	Hoe	
	String	

Table 3.1: Price of materials in $US

Source: (Global Shelter Cluster, 2019)

3. Construction & Implementation

- **Construction time**

In December 2017, the first shelter NFI needs assessment was conducted and then in January 2018, the assessment report was presented to the humanitarian organizations and the donors. In March 2018, project beneficiaries were chosen based on a vulnerability scorecard approach. Initially, the method used a rating of 0 (no need) to 5 (extremely vulnerable) based on parameters set. Criteria have been divided into five categories:

- Humanitarian situation.
- Density or security inside the shelter.
- Location (including tenure arrangement).

- Roof conditions.
- General shelter conditions (including foundations and walls).

In March 2018, four shelter construction and planning workshops were arranged with a minimum of 100 shelter construction committee members. After conducting the workshops, community building tools were distributed among the members. Within 15 days, the materials for the shelter construction were collected, and construction of the shelters began from the 4th of April 2018. On 30th June, the construction of 200 shelters was completed. The following figure 3.4 shows the shelter construction timeline:

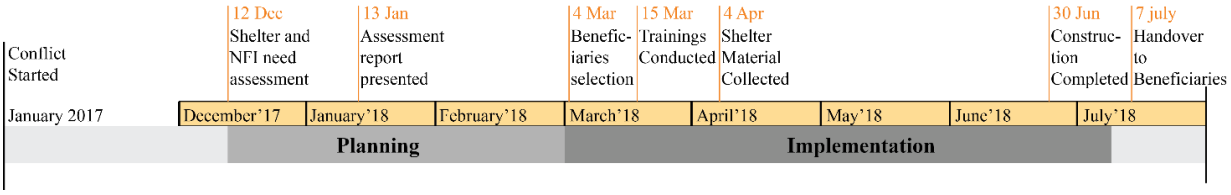


Figure 3.4: Timeline of the project

Source of Information: (Global Shelter Cluster, 2019) (Drawn by the author).

- **Self-Help Construction Process**

To oversee the operation, shelter committees or "solidarity groups" were organized, each supervising 18–20 households. Every committee was consisted of five members (generally three women and two men) and was responsible for coordinating the purchase, distribution and storage of local building materials, managing construction and assisting vulnerable households where necessary. Solidarity groups were formed to help the most disadvantaged beneficiaries in the shelter construction and guide newly arrived beneficiaries on the construction techniques.

Women were found to be more active than men (even though housing construction is generally a male-led activity), which was the reason behind more women were included in the committees. Women played a leading role in collecting local materials, such as sticks, ropes, palm

leaves, soil and reeds, while men also assembled the materials before construction. Both men and women performed shelter-building or retrieval activities (Figure 3.5).

Figure 3.5: Construction process of a shelter by the refugees

Source:(Global Shelter Cluster, 2019)

At first, there was uncertainty among the receivers regarding how the tasks would be carried out. Continuous interaction and the signing of an agreement between the employees and the committee members, outlining duties and obligations, helped to address the uncertainty. Once the construction was completed and shelters were handed over to the beneficiaries, NFI kits were distributed among 630 households.

- **Skills:**

At the outset of the initiative, the organization held four shelter construction workshops to provide the committee participants and the local community (Total 100 people including municipal councils and village leaders) with the expertise required to build shelters safely and assist new refugees in future construction. In addition, health, environment, and gender awareness workshops were also held in the targeted groups.

Figure 3.6: Solidarity Groups were formed and trained for construction

Source:(Global Shelter Cluster, 2019)

4. Other facilities:

One of the weaknesses of these refugee shelters was, they have no toilet inside the houses and the dwellers used to go to the latrines outside of their homes.

5. Strength & Weaknesses:

According to the report by the Global Shelter Cluster (2017), the following are the strengths and weaknesses of the project:

- **Strengths:**
  - By using local materials, housing typology, and construction techniques combined with training; enabled cost-effective housing construction, mitigated negative environmental impacts, and ensured replicability.
  - Cash investment into local areas by buying materials from local markets contributed to the development of new businesses.
  - Community people and the selected households' strong participation in the project (including collection and construction) minimized construction time.
  - Involving vernacular architecture strategies contributed to the permanence of the shelters for the beneficiaries.

- Efficient targeting by incorporating the scorecard strategy with additional parameters to determine vulnerability helped to identify the beneficiaries.
- Women were encouraged to take positions in construction which was traditionally played by men. This increased awareness of health problems and supported the distribution of hygiene kits for women.

- **Weaknesses:**
  - Shelters were designed without toilets inside which created safety concerns and health hazards for women and children.
  - Several challenges arose during the implementation. Although community meetings were held, and a feedback system was developed, these concerns should have been best handled from the outset through consistent communication.

5. Concluding Remark:

Shelters for the internally displaced people in the Democratic Republic of Congo is a successful transitional shelter project that was self-built by the displaced people. The project followed vernacular architectural design and construction techniques, which eased the construction process for the refugees. Moreover, the workshops also helped to develop the skills necessary for self-help construction. By creating the 'solidarity groups' the refugees could share their needs, challenges and problems with the staff of the organization, which was beneficial to solve the self-help construction problems. However, the design of the shelters should incorporate the toilet inside the shelter, which could minimize the sanitation problems of the refugees.

3.3.2 Case 2: Shelter for Internally Displaced People (IDP) in Iraq

Project Location: Baghdad, Dohuk, Kerbala, and Missan Governorates.

Crisis: Armed conflict in Iraq.

Year of Crisis: January 2014 - June 2015.

The number of Displaced People: 3.1 million IDPs in Iraq, 1.3 million returnees.

Beneficiaries: 1,252 IDP families (8,231 individuals, 4,506 female and 3,725 male), including 145 female-headed households and 488 physically or mentally impaired individuals.

Source of Information: (Global Shelter Cluster, 2017).

1. Background:

Iraq's internal conflict with armed opposition groups led to a prolonged crisis that left nearly 3.2 million people displaced. The global downturn had seen a 40% decline in oil sales, leading to the decline of the country-wide social protection and severely undermining citizens' capacity to afford public benefits, sustain wages and fulfil everyday needs. By the end of 2016, it was reported that more than 10 million Iraqis needed some form of humanitarian aid, of which a significant proportion were host communities.

2. Shelter Details:

- **Shelter Design:**

Based on the national strategy developed by the Ministry of Migration and Displacement, the Shelter-NFI Cluster in Iraq outlined the response strategy in the following three packages: 1) Response to the emergency shelter needs of newly displaced persons; 2) Response to upgrade shelter for critically needed existing IDPs and 3) Effective solution to maintain the existing shelter.

The project aimed to provide more long-lasting solutions to protracted displacement, improve security and livelihood opportunities, and find ways to mitigate tensions with host communities and avoid further conflicts.

The project fulfilled its aims by developing four prefabricated shelter sites and facilities. It considered both social and economic vulnerabilities and cultural differences. The prefabricated shelters had one living room and one bedroom, with a partition for women and girls to ensure privacy (Figure 3.7).

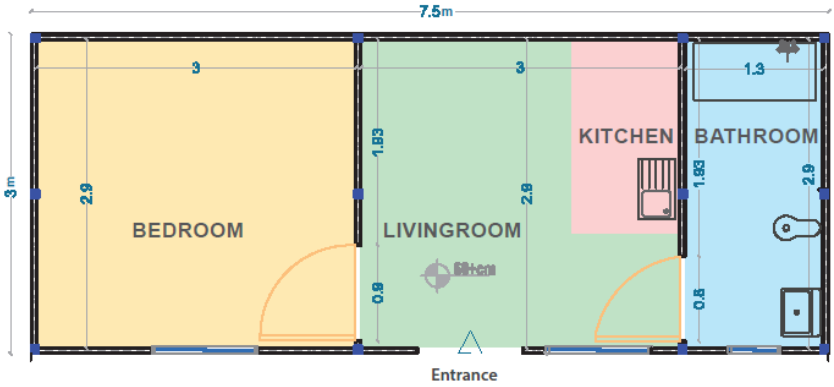


Figure 3.7: Plan of shelter

Source: (Global Shelter Cluster, 2017)

Figure 3.8: Shelter for the IDPs after completion

Source: (Global Shelter Cluster, 2017)

- **Structure & Materials:**

For the structure of the shelter, hollow steel tube columns were used. External and internal walls were made using prefabricated wall panels. The materials for the prefabricated units were procured from the local markets after a fair bidding and systematic procurement process (although initially purchased from neighbouring countries). The following table 3.2 demonstrates the list of materials in the shelter kits.

Main Framework	Base Frame (10cmX10cmX3mm), Hollow steel tube columns, Roof frame, Rectangular hollow tubes, Steel plate, Steel angle
Floor	Plywood sheet, fibre glass sheet for toilet floor
External Cladding	PU insulated sandwich panel upper layer
Internal Cladding	PU insulated sandwich panel upper layer
Roof	PU insulated sandwich panel upper layer, Canopy top: Galvanized steel sheet
Kitchen and Bathroom	Water outlet, Shower base and mixer, Hand wash basin and mixer, Mirror and Stainless-steel kitchen sink,
Door (3 pcs) and Window (3 pcs)	Frame, Wing, Handle and lock for doors
Electrical installation	Distribution board, cables, wires, lighting and water heaters

Table 3.2: Material list in the shelter kit

Source: (Global Shelter Cluster, 2017)

- **Space Analysis:**

Each shelter had three rooms- a bedroom, a living room with an attached kitchen and a toilet. The shelter was designed to meet cultural needs and expectations, particularly women's privacy and dignity. The area of each shelter was 22.5m^2 and shelter density was 3.75 m^2 per person, where the average household size is 6 persons.

- **Cost:**

The average material cost per household was $5,500US (average) and total project cost per household was $9,621US (average) including site preparation and infrastructure.

2. Construction & Implementation

- **Construction time**

The project planning started in March 2015 and continued for about 7 months. Locations were chosen through comprehensive consultations with counterparts in the Governorate. The organization found a range of locations that could be assigned for shelter construction, which were far from the conflict zones and at the same time close enough to the main cities. This provided the opportunity to extend the essential facility. Hence, the organization carried out technical studies to determine the geophysical condition.

In November 2016, the governorates handed over the site for construction. Within May 2016, construction of shelters and other infrastructure was completed and in June 2016 the site was handed over to the IDPs. At the end of August 2016, the IDPs were relocated to the site.

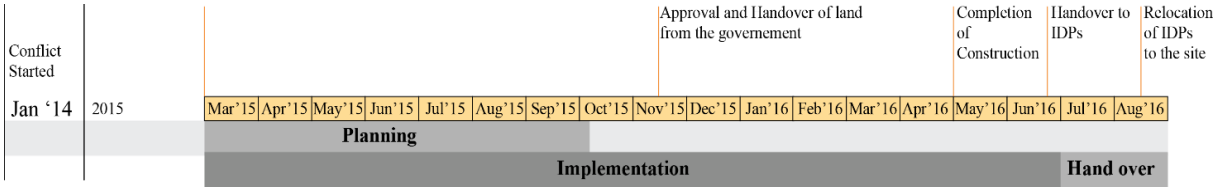


Figure 3.9: Timeline of the project

Source of Information: (Global Shelter Cluster, 2017) (Drawn by the author)

- **Self-Help Construction Process**

The organization provided the targeted governorates with technical assistance for the development of beneficiary selection criteria; considering vulnerability, socio-economic context, and gender sensitivity. Special attention was paid to the families living in unfinished buildings;

such as schools and mosques, outside the tents camp, and rental housing facing the risk of being evicted.

The organization developed site plans including basic infrastructures, such as roads, electricity networks, as well as public facilities, such as health clinics, women's centres, and outdoor areas. After that, the IDPs and members of the host community were actively engaged in the initiative as construction labourers. This also led to strengthening their livelihoods and increasing greater community recognition and awareness.

Local committees made up of IDP family members were then assigned in the developed sites to assist with management duties. The committees recognized the key issues and discussed the preventive or corrective steps for the construction. For example, one committee foresaw the risk of construction delay, due to winter snow and wet ground conditions. The committee proposed that the labour force were needed to be expanded to allow full use of the available resources, with increased monitoring frequency. Such steps allowed the project team to keep up the progress despite the difficult weather conditions, which ultimately resulted in the timely project delivery.

Finally, coordination with different organizations was necessary for the service and maintenance of reproductive health clinics, women’s centres and the establishment of a primary school at one of the sites.

Figure 3.10: The IDPs before and after the new shelter construction

Source:(Global Shelter Cluster, 2017)

- **Skills:**

The initiative offered training to committees and site administrators for skill development on construction and site development. The site administrators developed their management capability through the training.

3. Other facilities:

The sites provided social facilities accessible to host populations, improving their access to basic public services, especially in areas with a huge number of IDP populations. It led to increased acceptance and reduction of IDP residents' tensions. The initiative also provided the citizens with livelihoods, temporary educational facilities and accommodation for students. This project helped around 512 students with shelters.

Figure 3.11: The new sites and shelters provided a major improvement in health, privacy and integrity for the households selected

Source:(Global Shelter Cluster, 2017)

4. Strength & Weaknesses:

According to the report by the Global Shelter Cluster (2017), the following are the strengths and weaknesses of the project:

- **Strengths:**
  - Close cooperation with subordinates of the government, implementing partners, and the committees helped to address many issues during the implementation phase.
  - Collaboration with other organizations to enhance essential infrastructure improved health and education and boosted the project's sustainability.
- **Weaknesses:**
  - The initial cost of setting up the prefabricated shelter sites was higher than that of supplying other emergency shelter options.

- Several challenges arose during the implementation. Although the design was accepted within the cluster and with local authorities (based on the average size of six households), some families argued about the scale of the shelter units due to cultural reasons. This led the organization to adopt a different design (with larger space) at the latest site.

5. Concluding Remark:

The design of shelters for the refugees in Iraq was prefabricated shelter types which provided many benefits of self-help shelter construction, such as these were easy to transport and the shelters could be built more easily within less time than the other type of shelters. Although the cost for these shelters was higher, the design ensured the permanence of the structure, where the refugees could stay for a longer period. Moreover, the shelters included kitchen and toilets inside the shelters which could minimize the problems of health and sanitation. The camp also provided the refugees with educational facilities and livelihood opportunities which is also a positive side of the project master plan.

3.3.3 Case 3: Shelter for Internally Displaced People (IDP) in Myanmar

Project Location: Rakhine State, Myanmar.

Crisis: Violence within the community in Rakhine State.

Year of Crisis: From June 2012 to October 2012.

The Number of Displaced People: 140,000.

Beneficiaries: 140,000 people with 2,843 shelters.

Source of Information: (UNHCR, IFRC, & UN Habitat, 2014).

1. Background:

Rakhine State is Myanmar's least developed state, with high population density, high mortality rates, low-income levels, insecurity and poor infrastructure. Two cyclone seasons exacerbate the situation, with subsequent flash floods and wet season landslides. Two main ethnic groups conflict with each other for many years. The Rakhine are the first, who are Buddhist. The second group is named Rohingya and are Muslims.

Violence between communities in parts of Rakhine State started in early June 2012 and flared once more in October 2012, when 167 people were killed, and 223 people were injured, and 10,100 buildings including homes, mosques, and public buildings were damaged or demolished, with 140,000 people displaced (95% Muslim; 5% Rakhine). There were 2 different caseloads of IDPs: refugees from urban areas, and remote ones. In rural Sittwe, the IDP camps were home to 88,500 Muslim IDPs (63% of all IDPs) fleeing from urban areas of Sittwe. They used to work mainly as merchants or porters living in slum-like conditions in Sittwe port. The Rakhine State Government (RSG) distributed tents in rural Sittwe as part of the initial emergency response but the stock, which was residual from the 2010 Cyclone Giri response, was soon depleted. During the second wave of relocation, the local agency provided tarpaulins, wire, and about 5,500 tents.

2. Shelter Details:

- **Shelter Design:**

The RSG 's primary concept of the shelter was based on the shelters previously built for emergency response in the state of Kachin. These shelters were 13.7m x 9.1m, offering about 12.5 m^2 per household for 10 family members. The living space was just about $2m^2$ per person as the typical family size was about 6 people. The principal agency recommended that the shelters should follow the Sphere Project's criterion of $3.5m^2$ per person. In the end, an agreement was reached with eight families per shelter. For Disaster Risk Reduction (DRR), wooden bracings and twisted steel plates were added to the roof framing to resist high winds. The walls and floors were also reinforced with suitable wooden bracings or joists. The floor elevation of the shelters which were situated in camps located in paddy fields or low-lying areas was increased by 30 cm (from 60 cm to 90 cm) to mitigate the risk of flooding.

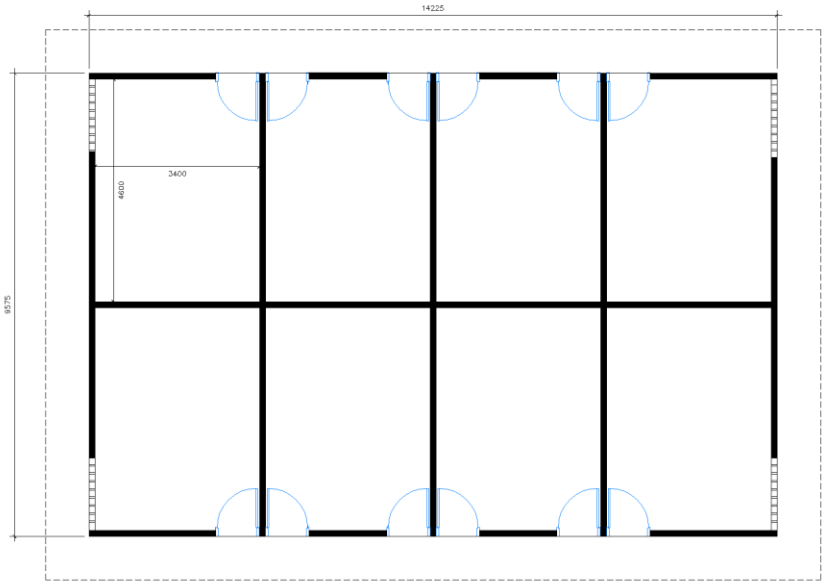


Figure 3.12: Schematic plan of the shelter

Source of information: (UNHCR, 2016), (Drawn by the author)

The shelters were lifted from the ground in some settlements, and walkways were constructed across the shelter. Besides, firewood was in such low supply that the survivors cut up the wooden walkways for fuel in some situations. Therefore, instead of wooden walkways, rammed earth walkways had to be built (Figure 3.13).

Figure 3.13: Elevated shelters for the IDPs after completion

Source: (UNHCR et al., 2014)

- **Structure & Materials:**

The shelters were made of traditional Myaw timber posts structure, CGI roof sheets, bamboo mat for wall cover and GI plain sheets for ridging. The following table 3.3 shows the list of materials in the shelter kit for 8 family units.

Item	Quantity
Myaw posts (100mmdia.- 152mmdia.)	35 pcs
Myaw posts (50mmdia.- 100mmdia.)	215 pcs
Timber scant (local hardwood)	1.74 tons
CGI sheets (roof cover)	162 sheets
GI plain sheet (600mm wide) for ridging	56ft
Wire nails	30kg
Bamboo (seasoned/dry)	2,345 pcs
Dahnee/nipa	820 pcs
Roofing nails (umbrella nail)	12 kg
Nylon rope	15 coils
Plastic rope	5 coils
Twisted steel plate (min. 2mm thick x 25.4mm x 152mm) with screws	15 pcs

Table 3.3: Material list in the shelter kit

Source: (UNHCR et al., 2014)

Much of the materials were sourced within Rakhine State. Since the best bamboo matting weavers were available in the IDP community, many of the wall and floors were prefabricated in Sittwe's rural areas and then shipped to remote towns and villages. The contractors were outsourced with the responsibility of procuring materials, and some did not meet state requirements for the use of timber.

- **Space Analysis:**

The shelter was designed in the form of collective shelters, each of which housed eight families (8-unit buildings) with associated IDP camp infrastructure. The size of the 8-unit building was: 45 ft x 30 ft (13.7m x 9.1m), having an area of 124.7 m^2. The size of each room was 11.25 ft x 15 ft (3.4m x 4.6m) consisting of an area of 15.6m^2.

- **Cost:**

The total cost of each 8-unit houses was $4,800US and the cost of each room was $600US. Moreover, the project administration costs of each building were $700US, whereas the cost per room was $88US.

2. Construction & Implementation

- **Construction time**

The first wave of violence and displacement happened in June 2012. In the first phase, the construction of 525 shelters for 30,000 IDPs started in the same month. Within 7 months, the construction for the first phase was completed and handed over to the IDPs.

In October 2012, the second wave of violence occurred. In January 2013, the construction of 262 shelters for 15,000 IDPs was started and it was completed in April. Furthermore, the third phase of construction of 2,056 shelters for 95,000 IDPs was started in May 2013 and it was

completed in October 2013. The third phase of the shelter project was organized by multiple agencies and handed over to the IDPs in November.

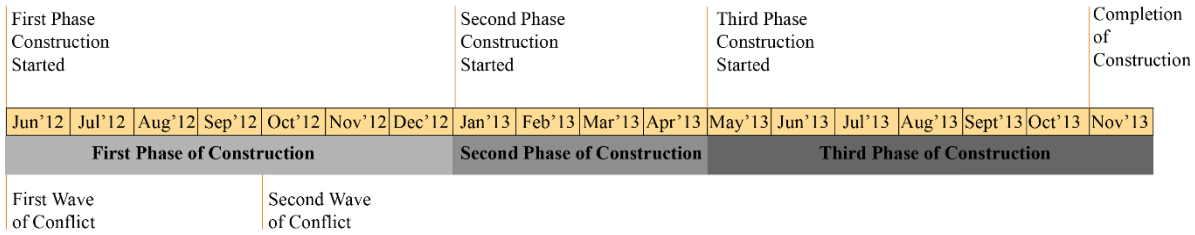


Figure 3.14: Timeline of the project

Source of Information: (UNHCR et al., 2014)(Drawn by the author)

- **Self-Help Construction Process**

After the conflict, commitments were made in the Shelter Cluster Strategy 2013 to provide temporary shelter for all qualifying IDPs. However, the eligibility criteria were strictly controlled by the RSG which never disclosed clear entitlement criteria, and only the General Administration Department (GAD) knew after construction which group of IDPs would be moving into the shelters. Joint site planning exercises opened an opportunity to strengthen cooperation between government agencies and foreign organizations, which was historically weak.

Shelters were constructed by recruiting local building contractors authorized by the RSG. The contractors recruited IDP labour (skilled and unskilled) to ensure cash flows into the vulnerable microeconomies developed in the IDP camps. Workers were paid at government standard rates. The leading organization conducted site planning in partnership with three government departments. The camp infrastructure was also built to provide the basic amenities. After that, maintenance and repair programmes were implemented through CCCM Cluster partners, which allowed a community-driven approach. However, the RSG opposed the distribution of toolkits to beneficiary households, as they believed these could be used as weapons.

Figure 3.15: Shelter construction by the IDPs

Source:(UNHCR et al., 2014)

- **Skills:**

Within the IDP community, the best bamboo matting weavers were found. Hence, their skills were used to construct shelters.

3. Other facilities:

Besides shelters for the IDP community, other infrastructures were also built within the project. The camp included an outdoor common water pump, kitchen and bathroom. Additionally, it had temporary learning space, child-friendly space, women-friendly space, health centres and mosques. The following figure 3.16 shows the site plan of the shelters and the infrastructures.

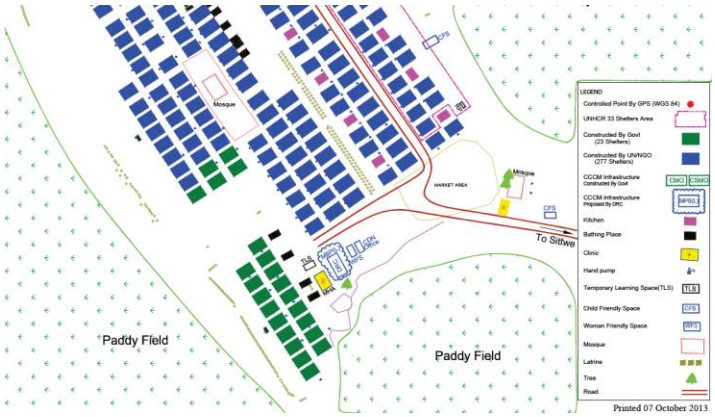


Figure 3.16: The site plan of the camp showing the shelters and the infrastructure

Source: (UNHCR et al., 2014)

4. Strength & Weaknesses:

Following are the strengths and weaknesses of the project according to the report by UNHCR et al. (2014):

- **Strengths:**
  - The project sought to alleviate tensions by helping both parties equitably and effectively including Buddhist workers in the building of shelters for Muslims.
  - The project used local materials which minimized the cost.
- **Weaknesses:**
  - From the perspective of the beneficiaries, the temporary design of the shelter did not consider the cultural need for women to bathe and cook within their shelters. That, along with congested circumstances, also meant less sense of ownership of the structures.

5. Concluding Remark:

This transitional shelter project in Myanmar was a durable solution for the IDPs. The design of these shelters considered disaster risks which were a positive aspect of the project. Moreover, traditional construction techniques were used in the self-built construction process which made the shelters easy to build. But there was some scope of improvements in this project, such as shelters could include kitchen and toilet inside. Besides, instead of making 8-unit shelter types, 4-unit shelter types could be built which can ensure every unit receiving the adequate and same amount of daylights inside their shelters.

3.3.4 Case 4: Shelter for Refugees in Tierkidi Refugee Camp, Ethiopia.

Project Location: Tierkidi Refugee Camp, Gambella, Ethiopia.

Crisis: South Sudan refugee crisis.

Year of Crisis: Dec 2013-ongoing.

Number of Displaced People: 245,298 refugees in the Gambella region, 48,507 refugees in Tierkidi camp (as of September 2014).

Beneficiaries: 835 households (4,125 individuals) received 835 transitional shelters (Tukuls).

Source of Information: (Global Shelter Cluster, 2017).

1. Background:

The South Sudan conflict erupted in December 2013 and caused massive internal and neighbouring displacement. As of November 2016, Ethiopia was the country housing most refugees and asylum seekers in Africa, with a total of 783,401 people (as of November 2016), primarily from South Sudan, Somalia, Eritrea and Sudan. The Gambella area received significant numbers of refugees from the eastern parts of South Sudan escaping the conflict. As of August 2014, the country had more than 190,000 refugees.

Several refugee camps were set up, provided with food, water and basic facilities. These camps experienced a large influx of people seeking security and sufficient housing. In September 2014, at the planning stage, the Tierkidi camp was already housing around 48,500 refugees and asylum seekers from South Sudan, most of whom were staying in temporary tents, in unhabitable conditions.

2. Shelter Details:

- **Shelter Design:**

This project supported 835 households in the Tierkidi camp as part of a broader programme which included components of NFI, water and sanitation. The shelter design was based on the standards used by various agencies in Gambella and agreed by the shelter working groups. Initially, the refugee community opposed the standard design; therefore, the organization faced difficulties in implementing the design chosen. This problem was addressed by integrating feedback given to the working group and other organizations by the beneficiaries. Also, the design process included sector partners, local authorities and beneficiaries, such as the elders and vulnerable refugees.

The shelter design chosen for the refugees was mud tukul house, which is a traditional form of house design in the region. This form of shelter is very resilient against heavy winds and heat (UNHCR, 2016). It can be built using timber, bamboo or brushwood structure. The form, as well as the dense layer of mud, protect the structure from the weather and help sustain a cooler temperature in the interior. The following figure 3.17 shows the plan of the tukul house:

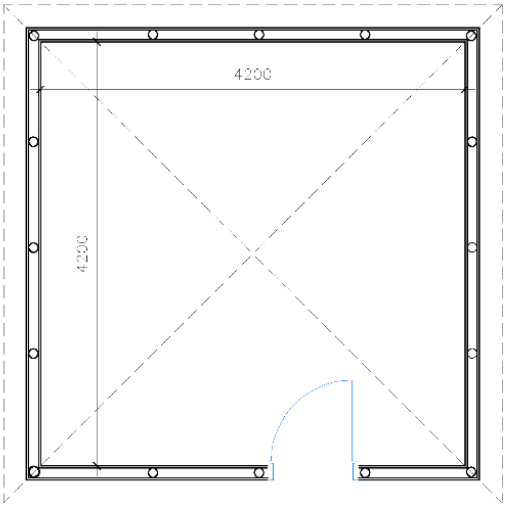


Figure 3.17: Schematic plan of tukul shelter

Source of information :(UNHCR, 2016), (Drawn by Author)

Figure 3.18: Construction of tukul houses by the beneficiaries.

Source: (Global Shelter Cluster, 2017)

- **Structure & Materials:**

The shelters were constructed of wooden eucalyptus structure finished with bamboo matting or grass-thatch. The materials were grown in abound in the region. However, a quick business analysis revealed the risk of bamboo shortage, therefore, the project decided to use grass lattices primarily. The following table 3.4 shows the list of material in the shelter kit and their costs:

Item	Unit	Quantity	Cost ($US)
Bamboo poles, 10cm diam	pcs	8	27.3
Eucalyptus poles, 8cm diam.	pcs	16	49.9
Eucalyptus poles, 6cm diam.	pcs	4	10.9
Bamboo poles, 5cm diam.	pcs	200	237.4
Corrugated Iron Sheet	pcs	1	6.9
Bolt, latch, hinges for the door	lump	1	3.5
Local fibre string	Roll	1.5	5.2
Plastic rope	M	200	4.9
Roofing nails	Kg	0.5	1.5
Assorted nails: 10cm, 8cm, 6cm	Kg	5	7.2
Soil for walling and plaster	M^3	4	59.4
Grass: 55cm, 150cm long	Bundle	35	103.9
Transport + labour to load	Lump	1	4.9+1.0
Used motor oil	Litre	1	1.0
Community mobilization	Lump	1	24.7
Labour for shelter structure	Lump	1	32.1
Labour for roof thatching	lump	1	22.3

Table 3.4: Material list in the shelter kit in $US

Source: (Global Shelter Cluster, 2017)

- **Space Analysis:**

The size of each shelter was 4.2m x 4.2m, having an area of 17.6m^2. The density of shelter was 3.5m^2 per person, where the average household size was 5.

- **Cost:**

The total material cost for each shelter was $604US, including labour cost. The total estimated project cost was $800US per shelter (Global Shelter Cluster, 2017).

2. Construction & Implementation

- **Construction time**

Estimated construction time for each shelter was a day if three people were assigned (UNHCR, 2016). The planning for the project started in August 2014 and completed in September. In December 2014, the implementation of the first phase started in the Tierkidki camp. Within March 2015, safe water was provided to all refugees in the camp through trucking of purified water to 33 emergency water points. At the same time, the construction of 500 tukul shelters was completed in zone D (Figure: 3.21). In October 2015, the second phase of shelter construction started, and it took 5 months to complete 335 more shelters in zone C (Figure: 3.21) of the camp. Finally, beneficiaries were moved from the emergency shelters to the newly constructed transitional shelters in April 2016, although the project was handed over to municipality authorities and the community by end of 2015. The following figure shows the timeline of the project:

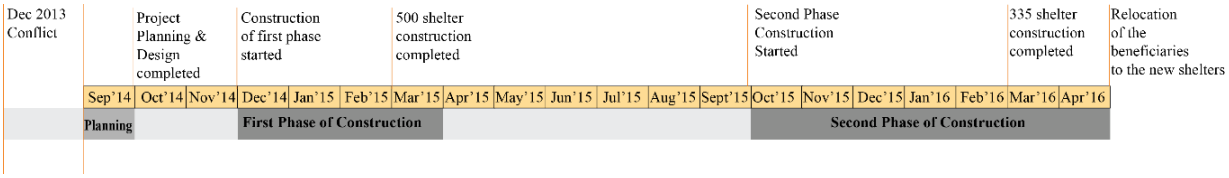


Figure 3.19: Timeline of the project

Source of Information: (Global Shelter Cluster, 2017)(Drawn by the author)

- **Self-Help Construction Process**

The project targeted refugees from South Sudan who resided in three camps in the area of Tierkidi, Leitchuor, and Kule. The targeted households were new refugees who lived in the camps temporarily. According to specific risk requirements, the lead camp management agency and the refugee government agencies were actively involved in assessing and identifying the beneficiaries. Priority was given to those who lived in emergency shelters for a longer time.

After the selection of the beneficiary, the project was carried out as follows:

- Plot demarcation followed by location mapping of the shelters.
- A prefabrication workshop was arranged to produce the shelter elements, such as doors, poles and frames, in a standardized approach in a warehouse in section D of the camp. Pre-cutting and processing capability were strengthened in the workshops to meet the construction goals.
- A team of carpenters from the host community built the roof superstructure (frame and roof).
- Skilled refugee workers, who were being paid for construction, completed the bamboo or grass lattice.
- A team of trained refugee staffs built the grass thatch roof. Due to some parts of the roof being deteriorated relatively quickly, the thatching technique was improved in the second phase of the project.
- The shelters were then handed over to the family of the designated beneficiaries.
- Appropriate locations for soil quarrying were agreed with the host community to ensure compliance with safe practices and mitigate conflicts with the host community. The soil was obtained by the refugees themselves, with the aid of field officers.

- Then, the beneficiaries were supplied with the requisite local materials, tools and technical assistance to conduct mud rendering and elevate embankments to protect against flooding.
- Regular technical help and guidance were provided, according to the design and accepted requirements.
- Coordination and supervision of the project were provided with the staff of the agency, and other implementation partners to resolve any problems that might arise.
- The organization conducted a post-implementation evaluation among the refugees to understand whether they were satisfied with the shelter. Most beneficiaries reported being satisfied with the shelter design and materials (over 80%) or very satisfied (over 10%).

Figure 3.20: Shelter construction by the refugees

Source: (Global Shelter Cluster, 2017)

- **Skills:**

The refugee group had been engaged in implementing the shelters through several activities, including the general site planning, design and construction by integrating their demands. One of the main challenges during implementation was finding skilled workers (such as carpenters, masons, and foremen). There were no such technicians readily available, particularly

among the refugees. This was addressed during the project by providing training and technical assistance. Owing to the professional expertise acquired through their participation, some workers were promoted to "shelter foreman level". The refugee community also participated in the plastering of the shelters based on their traditional construction skills. However, women did not participate only except contributing to the grass collection for thatching.

3. Other facilities:

The camp also consisted of water points, schools, markets, health centres and distribution centers. Following is the master plan showing the shelters and infrastructures within the site.

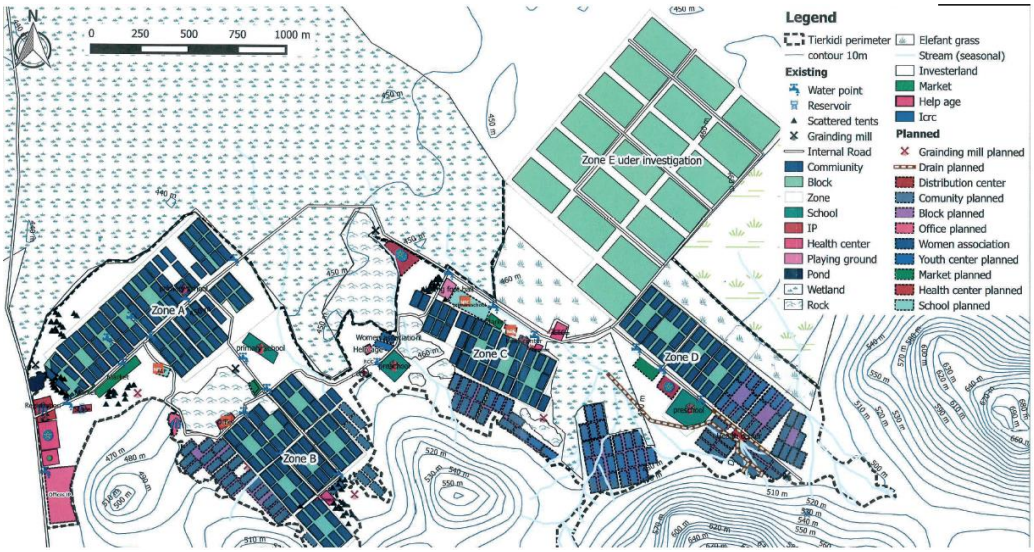


Figure 3.21: The site plan of the camp showing the shelter clusters and the infrastructure

Source: (Global Shelter Cluster, 2017)

4. Strength & Weaknesses:

The strengths and weaknesses of the project according to the Global Shelter Cluster (2017) are discussed below:

- **Strengths:**
  - The project included both the host communities and refugees, to develop their construction activities, skills and awareness.

- The project was managed efficiently and timely by providing technical support and workplace monitoring.
- The project minimized unnecessary costs through the effective implementation of ideas.

- **Weaknesses:**
  - Poor choice of site. The second allocated site was at the bottom of a hill and therefore, was more prone to flood.
  - The soil chosen for the construction was far from the site, thereby impacting construction times and disrupting the whole project.

5. Concluding Remark:

The design of shelter for the refugees in this project incorporated traditional shelter types called the tukul shelters, which provided them with comfort inside their shelters, minimized disaster risks and eased construction processes of these self-help shelters. However, by incorporating a kitchen and toilet, these shelters can be improved. The project also included other amenities in the master plan which is important for the long term stay.

3.3.5 Case 5: Shelter for Refugees in South Sudan

Project Location: Kaya camp, Maban County, Upper Nile State, South Sudan.

Crisis: Conflict in Blue Nile state (Sudan).

Year of Crisis: Since 2012.

The Number of Displaced People: Maban County hosts 127,715 refugees, including 21,428 in Kaya Camp.

Beneficiaries: 4,007 households (15,433 refugees) received 3,747 timber-frame shelters.

Source of Information: (UNHCR et al., 2014).

1. Background:

After the end of the conflict between North and South Sudan, the 2005 Comprehensive Peace Agreement failed to address the conflict status of the Blue Nile State. Although South Sudan formally became independent in July 2011, unrest in the state exploded again and resulted in a combination of local and regional conflicts.

2. Shelter Details:

- **Shelter Design:**

During the preliminary design phase in December 2012, timber poles were chosen for the structure. At that time, Maban County sold timber poles to other parts of South Sudan, then tensions between refugee and host communities amplified as the number of refugees increased and demand for building poles increased gradually. It was decided to ship timber to Maban so as not to worsen the situation and to start the construction process on time. Mud bricks were also considered, but the amount of water needed to produce thousands of shelters was not available.

During the dry season, Maban County experiences intense heat, storms and flooding during the rainy season. Shelters were built with bracing to withstand heavy winds (sandstorms are

common). Moreover, the CGI roofing could provide greater insulation against the sun compared to the tarpaulin. The site was chosen keeping in mind the flood problem, and steps were taken to prepare gravel for roads. The floor of the shelter was lifted using a marram (gravel mixed with laterite).

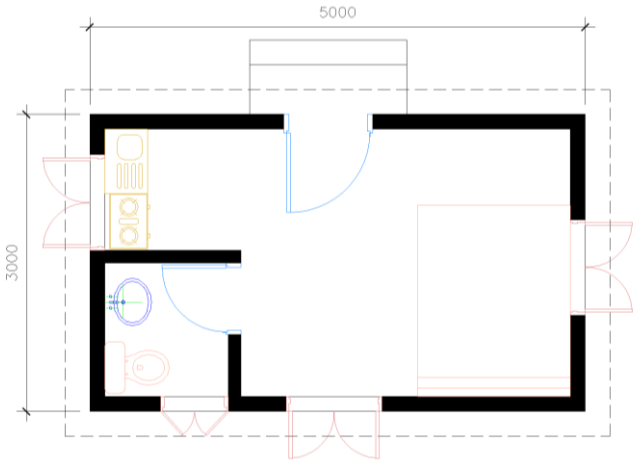


Figure 3.22: Plan of shelter

Source of Information: (UNHCR et al., 2014) (Drawn by the author)

- **Structure & Materials:**

The shelters were made of the timber structure with a prefabricated roof. The shelters were designed with flexibility, enabling the beneficiaries to upgrade to CGI roofing and can be expanded in the future. The following table 3.5 shows the list of materials and their quantity in the shelter kit.

Material Items	**Quantity**
1 pre-assembled roof (12 timber pieces 101mm x 50mm, and 8 timber pieces 50mm x 50mm)	1
End walls (to be joined with bamboo)	2
Pieces of bamboo	22
Plastic sheets 4m x 5m (one for wall, one for roof)	2
Binding wire	3 kg
Nails	3kg of 4mm and 64mm

Table 3.5: Material list in the shelter kit

Source: (UNHCR et al., 2014)

- **Space Analysis:**

The area of shelter for each family of three or more members was 15m^2.

- **Cost:**

The cost of material and transport was $310US and for construction and implementation $56US per shelter.

2. Construction & Implementation

- **Construction time**

The refugees arrived at Maban County in December 2011. At that time, conflict was still ongoing in Blue Nile State. In December 2012, the project planning started and completed in February 2013. Within February to May 2013, the construction of 700 shelters was completed and relocation of the refugees from Jamam camp to Kaya camp began. In June 2013, paid prefabrication and voluntary construction started and ended in March 2014. In December 2013, conflict halted the supply of material and construction process delayed due to this conflict.

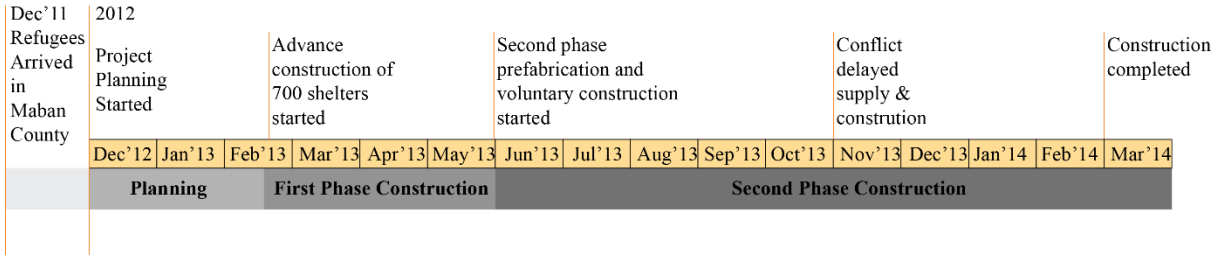


Figure 3.23: Timeline of the project

Source of Information: (UNHCR et al., 2014)(Drawn by the author)

- **Self-Help Construction Process**

The shelters were prefabricated by paid teams as shelter kits, while the beneficiaries conducted the construction and installation of the shelters themselves. Each team was comprised of 60 paid workers. Four different teams brought the shelters together in 4 stages:

- Pre-fabrication stage
- Distribution stage
- Roof assembly stage
- Installation stage

Pre-fabrication stage

The end walls and parts of the roof had been prefabricated. The manufacturing line was split into 3 sections:

- Cutting section: saw timber/poles to length.
- Truss section: assemble trusses with two rafters and two beams.
- Walls section: assemble walls with 1 x 4m and 4 x 2m timber/poles. Prepare bundles of bamboo and binding wire.

Distribution Stage

The distribution unit loaded the vehicles, brought the pre-assembled parts and kit items for shelters from the distribution points.

Roof assembly Stage

Four teams of four people undertook the roof assembly. These teams worked with the distribution teams in assembling the two sections of roof trusses. The installation took approximately 15 minutes per roof, and four sets of roofs were assembled simultaneously. Finished pieces were transported by the families themselves to the shelter plots.

Installation stage

In the beginning, a paid team installed the shelters. The coordinating party negotiated with the camp shelter committee that the beneficiaries themselves should construct the shelters without

payment until the refugees settled into Kaya. The five carpenters helped to install the shelter. The final structure was reviewed by the engineering staff at the project.

- **Skills:**

Beneficiaries received construction training to develop their skills for shelter construction. They were also trained in carpentry to make prefabrication units and installation of the structure.

Figure 3.24: Construction of the shelters by the beneficiaries

Source:(UNHCR et al., 2014)

4. Strength & Weaknesses:

The strengths and weaknesses of the project according to UNHCR et al. (2014) are listed in the following sections:

- **Strengths:**
  - Prefabricating the shelter parts enabled the shelter to be built within a single day.
  - The recipients were trained on how to construct both the prefabricated pieces and the shelter itself, resulted in a transfer of experiences and skills, and a decline in the need for professional expertise.

- **Weaknesses:**
    - It was improper to use plastic tarpaulin as a roofing material because it offered inadequate protection from the light. There were plans to replace 2,000 shelter roofs with CGI sheeting later on.
    - Payment for the construction of the first batch of shelters created an unrealistic expectation within the camp population that all labour should be paid to build and install the shelters.
    - Initially, the construction monitoring process was weak, and some shelters needed corrections.

5. Concluding Remark:

The design of the shelters for the refugees in South Sudan was prefabricated shelter types. By incorporating prefabricated construction techniques, the project minimized construction times and improved construction processes for the refugees. Additionally, training was provided to the refugees for the self-help construction of the prefabricated units, which helped to build skills for the self-built process. However, in this project procuring materials for the shelters took a long time and delayed the construction process. Therefore, a market survey was needed to be conducted in the planning process.

3.3.6 Case 6: Shelter for Refugees in Dollo Ado Camp, Ethiopia

Project Location: Dollo Ado camp, Ethiopia.

Crisis: Conflict and drought in Somalia.

Year of Crisis: From 1992 - 2010.

The number of Displaced People: More than 1 million Somali refugees registered. At the end of 2012, the five Dollo Ado refugee camps had registered 177,000 refugees.

Beneficiaries: 9,000 families received 7,127 shelters by the end of 2012.

Source of Information: (UNHCR, IFRC, & UNHabitat, 2013).

1. Background:

After a resurgence of the violence and drought in Somalia, a series of five camps were set up within 100 km of Dollo Ado, an Ethiopian border region, in 2010 and 2011. At the end of 2011, 34,000 Somali families were housed in the five camps of Bokolmayo, Melkadida, Kobe, Hilaweyn and Buramino, the highest number of refugees in Ethiopia. The refugee population grew during 2012, and 180,389 refugees were registered in the camps by the end of the year 2012. Being close to the equator and at low altitude, Dollo Ado experiences extreme weather conditions with high temperatures, strong winds and seasonal heavy rainfall.

In 2011, the shelter was described as a critical need in the refugee camps. The number of new arrivals peaked in June 2011, with an average of 168 people per day. They had been provided with tents. However, the tents' life span proved to be about 6 to 8 months, which meant that alternate options for the shelter of the camp were needed.

2. Shelter Details:

- **Shelter Design:**

The organizations decided in September 2011 to construct prototypes for analysis. During that time, they invited three organizations involved in the shelter programme to produce prototypes based on the shelters they had constructed before. Each of the three shelters was constructed following the same design layout. Then the shelters were assessed by a gender-balanced group of representatives from refugees, government, and key organizations. The chosen layout had a corrugated iron sheet roof, a post-and-beam eucalyptus structure, and bamboo split wall cladding. The intent was to plaster mud into the walls. The shelter had an internal partition, two lockable windows and a door that could be locked from both inside and outside for greater security. The corrugated iron sheet was chosen for roofing due to its toughness and protection from burning.

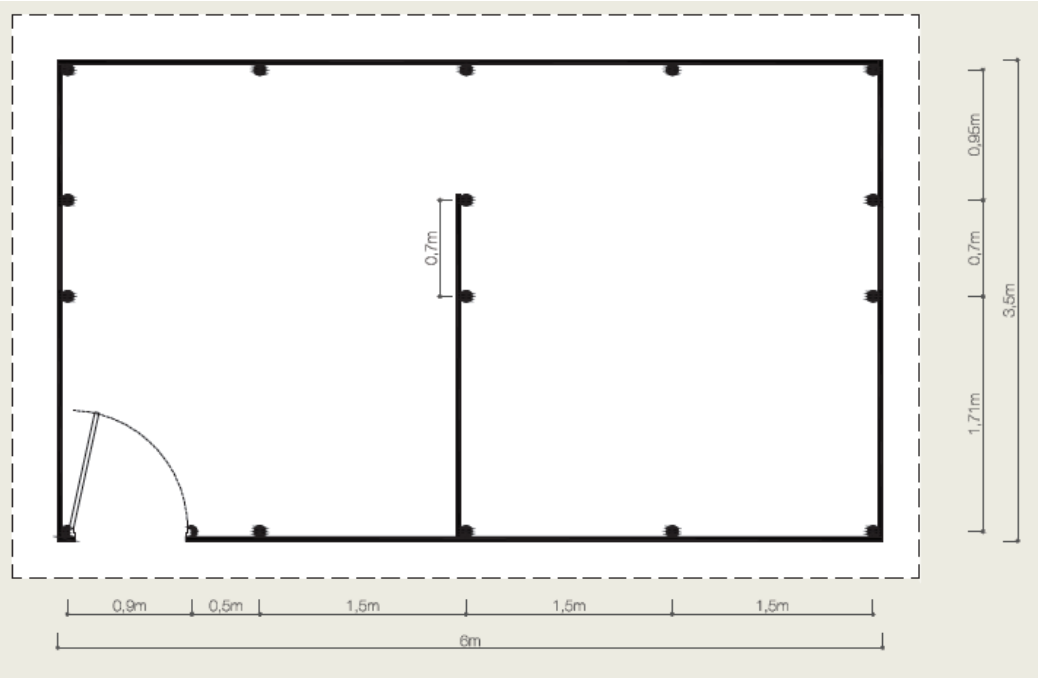


Figure 3.25: Plan of shelter

Source: (UNHCR, 2016)

- **Structure & Materials:**

The adopted design consisted of a wooden frame along with a support framework for the bamboo wattle. The columns, bracings, and roof structures were made of wood (Eucalyptus) with treated poles for improving the shelters' life span. The walling is a plaster structure made of bamboo slices. Plastic sheets or fabric were also put inside for bamboo-only walls, to protect from rain and wind. The resulting structure was fairly well ventilated in the hot climate, and enough rain protection was provided. For such shelters, households were reasonably pleased. Table 3.6 shows the list of materials in the shelter kit.

While highland Ethiopia had substantial plantations and production of both eucalyptus timber and bamboo, Dollo Ado was at least a day drive away from the nearest eucalyptus and bamboo plantations. Suppliers, mostly located in Addis Abbaba, who could provide the paperwork needed for major procurement were situated further away. Transport requirements were very complex and demanding. One truck could carry just enough materials for 15 shelters. The construction of 10,000 shelters took more than 600 trucks. Drastic changes in prices came for bamboo and shipping during the year. This led to an increase in the cost of shelter by 16%.

Material Items	**Quantity**
Corrugated galvanized iron sheet sheets roofing (2m x 0,90m)	24 pieces
Eucalyptus poles (8cm diameter)	32 pieces
Bamboo (6cm diameter, min. 6.5m, dry, straight)	62 pieces
Nails (#9, #8, #6, #4)	10.5 kg
Roofing nails	3 kg
Metal straps (2cm wide; 1.5- 2mm thick)	10cm
Wire Mesh (1.8m x 30m; 2cm opening)	1 piece
Hinges (T hinge 4 cm long sides)	6 pieces
Lock system	4 pieces
Black wire (10 kg rolls)	0.1 Roll

Table 3.6: Material list in the shelter kit

Source: (UNHCR et al., 2013)

- **Space Analysis:**

The area of shelter for each family was $21m^2$ (6m x 3.5m).

- **Cost:**

The cost of material and transport was $525US and total project cost per shelter was $800US excluding overheads.

2. Construction & Implementation

- **Construction time**

In February 2010, the first camp opened at Dollo Ado. After 7 months in September, criteria for transitional shelters were adopted. Then, in March 2011, the shelter prototypes were evaluated by the organizations, government and refugees.

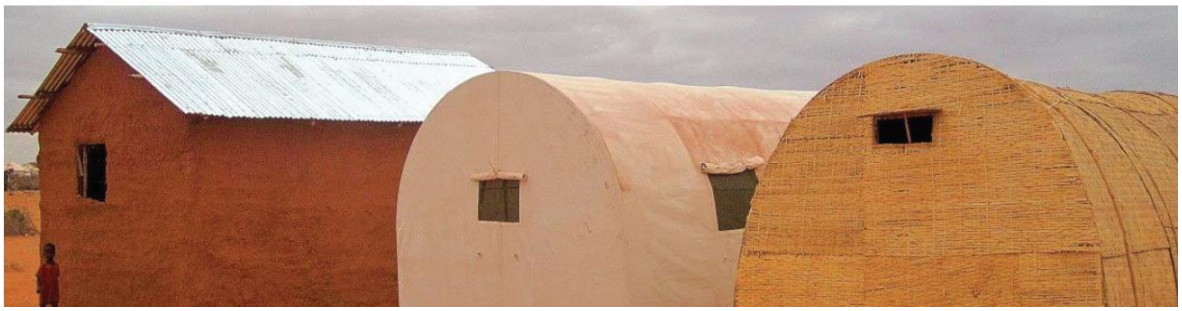


Figure 3.26: Different prototypes of shelters

Source: (UNHCR et al., 2013)

Just after a month, first transitional shelter strategies were approved and within four months, the strategies were reviewed and the construction for shelters started. In 2012, 120 shelters were built for host community households and the camp residents. Further targets were set for 2013. Each shelter was built by a team of 3 people within 1 day. The life span of these shelters was 2-4 years (UNHCR, 2016).

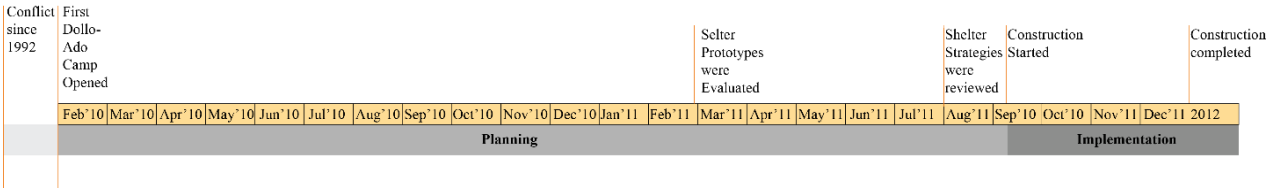


Figure 3.27: Timeline of the project

Source of Information: (UNHCR et al., 2013) (Drawn by the author)

- **Self-Help Construction Process:**

The organization built a workshop and storage area for supplies near the construction sites. Timber was precut at the workshops, bamboo was split, and doors, windows, and roof trusses were prefabricated. To optimize output productivity a well-organized laboratory with effective quality-control systems was required. For productive manufacture, the required workshop and storage area was 1 hectare (10,000m^2). A combination of skilled carpenters and daily labourers worked in the workshops.

The landscape at different sites was different than one another. In some sites, the digging of 60 cm deep holes by hand was fairly easy. In other sites the earth was hard and concrete in the foundations was necessary, which made the construction process difficult. Moreover, the organization faced significant challenges with the splitting of bamboo, due to the 50% shortfall of bamboo at the time had to be fixed.

- **Skills:**

Essential training was provided for skilled labourers involved in building on site. Activities on-site included digging holes for foundations, erecting structures, installing the roofing, lining the walls with bamboo slats and repairing windows and doorways. The training was provided in rendering mud for walls where the mud was available.

Figure 3.28: Shelter for the beneficiaries

Source:(UNHCR, 2016)

4. Strength & Weaknesses:

Following are the strengths and weaknesses of the project according to UNHCR et al. (2013):

- **Strengths:**
  - The process of selecting the design of shelter was transparent and included all stakeholders including camp dwellers.
  - Shelter construction supported refugees and the host community by paying for their jobs. It was estimated that the shelter projects contributed $16,000US a month to the economy of each camp.
- **Weaknesses:**
  - The supply of materials was attempted to be procured jointly but it was not successful.
  - Significantly fewer shelters were constructed than originally expected.

5. Concluding Remark:

The shelter designs in this project were transitional shelter types that were self-built by the refugees themselves. The training on self-help construction techniques helped to develop their skills. Moreover, the prototypes before the implementation phase helped to decide on the

appropriate shelter design. The participation of the refugees in decision-making was also a positive aspect of this project. However, the bamboo mats in the cladding provided the shelter with ventilation but it also needed dust and waterproofing.

3.3.7 Case 7: Shelter for Refugees after the Earthquake in Peru

Project Location: Pisco, Peru.

Crisis: Peru earthquake on August 15, 2007.

Year of Crisis: On August 15, 2007.

Number of Displaced People: Over 48,000 houses destroyed; 45,000 were uninhabitable.

Beneficiaries: 1,900 families in five selected communities.

Source of Information: (UN-Habitat, 2008).

1. Background:

On the 15th August 2007, there was a massive earthquake in Peru, that destroyed over 48,000 houses. An international agency employed a contractor as part of a broader post-earthquake initiative to provide supplies, machines, and professional tradesmen for the prefabrication of 1900 shelters.

2. Shelter Details:

- **Shelter Design:**

The design of the shelter was a single-storied, rectangular wood-framed structure. It had shed roof and the wall cover was made of straight, tongue and groove wood panel. Every panel was about 1 cm thick, and about 10 cm long. The shelter had one door and a wide window (at the front) on one long wall. The roof was a shed style built of about 1 m long and about 1⁄2 cm thick lightweight, corrugated cement plates. The roof panels were long enough to cover the whole distance of the roof. For flooring pre-existing slabs of concrete were used. The idea behind the prefabricated shelter was all the materials in the shelter could be reused later.

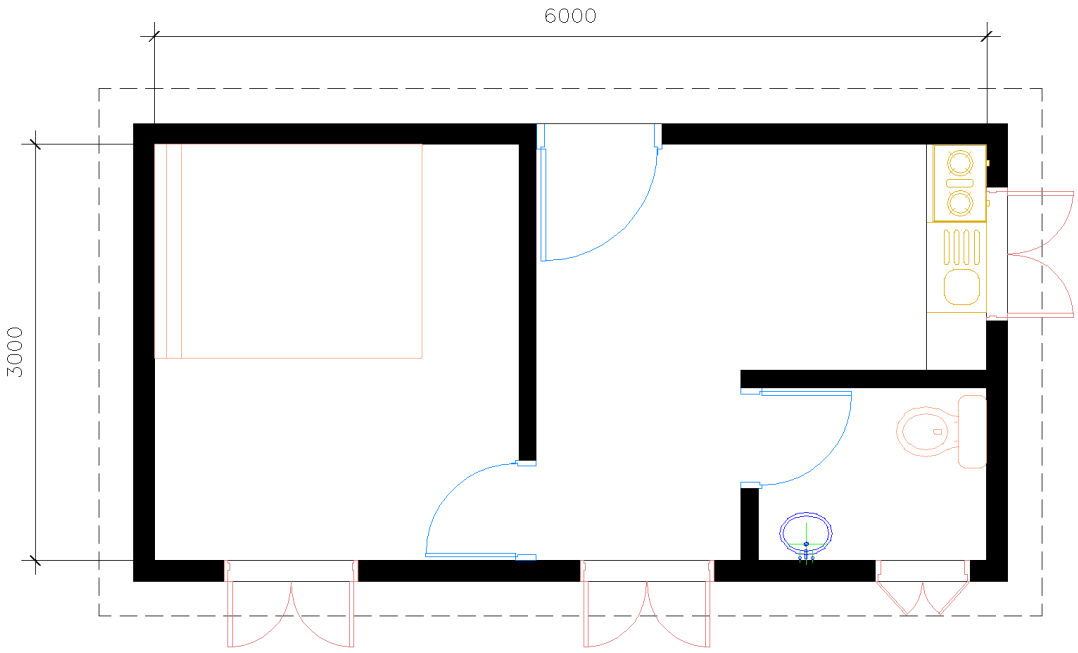


Figure 3.29: Plan of shelter

Source of Information: (UNHCR, 2016) (Drawn by the author)

Figure 3.30: Prefabricated shelter built on the roof of a destroyed house

Source: (UN-Habitat, 2008)

- **Structure & Materials:**

The transportation needs were minimized by the supply of essential raw materials (rough lumber, tongue-and-groove wall sheeting and corrugated iron, cement sheets and nails.) to the construction site. Warehousing was also limited, as non-value-added raw materials took less room than prefabricated materials. The cost of the components was minimized by employing people directly on-site to make them. Everything was prefabricated as required on-site according to measurement. This strategy also offered a 'just-in-time' procurement system. Following are the materials used for the construction of the shelter:

Material Items	**Quantity**
Wood (tongue and groove) 2.48m	68
Wood (tongue and groove) 2.3m	43
Wood (tongue and groove) 42cm	10
Wood (tongue and groove) 32cm	16
Wood (tongue and groove) 1.01m	16
Wood (tongue and groove) 2.48m to 2.30m	70
Wood strips 3cm x 6cm x 3m	2
Wall plates 6cm x 6cm x 2.5m	3
Hinge, steel 2.5"	7
Corrugated roofing 3m x 1m	6 sheets
Instructional manual	1
Plastic tape 1cm x 15cm	8
Screws	3

Table 3.7: Material list in the shelter kit

Source: (UN-Habitat, 2008)

- **Space Analysis:**

The size of the house was 3m X 6m having an area of $18m^2$ (UN-Habitat, 2008).

2. Construction & Implementation

- **Construction time**

The project started two months after the earthquake occurred. The assessment and selection of the beneficiaries by the organization had taken about two months. Then, the construction process began. It took each house about eight hours to build once the prefabricated materials were transported to the site. After 9 months in May 2008, the project was completed (UN-Habitat, 2008).

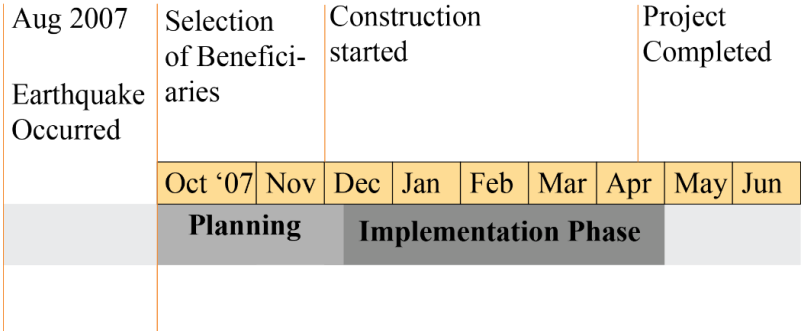


Figure 3.31: Timeline of the project

Source of Information: (UN-Habitat, 2008)(Drawn by author)

- **Self-Help Construction Process**

The organization hired a builder to prepare the prefabrication of 1900 shelters with materials, machinery, tools and trained tradesmen. The contractor was also responsible for training all beneficiaries for shelter assembly but was not responsible for land provision. The manufacturer was able to minimize costs by prefabricating wall panels, window frames and avoiding cutting wood on-site. The beneficiaries were responsible for the assembling of the shelters. The families were also accountable for clearing debris, cleaning the ground and marking out the location of the shelter.

Homeowners transported the products from their 'factory' to their homes. Then, they installed the wall sheeting of the tongue and groove onto the six wall framing panels. Employees

of the company and qualified members of the group then assembled the side frames (two for the sidewalls and four for the front and back walls) with the help of company advisors. Families hammered together the frames and fixed the doors and windows. The staff of the contractor performed monitoring and quality assurance. The contractor had one project manager and one technician whose main responsibility was to supervise and 5 skilled workers for cutting wood. Monitoring was carried out by a team of about 30 volunteers, 15 of them were involved regularly in the field. Among them, five to six worked regularly with the contractor and recruited volunteers from the neighbourhood. The rest of them worked in the community for assisting with registration, property rights and other developing problems.

Figure 3.32: Construction process of the prefabricated shelters

Source: (UN-Habitat, 2008)

- **Skills:**

To build up skills to assemble the shelters, the beneficiaries were trained by the staff of the contractors with necessary guidelines. The only carpentry expertise needed by homeowners was the ability to hammer a nail and follow the instructions for the connections.

4. Strength & Weaknesses:

Following are the strengths and weaknesses of the project determined by the case study of UNHabitat (2008):

- **Strengths:**
  - This project successfully employed a contractor to construct semi-permanent structures for families, addressing manufacturing and logistics challenges as well as many of the risks of a building project.
  - The project was able to respond to recommendations made for structural changes to the shelter design after an assessment early in the process.
- **Weaknesses:**
  - The planning process took a long time that delayed the handover of the shelters to the beneficiaries.

Concluding Remarks:

In this project, the shelter built for the refugees were wood-framed prefabricated shelters. The organizations established small 'factories' to prefabricate parts to minimize material and supply wastage, and associated costs. Before the construction commenced, the organization prepared all the prefabricated wall panel units which made the construction faster and easier for the beneficiaries. Although the prefabrication was done by the contractors, I find this project has the potentials of self-built prefabricated shelter by the refugees themselves.

3.3.8 Case 8: Shelter for Refugees after the Earthquake in Haiti

Project Location: Port au Prince, Haiti.

Crisis: Earthquake.

Year of Crisis: 12, January 2010.

The number of Displaced People: 180,000 houses were damaged.

Beneficiaries: Families with disabled persons.

Source of Information: (UNHCR, IFRC, & UNHabitat, 2012).

1. Background:

The project targeted the displaced persons with disabilities in rural areas of southern Haiti. The project employed a participatory approach to build sustainable shelters. The project had been re-engineered a well-known traditional technique known as clissade, which made it more durable and suitable for mass assembly. The shelters were prefabricated in the workshop and later assembled by the beneficiaries themselves.

2. Shelter Details:

- **Shelter Design:**

Before the earthquake, many Haitian families living in rural areas used to dwell in self-constructed houses. Many were constructed using the clissade, a Haitian technique of weaving palm wood bars to make walls. Later those walls were covered with mud and cement. The roof was covered with corrugated zinc. In general, the clissade houses could resist the earthquake better than the concrete buildings. The injuries to the occupants were not as severe as those caused by the collapse of concrete houses, where much had been damaged due to the earthquake. The shelters were designed and tested to be hurricane, earthquake and flood-resistant by the structural

engineers. It was also designed in a way to provide natural ventilation. Each shelter was elevated from ground level by 30 to 50 cm to prevent water entry in the event of flooding.

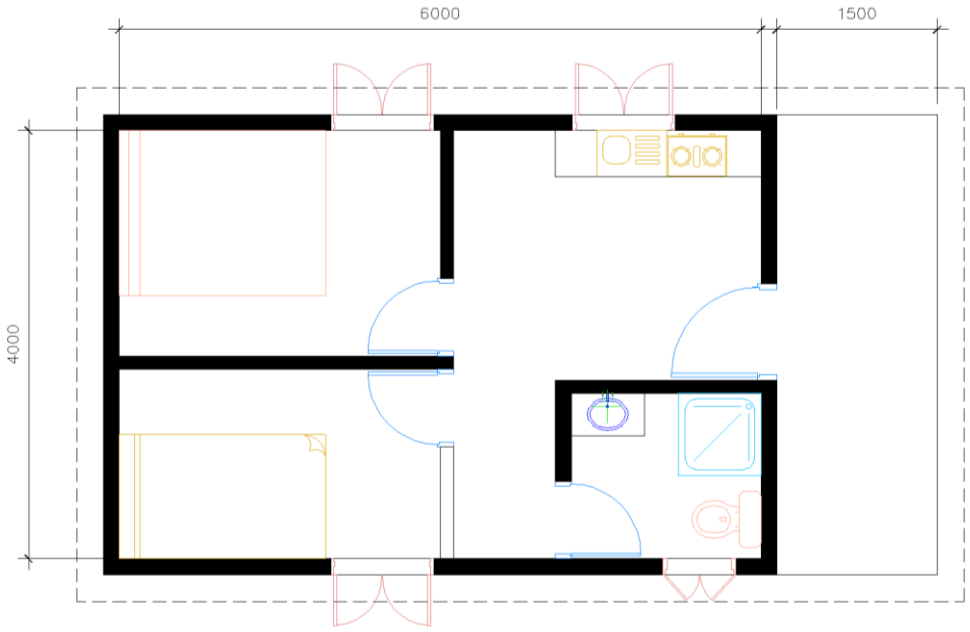


Figure 3.33: Plan of shelter

Source of Information: (UNHCR, IFRC, & UNHabitat, 2012) (Drawn by the author)

Figure 3.34: A completed prefabricated shelter assembled by the beneficiaries

Source: (UNHCR et al., 2012)

- **Structure & Materials:**

The T-shelter was made from pine wood which was treated with heat. Corrugated bituminous sheets were selected for roofing. They were chosen because of their 15-year warranty, thermal properties, and strength. Many of the raw materials were imported to Haiti. For instance, the timber used for construction was pressure-treated pine that was not available in Haiti. Most of them were brought in and then trucked into the Petit Goave workshop. Following are the list of materials used in the shelter construction:

Material Items	**Quantity**
Timber 4"x4"x14’ (50mmx50mmx4.2m)	4 pieces
Pine 2"x4"x14’(50mmx100mmx4.2m)	89 pieces
Pine 1"x4"x14’ (25mmx100mmx4.2m)	23 pieces
Pine 1"x6"x14’(25mmx150mmx4.2m)	3 pieces
Plywood 1/2" (13mm)	3 pieces
Plastic mosquito net 48" (1.2m)	20' (6m)
Wood Glue	0.5l
Corrugated fastener 1"x5" (25mmx125mm)	Unit
Corrugated roof sheets (Onduline)	19 pieces
Ridge (Onduline)	9 pieces
Twisted roofing nails for wood 2 1/2"x9" (64 mmX230mm)	23' (7m)
Nails: 1 ½"-5" (30mm-125mm)	
Coiled strap (Hurricane strap)	15 m
Hinge 4"x4" (100mmx100mm)	1
Hinge 3"x3" (75mmx75mm)	2
Bolt 4", 3"(100mm, 75mm)	2
Wood screw 3½"x10” (89mm X 254mm)	
Cement	18 bags
Sand	6 m^3
Gravel 5/25	4 m^3
Cement blocks	70 pcs

Table 3.8: Material list in the shelter kit.

Source: (UNHCR et al., 2012)

- **Space Analysis:**

There were different sizes of shelters depending on family size and land. There were three different types of shelters having an area of 12m^2, 18m^2 or 24 m^2 with a 6m^2 porch.

2. Construction & Implementation

- **Construction time**

The project started after 5 weeks of the earthquake with a participatory process that lasted for 10 days. Once a site has been identified, it took another 10 days to organize teams and materials to commence construction. After 5 months, in June 2010, the supply chain and workshop were established. Next, the construction of 50 pilot shelters started and within 2 months the project was scaled up. After about 22 months in December 2011, the project completed.

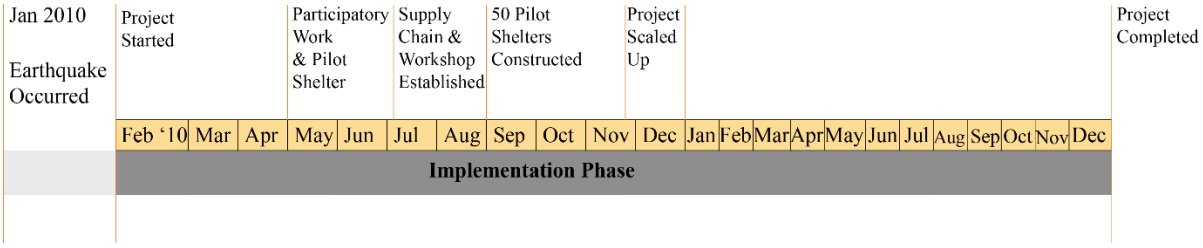


Figure 3.35: Timeline of the project.

Source of Information: (UNHCR et al., 2012)(Drawn by author)

- **Self-Help Construction Process**

In the beginning, the local authority had to select a site for constructing the pilot shelter. The pilot shelter was intended to be used for the community. Hence, it became a clinical center for people with disabilities. The pilot shelter allowed the testing of various technical solutions. For improving the final shelter design and suit it in the budget, several corrections were made to the pilot shelter. The workshop was developed and coordinated with a supply chain manufacturing team. They built about 30 shelters a week with approximately 45 people working inside.

The entire shelter was prefabricated in panels and trusses in the workshop. The pre-assembled components were then transported by trucks or by hand to the site in areas that were difficult to access. The pieces were then bolted together on-site. All the nails and screws (with nuts and bolts attached to the doors, not the nails) were galvanized using a double hot dip. For leading the construction, the organization provided skilled workers. The prefabricated units were assembled on-site by the beneficiaries. The following table 3.9 shows the stages of construction including construction workers and construction time.

Day	Stage	Worker days
1	Ground preparation	2 x technical advisor, 6 x beneficiaries
2	Digging foundatrions	6 x beneficiaries
3	Bolting and fixing columns	1 x chief carpenter 1 x chief mason 6 x beneficiaries 6 x labourers
4	Embankments	6x workers
5	Installation of panels and carpentry	1 x chief carpenter 6 x beneficiaries 3 x workers
6	Paving and drainage	1 x chief mason 6 x beneficiaries 3 x workers
7	Fixing roof windows and doors	1 x chief carpenter 6 x beneficiaries 3 x workers

Table 3.9: Construction stages of the prefabricated shelters.

Source: (UNHCR et al., 2012)

Figure 3.36: Shelters built using traditional clissade technology.

Source: (UNHCR et al., 2012)

- **Skills:**

Although the shelter was prefabricated in pieces in the central workshop, they were sent to the field for assembly by the beneficiaries themselves. Traditionally, the clissade construction is a self-built construction technique in those regions. So, using this technique, the beneficiaries could utilize their previously developed skills for the construction of their houses.

4. Other Amenities:

A sanitation aspect included in the programme provided access to latrines or an adapted sanitation solution. Both the shelters and the sanitation component were customized to the need of the disabled beneficiaries.

4. Strength & Weaknesses:

Following are the strengths and weaknesses of the project determined by UNHCR et al. (2012):

- **Strengths:**
  - The project has paid attention to disabled beneficiaries. Every shelter and its sanitation facilities were tailored to address the disability. It was followed by a rehabilitation programme for people with disabilities to improve their mobility.
  - The project was conducted with students from a youth vocational training centre. This aimed at improving their skills and ability to enter the labor market.
- **Weaknesses:**
  - The selection of beneficiaries relied on a system of referrals from other organizations. It was proved to be very time-consuming and resource-consuming to obtain the referred beneficiaries in this manner.

Concluding Remarks:

Cultural needs were taken into consideration while designing the shelters for this project. But the timber used in the project was not available in that area. Therefore, the procurement of materials took a long time and caused a delay in project delivery. However, prefabrication of the wall panels was done by the skilled workers and the beneficiaries were involved in the assembly of the shelters, which minimized construction cost and reduced construction time. Besides, the construction of the pilot shelters helped to solve many problems that could arise during the implementation phase.

3.3.9 Case 9: Shelter for Vulnerable Households in Gaza, Palestine

Project Location: Gaza, Palestine.

Crisis: Israel-Hamas Conflict.

Year of Crisis: July-August 2014

Number of Displaced People: 974,700 individuals.

Beneficiaries: 484 households received 470 Shelters (244 small, 98 medium, 13 large, 14 two stories and 1 pilot) and 235 conditional cash grants.

Source of Information: (Global Shelter Cluster, 2017).

1. Background:

Fifty-two days of heavy fighting between Israel and Hamas in July and August 2014 caused significant losses of lives and damages to infrastructure all over Gaza. During the fight, Israeli forces ordered Gaza 's population to evacuate within a 3km-wide area. This region was subjected to bombing, and then land forces caused further residential and property damage. Many people fled to live with family and friends, while some, sought shelter in communal centres, mostly in schools. Before the conflict, houses were built with reinforced concrete and concrete blocks and had access to public services such as water and electricity. The conflict damaged and destroyed many houses. Even after the war, the majority of those affected lived in about 19 community centres, as well as in rental housing and with host families.

2. Shelter Details:

- **Shelter Design:**

Firstly, the target populations had been told about the shelter project and households impacted were encouraged to enroll. Beneficiaries were selected based on some criteria. Then, a set of

options was offered depending on the condition of the houses. The following figure shows the options for shelters:

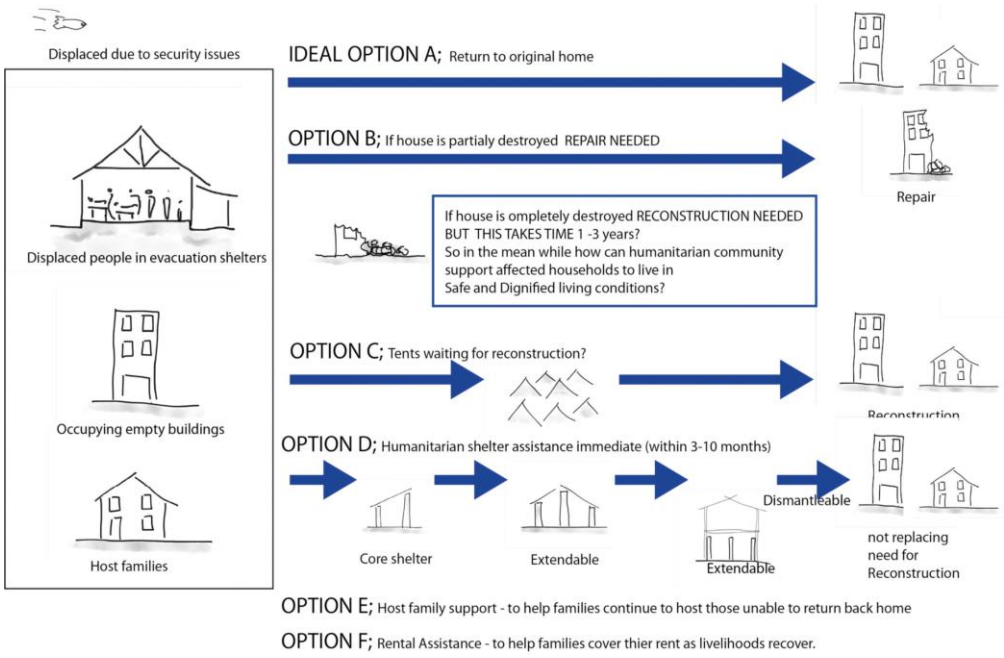


Figure 3.37: Menu of shelter options for the refugees.

Source: (Global Shelter Cluster, 2017)

Shelters were designed in different sizes to match the various family groups. The shelters included a living or bedroom area, a bathroom, a kitchen and an open veranda that could be used by adding walls to extend the covered space.

Figure 3.38: Shelters made by the communities

Source: (Global Shelter Cluster, 2017)

The shelter was specifically planned to be upgraded, expanded, and re-purposed after an estimated five-year life period. The L-shape architecture with the veranda made it possible for households to create perimeter walls using timber posts and sheeting material, extend the living room and give people more privacy and freedom of movement. There was also scope for modification, such as electrical installation, the addition of room dividers, external wall construction, ceiling covering, landscaping around the shelter, and several other decorative and functional enhancements.

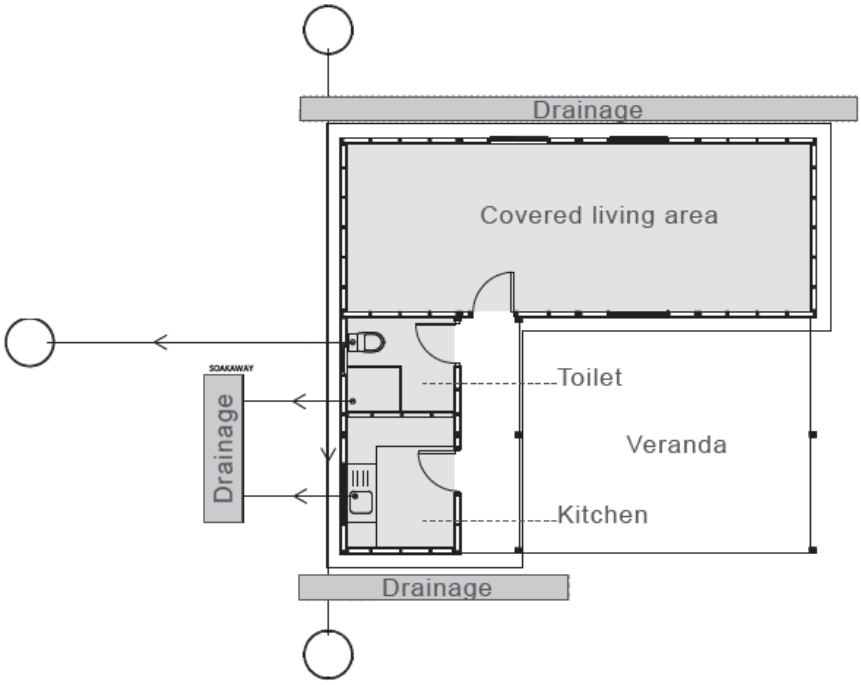


Figure 3.39: Plan of shelter.

Source: (Global Shelter Cluster, 2017)

- **Structure & Materials:**

The shelters were made of wood structure and façade. They were built on foundations and plywood floors. The following are the list of materials in the shelter kits.

Main Framework	White Wood
Floor	Plywood 17mm thickness
External Cladding	Wood (Tongue and groove)
Internal Cladding	Normal Gypsum Board
Roof	Corrugated Galvanized Iron (CGI)
Kitchen and Bathroom	Vinyl
Door and Window	Aluminum
Tarpaulin	
Nails and screws	
Paint	
Sink, toilet bowl	

Table 3.10: Material list in the shelter kit

Source: (Global Shelter Cluster, 2017)

- **Space Analysis:**

Each shelter consisted of three rooms; a bedroom, a kitchen and a bathroom-designed to meet cultural needs and expectations, particularly women's privacy and dignity. The size of shelters varied from 44m² for up to 7 persons, 53m² for up to 10 persons, 62m² for up to 11 or more and 80m^2 for two-story shelter for extended families. That resulted in a density of over 5m^2 per person.

- **Cost:**

The average material cost per household was $4,600US and total project cost per household was $6,600US (average).

2. Construction & Implementation

- **Construction time**

The project planning started in September 2014 and prolonged until October 2014. From November 2014, the implementation phase started. There were four main steps to implement the project:

1. Public announcement of the project

2. Visit homes for verification

After the public announcement of the project, the target beneficiaries were selected based on a set of criteria. Following are some of the criteria:

- Completely damaged or uninhabitable house

- Enough space on the plot to build a shelter

- The land is owned by the family

After verification of the information provided by the community, the beneficiaries were selected.

3. Selection of the most vulnerable households

The selection then proceeded on a case-by-case basis, using both pre-existing and conflict-related vulnerability criteria; which were developed by the organization and the local communities. This included families with disabled people, small children, families headed by women and households with low incomes.

4. Completion of shelter construction and inspection by the staff.

The total implementation process took 1 year 5 months including the selection of the beneficiaries, verification and construction of the shelters.

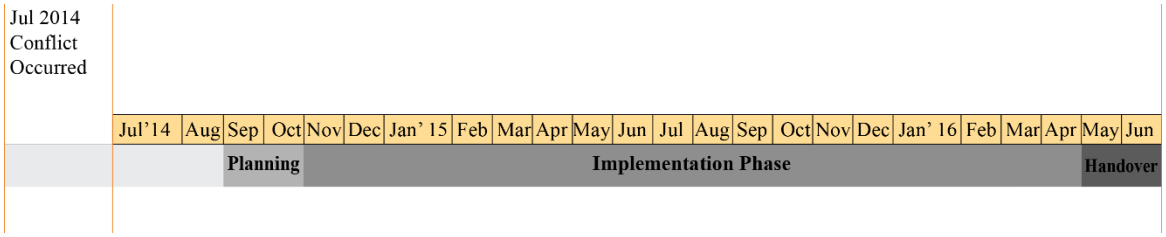


Figure 3.40: Timeline of the project

Source of Information: (Global Shelter Cluster, 2017)(Drawn by the author)

- **Self-Help Construction Process**

The organization and a local partner designed the shelter through a series of workshops and neighbourhood meetings before the selection of beneficiaries. A pilot building was designed for the community and a technical assessment was conducted to decide on the most effective, secure and culturally acceptable construction process. Extensive consultation sessions with community leaders verified the decided approach.

The organization decided to use a wood-frame construction because of the embargo on other building materials other than timber. The company then hired a contractor having timber building expertise, to help with the project's sourcing and execution. Timber construction was not usual in Gaza, so the wooden panels were prefabricated off-site. Due to the time shortage and for quality assurance, the installation was performed by the contractor. This was chosen through a competitive tender process. The timber frames were made in a factory and transported to the site by truck. When erected, the materials for the cladding, flooring, and roofing were supplied and fitted to the frames. The house was installed by other construction technicians, such as electricians, plumbers, and dry-lining wall fitters. A mixture of on-site and off-site working methods permitted higher speed, greater productivity and better quality control.

Figure 3.41: Construction Process of the shelters

Source:(Global Shelter Cluster, 2017)

Although the organization supplied the houses, it was the duty of the families to construct or connect to a septic tank, as well as other enhancements. A user manual for the buildings was created, and all families were provided with it. The contractor was expected to supervise his staff, while the organization's field engineers oversaw the works and liaised with households and the wider population. The organization also supported monitoring and providing technical assistance for design, construction and financial administration. 235 households were also given a conditional cash grant of $500US to repair their shelters. This type of assistance provided the households with the right to choose, build and upgrade to shelters, such as false ceilings, wall partitions, electrical network, courtyard CGI roofing, sinks, toilets, toilet tiling, kitchen shelving, window screens and water tank stands.

- **Skills:**

Necessary training was given to reduce hazards associated with unexploded war objects and even radioactive waste, such as asbestos. The timber frame construction was done by the skilled workers hired by the organization. The beneficiaries were responsible for the construction of the septic tank and connect the plumbing fixtures. They were provided with a manual to develop the skills needed.

Figure 3.42: Experienced workers built the structure as timber construction was new in the country
Source:(Global Shelter Cluster, 2017)

4. Strength & Weaknesses:

Following are the strength and weaknesses of the project according to the case study by Global Shelter Cluster (2017):

- **Strengths:**
  - The use of timber offered a permanent solution to housing needs. Unlike other shelter solutions this offered maximum space and thermal comfort.
  - Beneficiaries were provided with the preference through the cash grants for developing shelter.
  - Community people and the selected households' strong participation in the project (including collection and construction) minimized construction time.
  - A variety of shelter sizes ensured equal accommodation for a variety of family sizes.
- **Weaknesses:**
  - During construction, problems with the design became evident, such as the limited interior height.

Concluding Remarks:

In this project, the sizes of shelters were varied according to the sizes of the households, which ensured equal accommodation for the different family sizes. Although the construction of the prefabricated wall units and their assembly were done by the local contractors, in my point of view, this prefabricated shelter has the possibilities to be built by the displaced people themselves. Moreover, the construction of the pilot shelter before the implementation phase solved many unwanted challenges during the construction phase.

3.3.10 Case 10: Shelter for Refugees after Cyclone in Fiji

Project Location: Coastal areas of Western Division, Fiji.

Crisis: Tropical Cyclone.

Year of Crisis: 17th to 19th December 2012.

Number of Displaced People: Over 40,000 people affected in the formal sector and over 800 displaced in the informal sector.

Beneficiaries: 254 households (approximately 1,250 people).

Source of Information: (UNHCR et al., 2014).

1. Background:

After the cyclone occurred, many families started living with neighbours or family members whose homes had not been destroyed. Also, many continued to live under leaked roofing iron, tarpaulins and rusty sheets for up to a year after the cyclone had hit. The Shelter Cluster was formed as a direct response to Tropical Cyclone Evan in Fiji in January 2013. A national policy accepted that the government would address the needs of the 8,500 houses destroyed in the formal sector (homes constructed on land officially designated as residential and was according to building code regulations) while the Shelter Cluster Organization will address the informal sector needs (informal houses without access to utilities).

2. Shelter Details:

- **Shelter Design:**

Although the structures could not be classified as a completely safe refugee shelter, the transitional shelters were designed to withstand the wind load of a Category Four cyclone (175 km/hour winds), with all bottom plates fastened to the bearers and all rafters fastened to top plates. CGI roofing was secured on each crest using cyclone-twisted nails with neoprene washers. Each

shelter on a rammed-earth base with treated pine pole foundations was raised 300 mm from the ground. The most important factor in determining whether the T-shelter design could be used during a disaster's emergency or recovery phase was depended on the availability of materials, especially at a remote location like Fiji. This project is probably among one of the few prefabricated shelter types throughout the world with such a high degree of structural integrity.

The T-shelters were designed to be portable and could be dismantled in less than a day, using very basic tools. It was not possible to move even the pine posts which were embedded in concrete. This meant that beneficiaries who might be forced to move away from informal areas could take their homes with them.

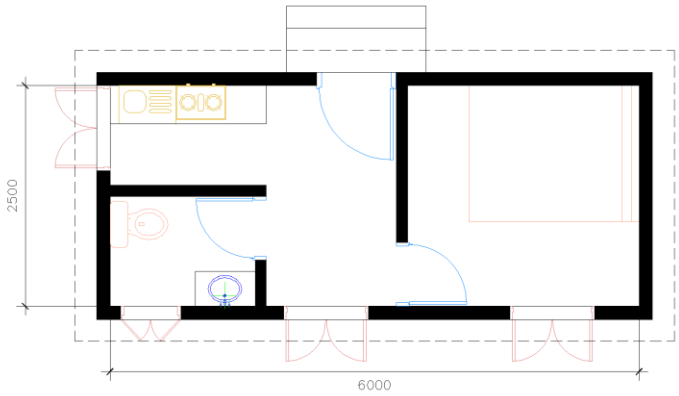


Figure 3.43: Plan of shelter

Source of Information: (UNHCR et al., 2014) Drawn by the author

Figure 3.44: After construction of the prefabricated shelters by the beneficiaries.

Source: (UNHCR et al., 2014)

- **Structure & Materials:**

Although the structure was initially designed with a rigid wall and floor covering, the government said the use of permanent wall and floor covering would ensure a permanent dwelling. Hence, tarpaulin walls were used, and floors were designed to be constructed of compact raised earth. Cluster leaders realized that homeowners would prefer to use permanent wall lining as soon as they could afford it. So, the structural frame was built to withstand extreme cyclonic wind loads in anticipation of the eventual replacement of the tarpaulin with durable material. Many families chose not to have the tarpaulin covering because they preferred to use roofing iron that they had saved from their damaged homes as a more permanent solution. Following are the list of materials in the shelter kit:

Material Items	**Quantity**
Pine Post (1m x 15cm diameter)	Embed 60cm in the ground, fill with concrete.
Bearers (15cm x 5cm)	Nail & strap to post.
Bottom plate (10cm x 5cm)	Nail to top of the bearer.
Wall studs (10cm x 5cm)	Nail & strap to top & bottom plate
Noggins (10cm x 5cm)	
Top plate (10cm x 5cm)	Strap to stud
Rafter (15cm x 5cm)	Strap to top plate
Purlin (7.5cm x 5cm)	Strap to top plate
Facia (20cm x 2.5cm)	Attach to gutter end only
Strapping	
CGI sheet	Nail to purlins with galv. twisted roofing nails
Canvas/tarp wall lining (2m x 17m)	All edges fixed with 2.5x1cm battens and roofing nails
Flashing, gutter & downpipe (7.5cm diameter)	

Table 3.11: Material list in the shelter kit

Source: (UNHCR et al., 2014)

CGI sheets, posts, and strapping were obtained locally but the wood was in such short supply due to the catastrophe that seventeen wood containers were needed to be shipped. This contributed to the delay in project delivery.

- **Space Analysis:**

The size of each shelter was 6m X 3.5m, having an area of 21m^2.

- **Cost:**

Materials and labour cost per shelter was 3,200 Fijian dollars (FJD) ($1,800US) and the total project cost per shelter was 5,300 FJD ($2,900US).

2. Construction & Implementation

- **Construction time**

The cyclone hit Fiji on 17th to 19th December 2012. In March 2013, Memorandum of Understanding was signed by the government allowing the construction of shelters for the displaced people, specifying the condition that the structure had to be non-permanent. From March to June 2013, the beneficiaries were selected, and local materials were procured. In September, the list of beneficiaries was confirmed, and the prefabrication of the shelter units started. Within December 2013, the construction of shelters for phase 1 was completed. In January 2014, funding for phase 2 was secured. It took two months to procure local materials and in May the beneficiaries for the second phase were confirmed. In June and July, prefabrication and construction of shelters were done and in August the project was completed.

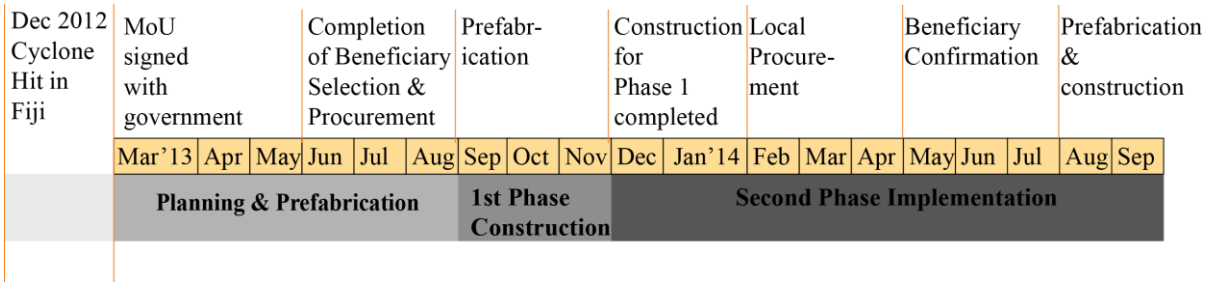


Figure 3.45: Timeline of the project

Source of Information: (UNHCR et al., 2012)(Drawn by author)

- **Self-Help Construction Process**

Procurement and construction were the responsibility of the organization, with families contributing in terms of labour. Once selected, beneficiaries within the project became "home partners." These involved beneficiaries agreeing to contribute to shelter building ("sweat equity") and undergoing basic construction training. Family members became part of the construction team from beginning to end.

Four teams were formed, each comprising four technical persons. The shelters were built in batches of three or four at a time, with each structure taking three days to complete. A temporary warehouse was set up on-site using supplies that would later be used for the last T-shelters. In the depot, two teams worked to make seven sets of wall frames a day.

Figure 3.46: Construction process during a prefabricated shelter

Source: (UNHCR et al., 2014)

- **Skills:**

Before the construction process started, beneficiaries were trained in construction techniques which improved their knowledge on safe building practices. They were also provided with a construction diagram describing the step by step processes of construction methods. Figure 3.58 shows the diagram for the self-built construction by the project beneficiaries.

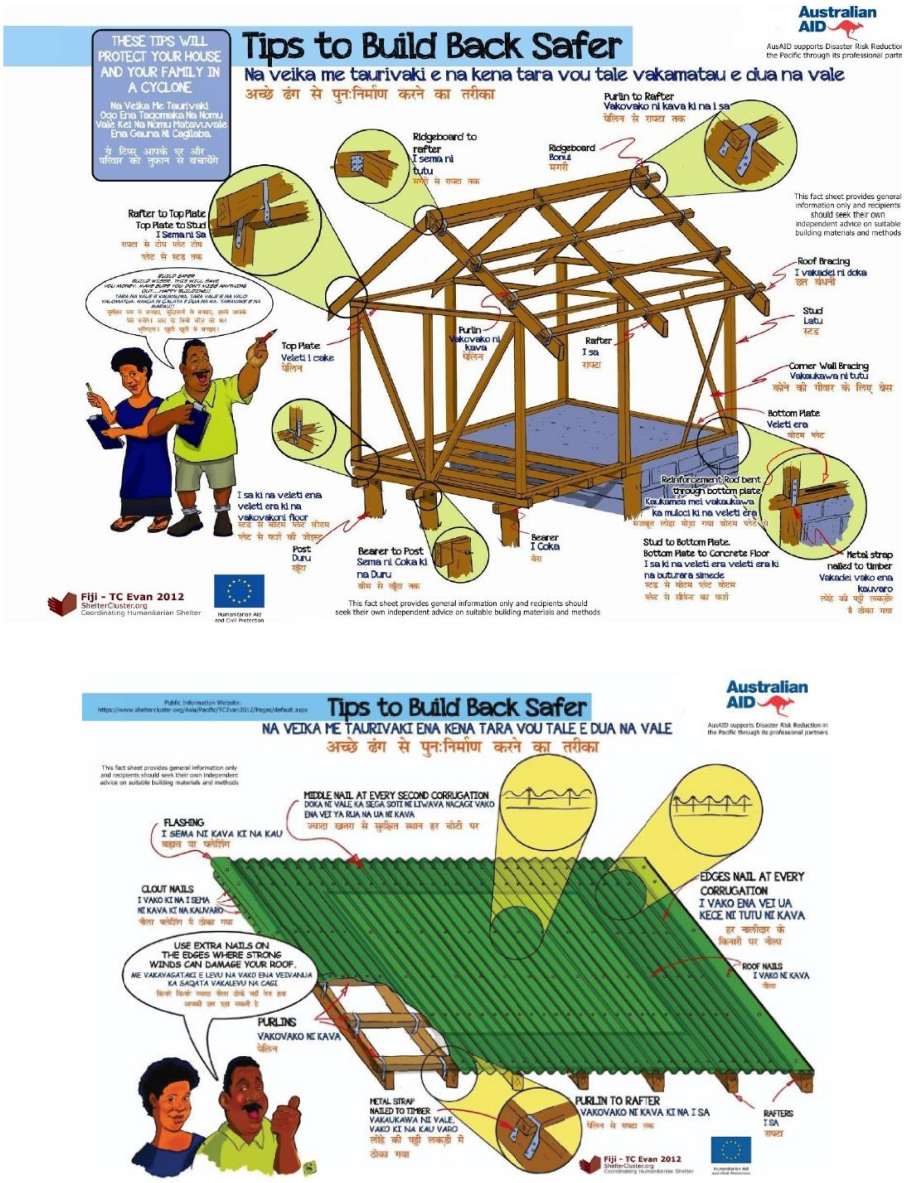


Figure 3.47: A diagram showing the construction details.

Source: (UNHCR et al., 2014)

4. Strength & Weaknesses:

Following are the strengths and weaknesses of the project determined by UNHCR et al. (2014):

- **Strengths:**
  - The wall panels, stairs, doors and windows were prefabricated which significantly speed up the construction process.
  - The displaced people were trained in basic building skills regarding safe building practices.
- **Weaknesses:**
  - The project started after three months due to the delay of change in shelter strategy by the governmental organizations.

Concluding Remarks:

In the design process, disaster risk analysis was done, and the prefabricated shelters were designed to withstand category 4 cyclone. Another reason behind the prefabricated shelters was to make the structures portable which could be moved from one place to another by the beneficiaries when needed. The prefabricated structures were assembled by the beneficiaries on site. The training and the manuals showing the step by step guidelines eased the construction process for them.

3.4 Final Observation:

All the case studies analyzed in this work are designed and the construction works are supervised by the government or non-profit organizations. All the ten case studies have pros and cons that have an impact on the dwellers' physical, mental comfort, privacy, cost, construction time and process of the shelters for the refugees.

It is observed that for designing the optimum size of shelter for the displaced families, it is necessary to design a variety of shelters according to household sizes. Based on the cost analysis in different projects, it is also evident that using local and traditional materials minimized the cost of materials and construction. Moreover, the beneficiaries can build the houses themselves easily if the materials and the construction types are familiar to them. In most of the cases, for self-help construction of the shelter units, training and instructions guidelines were provided to the project beneficiaries before the construction commenced.

Finally, regarding the shelter design, the designers should consider the permanence of the structure and fast construction process by the beneficiaries. Considering all the criteria, the prefabricated panel was a good option among the cases described. Additionally, by utilizing prefabricated shelter units many projects have minimized the construction time and delivered projects on-time.

Chapter 4: Design Guidelines

4.1 Introduction

The concept of self-help shelter construction is a common and effective method mainly used for affordable homes. Because of its many advantages, self-help construction is used not only for the refugees but also for the internally displaced people due to the environmental crisis. It has the potential to save time, money and create a sense of ownership.

While designing the shelter and master plan for refugee housing, designers need to consider many factors ranging from the permanence of the shelters to adaptabilities. Also, there are other factors associated with it. In this chapter, based on the analysis of case studies and literature review described in the previous chapters, the guidelines needed for designing refugee housing and self-help construction are discussed. This chapter also emphasizes the decision-making process during the planning period. Finally, comprehensive design guidelines are suggested for self-help refugees' shelter for the Rohingyas living in Bangladesh.

4.2 Summary of Case Studies

In all the cases described in Chapter 3, there are both advantages and disadvantages. The following table summarizes ten case studies to understand the pros and the cons, common points and specialties of self-help construction.

Cases	Project Image	Structure Type	Shelter Area Sqm	Cost Per Shelter USD	Construction Time		Construction Process	Skills
					Planning	Implementation		
Democratic Republic of Congo		Mud-brick structure with a thatched roof	20	140	3 months	5 months	Self- help construction by the refugees	Training & Workshops provided
Iraq		Steel tube structure with prefabricated wall panels and roof	22.5	5,500	7 months	9 months	Self- help construction by the displaced people	Training provided to build up construction skills.
Myanmar		Myaw timber posts structure with CGI roof sheets, bamboo mat for wall cover and GI plain	124.7 m^2 for 8 families each room 15.6 $m^{2.}$	4800 for each shelter, each room 600.		First phase construction- 7 months, second phase construction- 4 months,	Self- help construction by the displaced people	Skilled labourers within the community were used.

		sheets for ridging				third phase construction- 6 months.		
Tierkidi Camp, Ethiopia		Traditional wooden eucalyptus structure finished with bamboo matting or grass-thatch for mud wall	17.6	604	1 month	First phase construction-4 months, second phase construction- 7 months	Self- help construction by the beneficiaries	Traditional construction techniques were used to use the skills of the workers in the community
South Sudan		Timber structure, with prefabricated	15	366	2 and a half months	First phase construction-3 and half months, second phase construction- 10 months	Prefabricated by paid workers, construction and installation by the beneficiaries themselves	Training provided to develop construction skills.
Dollo Ado Camp, Ethiopia		Post-and-beam eucalyptus structure with bamboo split wall cladding and corrugated iron sheet roof	21	525	1 year and 7 months	4 months	Prefabrication of the timber structures and installation were done by the beneficiaries	Training provided to develop construction skills

Peru		Prefabricated wood frame structure with wood panel wall covers and corrugated sheet roof	18		2 and a half months	4 and a half months	Prefabrication was done by the contractors and the assembly was done by the beneficiaries	Training provided to develop the skills for assembling the house
Haiti		Prefabricated pine wood structure with corrugated bituminous roof sheets and	4 different shelter sizes: 12, 18, 24		10 months	1 year and 1 month	Prefabrication & assembly was done by the beneficiaries	Already developed skilled workers were used for construction
Gaza, Palestine		Prefabricated wood frame structure with CGI roof	4 different shelter sizes: 44, 53, 62 and 80.	4,600	2 months	1 year and 6 months	Prefabrication & assembly was done by the contractors	Training was provided to the beneficiaries for construction of the septic tank
Fiji		Prefabricated wood frame structure with CGI roof	21	1,800	6 months	First phase construction-3 months, second phase construction-10 months	Prefabrication was done by the skilled workers and the assembly was done by the beneficiaries	Beneficiaries were trained in construction techniques

Table 4.1: Summary of case studies

Source: Designed by the author

4.3 Planning & Decision-Making Process

When conflict happens in a country due to civil war or other political reasons, it needs immediate response to provide shelters for the displaced people. From the case studies, it is evident that it took a lot of time in planning and making decisions regarding the design of shelters and site planning. For some of the cases described in Chapter 3, the planning and decision-making process took more time than the construction of shelters. Therefore, the planners, architects, designers and engineers should follow an integrated design process to house the refugees on an immediate basis. Furthermore, the designers need to establish clear goals and consider a set of criteria to develop a creative and effective solution for the long-term stability and sustainability of the shelters. Apart from these, during the planning process, the designers need to include the displaced community for understanding their family sizes, way of life, needs and challenges they face in the camp. Humanitarian organizations that are responsible for ensuring the well-being of the refugees can conduct stakeholders meeting among the design team, community leaders and the stakeholders to discuss their needs, issues and concerns regarding their shelters. Additionally, the organizations may consider developing some metrics to measure success after constructing the prototype shelters for the refugees. In the project of shelter for refugees in Dollo Ado Camp, Ethiopia (case study 6), the construction of the pilot shelters helped to explore effective solutions (UNHCR, IFRC, & UNHabitat, 2013). By comparing the metrics and goals achieved in the pilot shelters, new goals can be set, and the final design decision can be taken accordingly.

The following flow chart shows the steps to be followed to design housing for refugees for self-help construction:

Steps for Designing Self- Help Housing for the Refugees

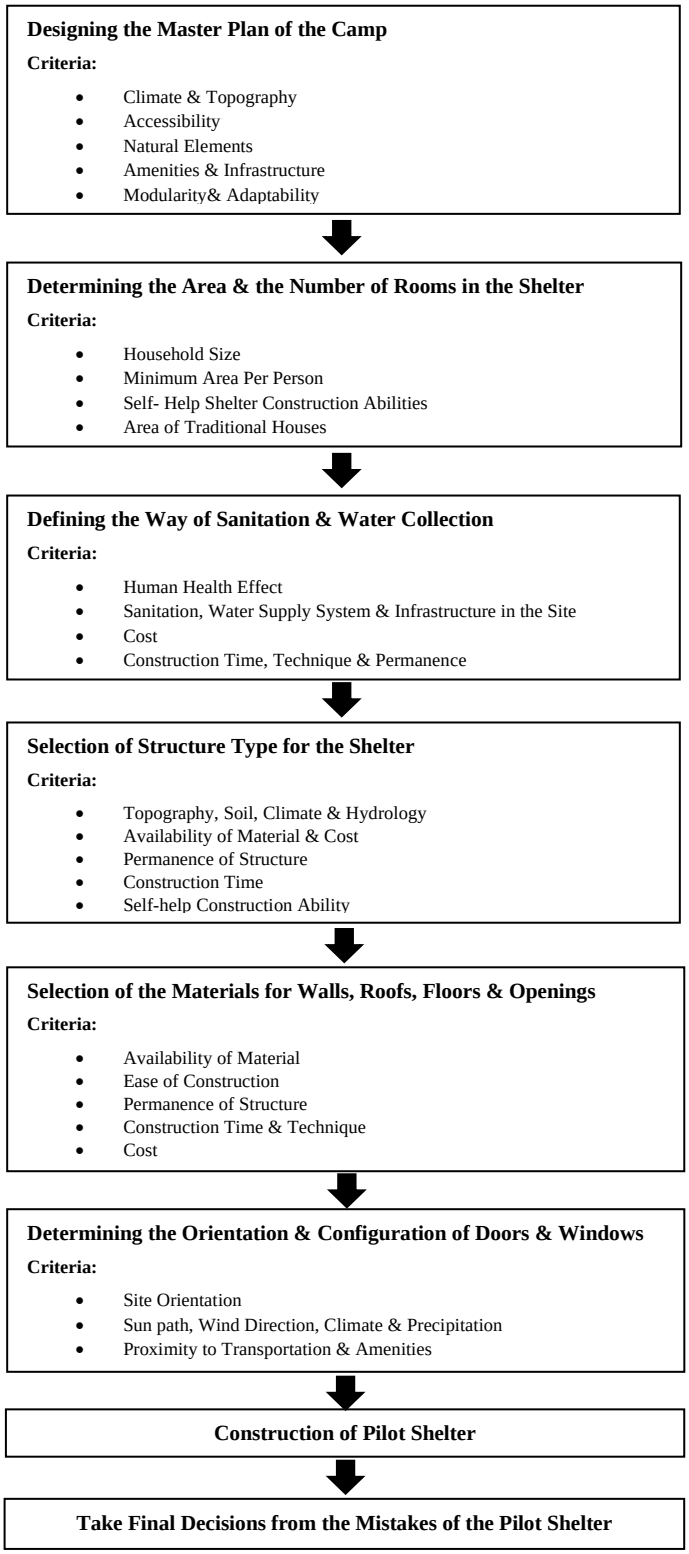


Figure 4.1: Steps showing the planning and decision-making process

Source: Designed by the author

4.4 Guidelines for Self – Help Refugee Housing:

It is important to consider the following recommendations while designing housing for the refugees, especially for the self-help construction by the beneficiaries themselves. Though the design guidelines are mainly focused on the context of Rohingya refugees in Bangladesh, the ideas can be transformed for other refugees in different circumstances in different countries.

4.4.1 Master Planning of the Camp

After any conflict, the first responsibility of the shelter organizations is to make the overall site plan of the camp. First, they need to count the number of beneficiaries, their household size, number of children and elderly people in the family. Then, they can start designing the masterplan considering the following points:

- **Climate and Topography:**

  Climate and topography of the region should be considered first for site planning. As the existing camps for Rohingya refugees are situated in the hilly region of Cox's Bazar, the designers should consider the contour lines and height. Also, as the site is prone to cyclones and landslides, the site plan should be designed in a way to prevent disaster risks in the rainy season. Moreover, for master planning of the refugee housing in other circumstances, the designers need to focus on the climate, topographical features and passive design considerations (sun path direction, wind direction and precipitation).

- **Accessibility:**

  The camp should be accessible to roads and the shelters should be connected with the tertiary road network to the secondary and then primary roads. It is also necessary to provide emergency vehicle access in the camp.

- **Natural Elements:**

  The master plan of the site should preserve the existing natural element, such as trees, water bodies, hills, flora and fauna. Although in Bangladesh trees have been cut abundantly for refugee settlement in many hilly areas, the future design should preserve it. Moreover, it is necessary to design the housing with natural features, ground cover and vegetation.

- **Amenities and Infrastructure**

  As the Rohingya refugees are and will be living in Bangladesh for years, it is required to design facilities and amenities for their long time stay. The amenities necessary for their sustainable living conditions are clinics or health care, schools, place of worship, community gathering area, markets and commercial areas. The master planning should distribute the amenities and sub amenities (such as small shops) within the camp. Following are the standards for the amenities and infrastructure according to UNHCR (United Nations High Commissioner for Refugees, 2007):

1 water tap	per	1 community (80 – 100 persons)
1 latrine	per	1 family (6 – 10 persons)
1 health centre	per	1 site (20,000 persons)
1 referral hospital	per	10 sites (200,000 persons)
1 school block	per	1 sector (5,000 persons)
4 distribution points	per	1 site (20,000 persons)
1 market	per	1 site (20,000 persons)
1 feeding centre	per	1 site (20,000 persons)
2 refuse drums	per	1 community (80 – 100 persons)

Table 4.2: Facilities necessary within a refugee camp.
Source: (United Nations High Commissioner for Refugees, 2007)

- **Modularity and Provision for Future Extension:**

  Modular masterplan denotes, using a modular grid pattern while designing a site plan of any large-scale project. The masterplan of the refugee camp can follow a modular grid pattern to minimize waste of material and allow future adaptability. It also helps to keep provision for future expansion of the camps. Therefore, for master planning of Rohingya refugee camps or in other contexts, this can ensure sustainability, adaptability and thereby enhance the quality of life within the camp. Figure 4.2 below shows an example of the modular masterplan of a refugee camp:

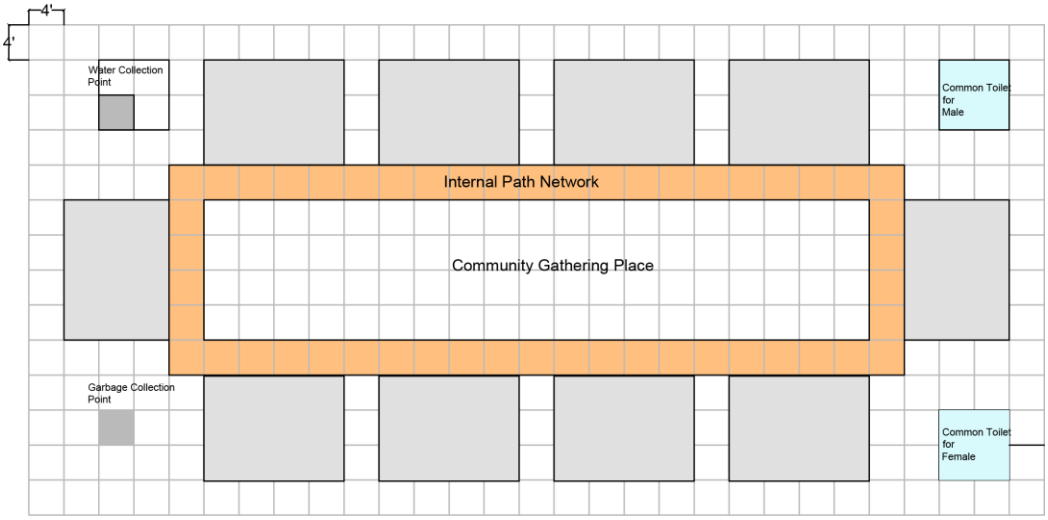


Figure 4.2: Modular camp master planning

Source: Designed by the author

4.4.2 Selection of Structure Type

After a crisis, it is very significant to build the structure within a very short period on an immediate basis, at the same time making it usable for the long term. Considering these criteria, a prefabricated shelter structure can be a very good option for the refugee shelters, even for the Rohingya refugees. Furthermore, it makes the self-help construction process easier and minimizes waste of material. Additionally, in the cases where shelter kits are needed to be transported by

UNHCR or other humanitarian organizations due to the emergency needs in the conflict or disaster zone, prefabricated shelter kits could be a viable option because of its easy transportability and convenient assembly process within less time.

Figure 4.3: A prefabricated refugee shelter in Gaza assembled by the beneficiaries themselves.
Source: (Global Shelter Cluster, 2017)

4.4.3 Size of the Shelter

It is recommended to determine the size of the shelter based on the household size of the refugee families. The shelter organization should have a survey on the number of people, the number of children in the family and their age group. The interior area of the shelters should be determined considering the minimum area per person and household sizes of the refugee families. According to the UNHCR Camp Planning Standard, the minimum area per person for the refugee shelters should be $30m^2$ per person (excluding garden area) (The UN Refugee Agency, 2019).

For the long term stay for the Rohingyas and refugees in other countries, the adaptability of the shelters is a very important issue. Hence, modular shelter design can be used as it allows future adaptability and minimizes material waste. Also, for the prefabricated shelter construction, it is highly recommended to follow modularity in the shelter design. The following figure shows how modular grid pattern can be utilized to design the interior spaces of the shelters:

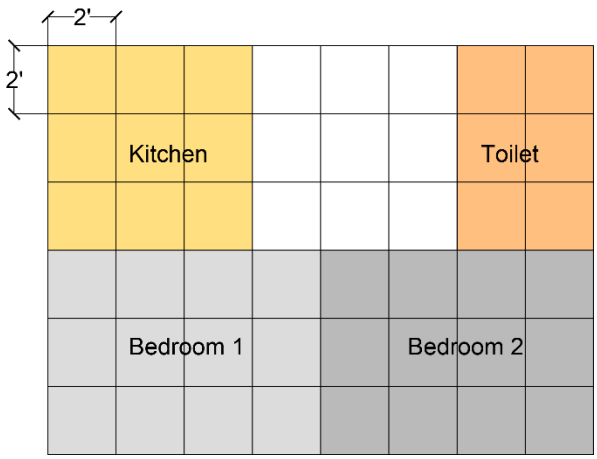


Figure 4.4: Modular design of the shelters

Source: Designed by the author

4.4.4 Selection of Structure & Exterior Material

For any type of refugee housing including Rohingya refugees, the major criteria for selecting materials for the structure and exterior envelope are durability, construction time, availability and cost of the material. Also, for self-help construction, the material should have the compatibility to be handled by the refugees themselves to avoid unwanted injuries.

Figure 4.5: A prefabricated wood shelter for refugees in Iraq.

Source: (Global Shelter Cluster, 2017)

In many cases, after the conflict, the shelter kits are transported to the conflict area by the UNHCR or other agencies. Therefore, the materials that are easily transportable in the container should be used. Considering these criteria, wood or timber gives the ability to transport without

any hassle at the same time ensuring durability and protection for a longer period (Figure 4.5). However, if the materials are collected by contractors from the surrounding markets in Cox's Bazar, bamboo is a good solution for the Rohingya refugees' shelters for self-help construction (Figure 4.6). Additionally, prefabrication of the shelter materials according to design can ease the self-help construction process and reduce construction time.

Figure 4.6: A bamboo shelter in Rohingya refugee camp in Bangladesh
Image retrieved from: https://www.globalcompactrefugees.org/article/building-durable-bamboo-shelters-coxs-bazar

4.4.5 Selection of Interior Materials

While selecting materials for the interior, such as for walls, floors, doors and windows; prior attention should be given to durability, protection from the adverse climate, construction time and availability. Also, the materials should be prefabricated in the workshop for the ease of construction. In Cox's Bazar, bamboo framed door and windows and mud floor are available interior materials. Moreover, if the shelter kits are transported by the organization, prefabricated wood floors, timber-framed doors and windows are sustainable materials for the immediate constructions ensuring the permanence of the structure (Figure 4.7).

Figure 4.7: Prefabricated wood panels used for the interior of a refugee shelter.

Image retrieved from:

https://images.adsttc.com/media/images/5016/0457/28ba/0d15/9800/06fd/slideshow/stringio.jpg?1414495023

4.4.6 Sanitation & Water Collection

The camp design should have access to water supply and toilets. In many refugee camps including the existing Rohingya refugee camp, there are common water supply points. However, while designing it should be kept in mind that the water collection points must be within the accessible distance and sufficient enough considering the number of refugees.

For the sanitation system for the refugees' Pod toilets are an easy solution for self-help construction due to its easy and quick installation process. These toilets can also be transferred easily and they solve many of the existing problems that the Rohingya refugees are facing in the existing camp; such as hygiene issues, inaccessibility, inefficient and faulty fixtures.

Figure 4.8: A typical POD toilet.
Image retrieved from: https://ilcaustralia.org.au/products/5393?search_tree=137

4.4.7 Sources of Energy

Renewable energy sources are very sustainable sources of energy for the refugee camps. In many refugee camps around the globe including Rohingya camps, renewable power is used for electricity, heating and other purposes. Therefore, the design of the shelters and masterplan of the site should include a solar panel on top of the roof or in any other suitable location in the camp (Figure 4.9). Other types of renewable energy sources such as wind power and hydropower can also be used in other contexts if available.

Figure 4.9: Solar panel on refugee shelters in a refugee camp in Syria.
Image retrieved from: https://www.ft.com/content/6809b4ec-1e82-11e6-b286-cddde55ca122

4.4.8 Orientation of the Shelter structure, Door & Window

The orientation of the shelter and the openings should be designed considering the passive design strategies. Such as, the openings should be placed considering the wind direction and sun path pattern to utilize natural ventilation, heating and daylights. As Bangladesh has a tropical monsoon climate natural ventilation is very important in the summer season. In other contexts, it is also very important to design a comfortable residence considering air temperature, airflow direction, relative humidity and precipitation.

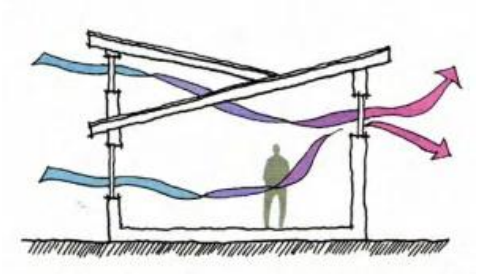


Figure 4.10: Cross ventilation diagram in a house.

Image retrieved from: https://buchholzssb11.wordpress.com/

4.4.9 Construction Process

For the self-help construction of the shelters, first, the beneficiaries are needed to provide training on the construction process. In many cases, including in Rohingya refugees' camps training of the trainers (ToTs) is given so that the trainers can teach the other beneficiaries how to construct and assemble the structure.

Figure 4.11: Training are provided to the Rohingya refugees for their shelter construction.

Source: (Global Shelter Cluster, 2019)

Besides training and workshops, the beneficiaries are also needed to provide guidebooks or infographics (Figure 4.12) showing the construction processes and assembly of the prefabricated materials in the shelter kit. The diagrams make the process easier and better understandable for the refugees.

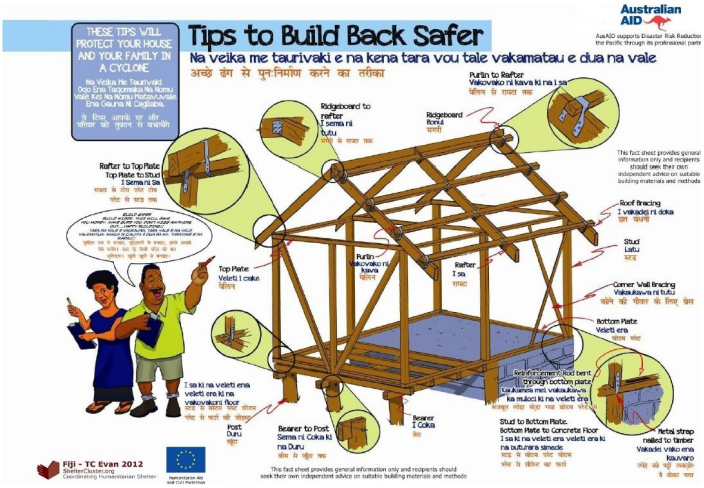


Figure 4.12: A construction diagram for self-help shelter for the displaced people in Fiji.
Source: (UNHCR, IFRC, & UN Habitat, 2014)

4.5 Conclusion

Throughout the world, the refugee crisis has become a serious issue. Bangladesh has also been experiencing the Rohingya crisis, which has led me to search for a sustainable solution for their shelter problems. Likewise, in Rohingya camps, many of the refugees in other countries had to stay in the host community away from their homes for many years. Therefore, they are needed to be transferred into transitional shelters for their long-term stay. In this regard, this research searches for a solution where the refugees can stay for many years and the shelters can be built immediately by their effort. Self-help construction can yield a lot of benefits for the displaced people in different circumstances.

After a brief literature and case analysis, the author has demonstrated the planning and decision steps, design guidelines for the self-help construction of the shelters. Considering

construction time and ease of self-help process, prefabricated shelters for the refugees can be a very good solution. Despite that, many criteria are needed to be followed by the designers while master planning and designing shelters, which are described in this chapter. Besides, the beneficiaries are also needed to provide training, guidelines and instructions to assemble the prefabricated units in the shelter kits.

To sum up, the ideas that this research advocates are not restricted to the Rohingya refugees only. Many of the design guidelines can be followed in other countries and scenarios for the self-help construction.

Bibliography

Building Rohingya Housing - Jewish World Watch | Jewish World Watch. (n.d.). Retrieved September 18, 2019, from https://www.jww.org/projects/rohingya-housing/

Burgess, R. (1992) Helping some to help themselves. Third world housing policies and development strategies, in: K. Mathey (ed.) *Housing policy in the socialist third world*. Mansell, London.

Devictor, X., & Do, Q.-T. (2017). How Many Years Have Refugees Been in Exile? *Population and Development Review*, 43(2), 355–369. https://doi.org/10.1111/padr.12061

Drone shows huge Rohingya camps - BBC News. (n.d.). Retrieved December 15, 2019, from https://www.bbc.com/news/av/world-asia-41530104/rohingya-crisis-drone-shows-huge-refugee-camps

Eddy, C.B. (1931) *Greece and the Greek Refugees*. Allen and Unwin, London.

Ghandehari, H. (2000). *Kit homes as a self-help affordable strategy*. McGill University.

Global Shelter Cluster. (2017). *Shelter projects 2015-2016*. (April). Retrieved from www.shelterprojects.org

Global Shelter Cluster. (2019). *Shelter Projects*. (May). Retrieved from www.shelterprojects.org

Global Shelter Clusters. (2018). *BANGLADESH 2017 – 2018 / ROHINGYA CRISIS*. Retrieved from http://shelterprojects.org/shelterprojects2017-2018.html

Global Trends - Forced Displacement in 2018 - UNHCR, the UN Refugee Agency. (n.d.). Retrieved December 1, 2019, from https://www.unhcr.org/globaltrends2018/

Gugler, J. (ed.) (1997) *Cities in the developing world: issues, theory, and policy*. Oxford University, New York.

Harms, H. (1992) Self-help housing in developed and third world countries, in: K. Mathey (ed.) *Housing policy in the socialist third world*. Mansell, London.

Harris, R. (1999). Slipping through the cracks: The origins of aided self-help housing, 1918-53. *Housing Studies*, 14(3), 281–309. https://doi.org/10.1080/02673039982803

Hodgkin, D., & Prideaux, F. (2018). *Humanitarian Bamboo Inception Report The use of Bamboo in the current response in Cox's Bazar, Bangladesh*.

IOM Bangladesh. (2019). *Need and Population Monitoring- Round 16* (Vol. 16).

Kapur, P. (1989). *From Ideas to Practice: " Self-Help " in Housing from Interpretation to Application*. Massachusets Institute of Technology (MIT).

Keivani, R. and Werna, E. (2001) Modes of housing provision in developing countries. *Progress in Planning*, 55, 65-118.

League of Nations (1924) *Greek Refugees*. American Friends Service Committee, Washington DC.

Leontidou, L. (1992) Greece, in: C.G. Pooley (Ed.) *Housing Strategies in Europe, 1880-1930* Leicester University Press, Leicester.

Martin, W. (2017). *Strategic Recommendations for Shelter Upgrade in Response to the Rohingya Humanitarian Crisis*. Retrieved from file:///C:/Users/earb2/Work Folders/Downloads/17OS-29051 Bangladesh Shelter Executive Summary - Rohingya Crisis v4.pdf

Mayo, S.K. and Gross, D.J. (1987) Sites and services-and subsidies: the economics of low cost housing in developing countries. *World Bank Economic Review*, 1(2), 301-335.

Mukhija, V. (2004) The contradictions in enabling private developers of affordable housing: a cautionary case from Ahmedabad, India. *Urban Studies*, 41(11), 2231-2244.

Ntema, L. J. (2011). *Self-Help Housing in South Africa : Paradigms , Policy and Practice*. (May), 1–238.

O' Connor, A. (1983) *The African city*. Hutchinson and Company, London.

Opinion | The Rohingya's Right of No Return - The New York Times. (n.d.). Retrieved December 12, 2019, from https://www.nytimes.com/2019/09/24/opinion/rohingya-refugees-myanmar-return bangladesh.html?auth=linked-facebook

Parnell, S. and Hart, D. (1999) Self-help housing as a flexible instrument of state control in 20th-century South Africa. *Housing Studies*, 14(3), 367-386.

Payne, G.K. (ed.) (1984) *Low-income housing in the developing world: the role of sites and services and settlement upgrading*. John Wiley and Sons, New York.

Robertson, J.T. (1978) The housing sector-perspective and prospects, Lusaka, government of Republic of the Zambia, in: R. J. Skinner and M. J. Rodell (eds.) People, poverty and shelter: problems of self help housing in the third world. Methuen, London.

Rohingya Refugee Crisis | OCHA. (n.d.). Retrieved September 18, 2019, from https://www.unocha.org/rohingya-refugee-crisis

Rohingya Refugee Crisis in Myanmar - What to Know | Mercy Corps. (n.d.). Retrieved December 12, 2019, from https://www.mercycorps.org/articles/bangladesh/rohingya-refugee-crisis-quick-facts

Rohingya refugees refuse to return to Myanmar without rights guarantee | World news | The Guardian. (n.d.). Retrieved December 12, 2019, from https://www.theguardian.com/world/2019/aug/21/not without-our-rights-rohingya-refugees-refuse-to-return-to-myanmar

Rohingyas reach paradise with stories of tragedy - Concern Worldwide. (2017). Retrieved January 27, 2020, from https://www.concernusa.org/story/rohingyas-reach-paradise-with-stories-of-tragedy/

Skinner, R. J. and Rodell, M. J. (eds.) (1983) *People, poverty and shelter: problems of selfhelp housing in the third world*. Methuen, London.

Soliman, A. M. (2004) *A possible wayout: formalising housing informality in Egyptian cities*. University Press of America, United States.

Teasdale, S., Jones, P. A., & Mullins, D. (2009). Briefing Paper 53 Connecting the dots : the potential for self-help housing to address homelessness. *Management*, (January), 1–27.

The UN Refugee Agency. (2019). Camp planning standards (planned settlements). *UNHCR Emergency Handbook*, 183(183), 1–8. Retrieved from https://emergency.unhcr.org/entry/45582/camp-planning-standards-planned-settlements

Turner, J. C. (1963). *Dwelling resources in South America*. London.

UN-Habitat. (2008). *Shelter Projects 2008*. 109. Retrieved from http://shelterprojects.org/shelterprojects2008/ref/UN_Habitat_shelter_projects_2008.pdf

UNHCR - History of UNHCR. (n.d.). Retrieved February 21, 2020, from https://www.unhcr.org/history of-unhcr.html

UNHCR - Shelter. (n.d.). Retrieved February 21, 2020, from https://www.unhcr.org/shelter.html

UNHCR, IFRC, & UN Habitat. (2014). *Shelter Projects 2013–2014*. Retrieved from http://humanitarianlibrary.org/resource/shelter-projects-2013–2014

UNHCR, IFRC, & UNHabitat. (2012). *Shelter Projects 2010*. Retrieved from www.ShelterCaseStudies.org

UNHCR, IFRC, & UNHabitat. (2013). *Shelter Projects 2011-12*. Retrieved from www.ShelterCaseStudies.org

UNHCR. (2016). *Shelter Design Catalogue*. https://doi.org/10.1002/9781119421511.ch3

UNHCR. (2019). *Rohingya Refugee Response- Population Factsheet*. Retrieved from https://data2.unhcr.org/en/situations/myanmar_refugees

United Nations High Commissioner for Refugees. (2007). *Handbook for emergencies*. Geneva: United Nations High Commissioner for Refugees.

United, N., & High Commissioner for, R. (1982). *Handbook for emergencies*.

Ward, P., Harms, H., Burguess, R., & Turner, J. F. (1982). Theories of Self-Help. In P. M. Ward (Ed.), *Self-Help Housing A Critique*. London: Mansell Publishing Limited.

Werlin, H. (1999) The slum upgrading myth. *Urban Studies*, 36(9), 1523-1534.

What is self help housing? | Self Help Housing. (2009). Retrieved February 14, 2020, from https://selfhelp housing.org/what-is-self-help-housing/

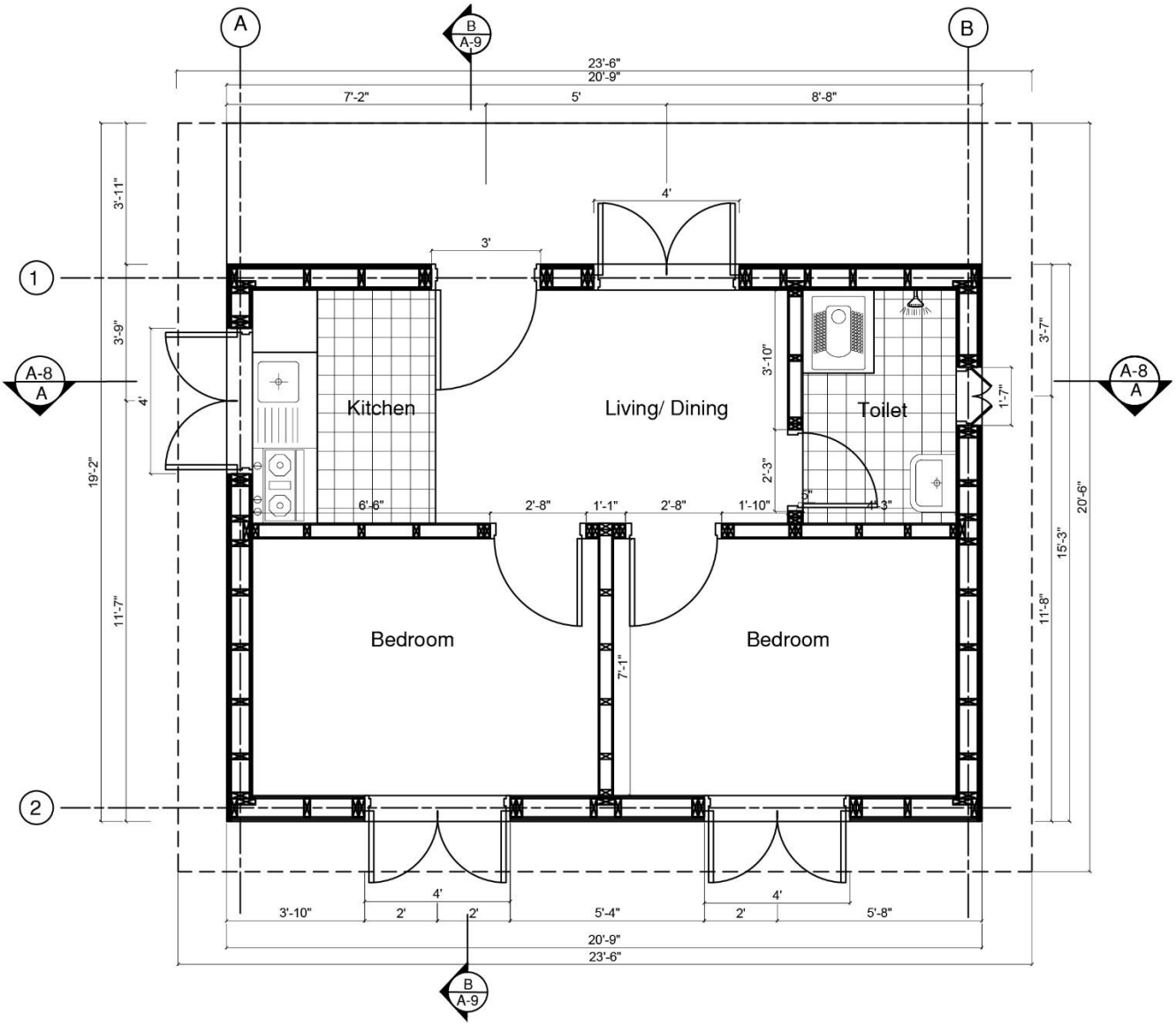
World Habitat. (2016). Self-Help Housing in the North of England - World Habitat. Retrieved March 30, 2020, from https://www.world-habitat.org/world-habitat-awards/winners-and-finalists/self-help-housing-in-the-north-of-england/#updates

Appendix

Following is a design of an emergency prefabricated long-term shelter for shipment by the humanitarian organizations to Bangladesh or other conflict areas for fast self-help assembly. This is a small, self-sustaining unit to be used by up to 6 people and can be transported to another location in Bangladesh or internationally in the container. This shelter was designed as a part of the course ARCH 635- Selected Topics in Housing 1 during this M.Arch under the supervision of Prof. Avi Friedman.

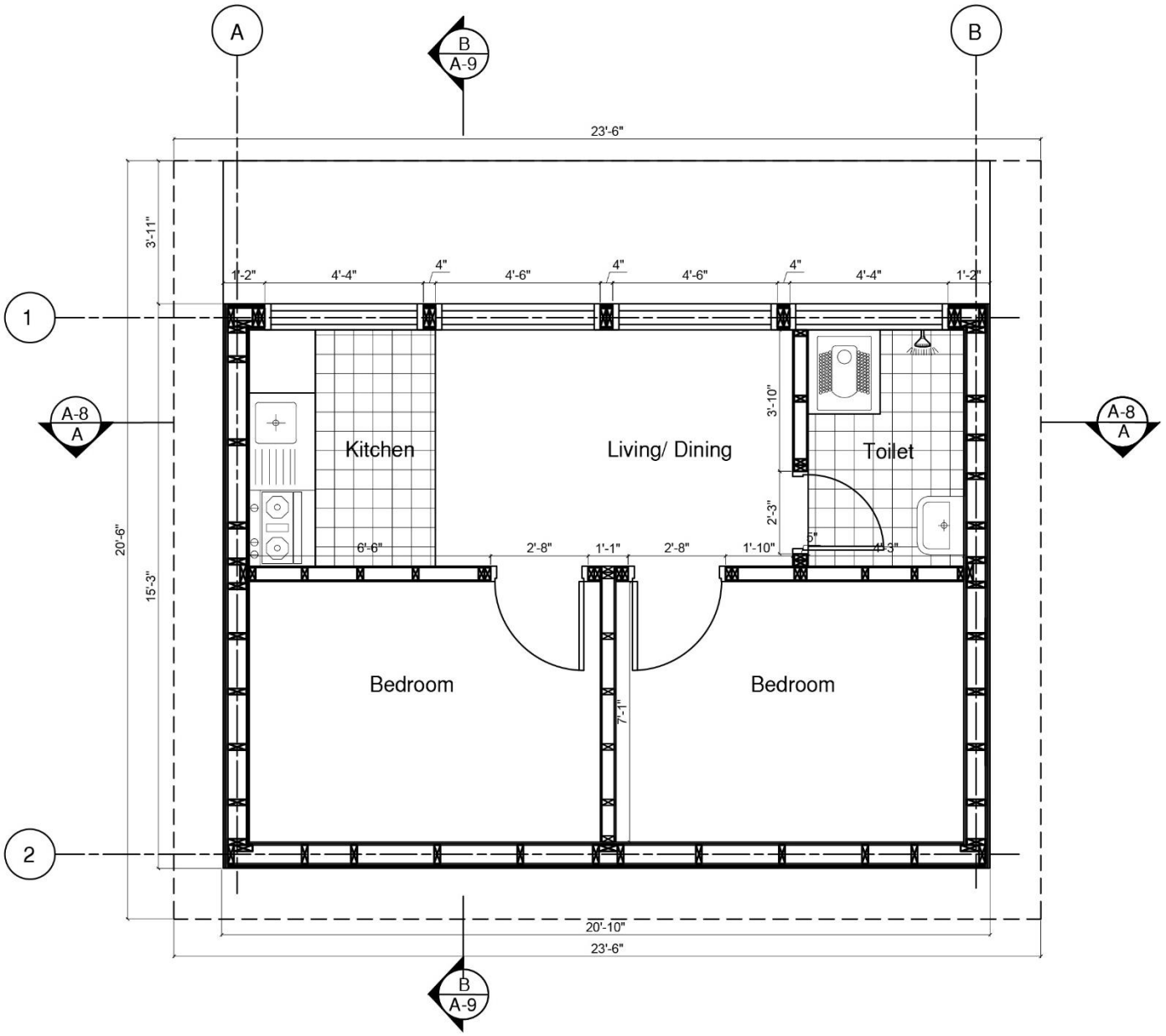
The design criteria were:

1. Interior Area- 270 square ft (for transport purpose, one dimension of the unit should not exceed 16 feet)
2. Maximum Interior Height- 12’ (Overall height of building no more than 15’ feet)
3. Foundation- Slab of Grade foundation
4. Roof- Single Pitch Roof
5. Program- Bedroom for up to 6 people, combined kitchen and living area, POD toilet and a front balcony.
6. Energy Source: Solar Power



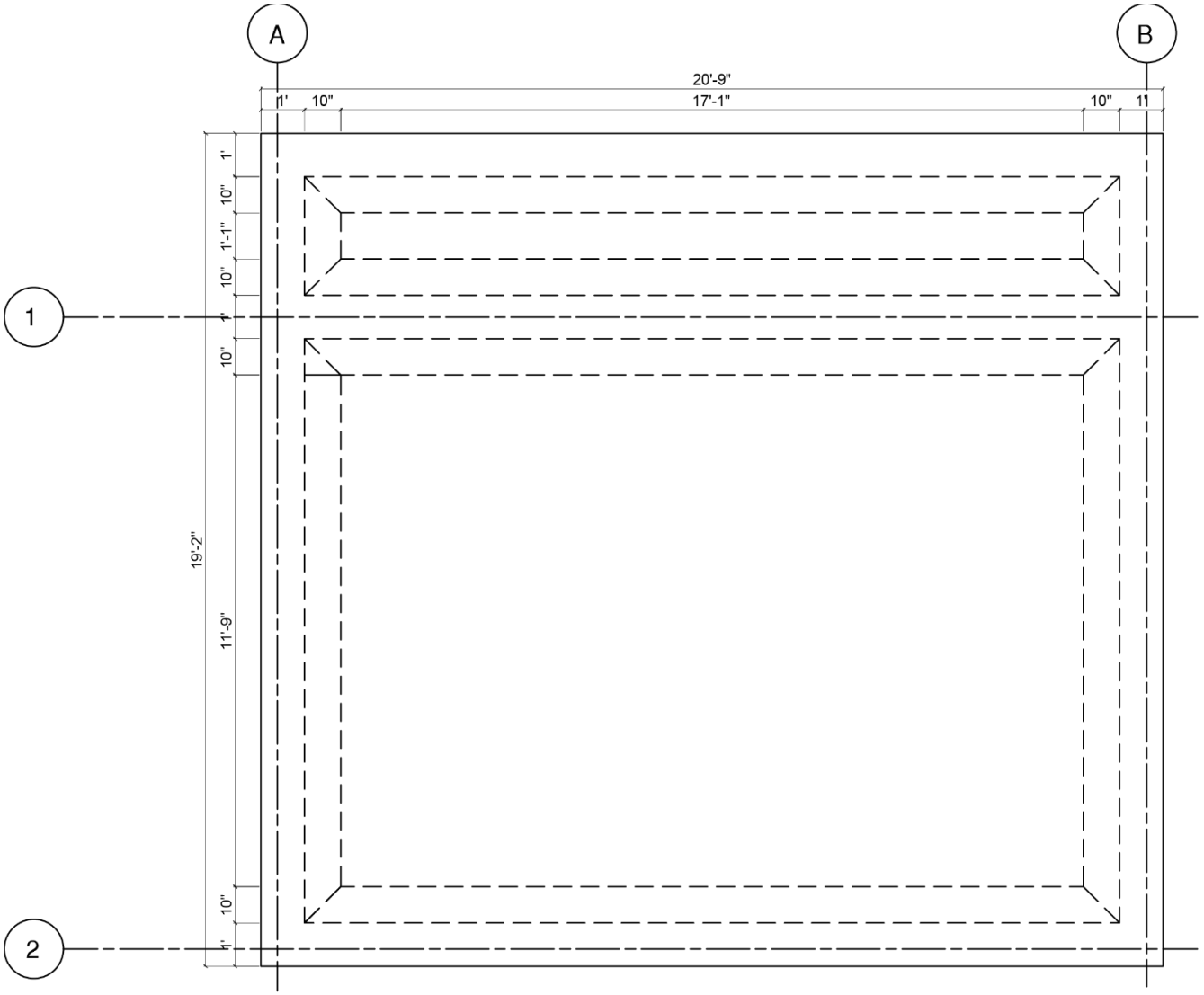
Floor Plan at 5' level

0 1' 3' 5'

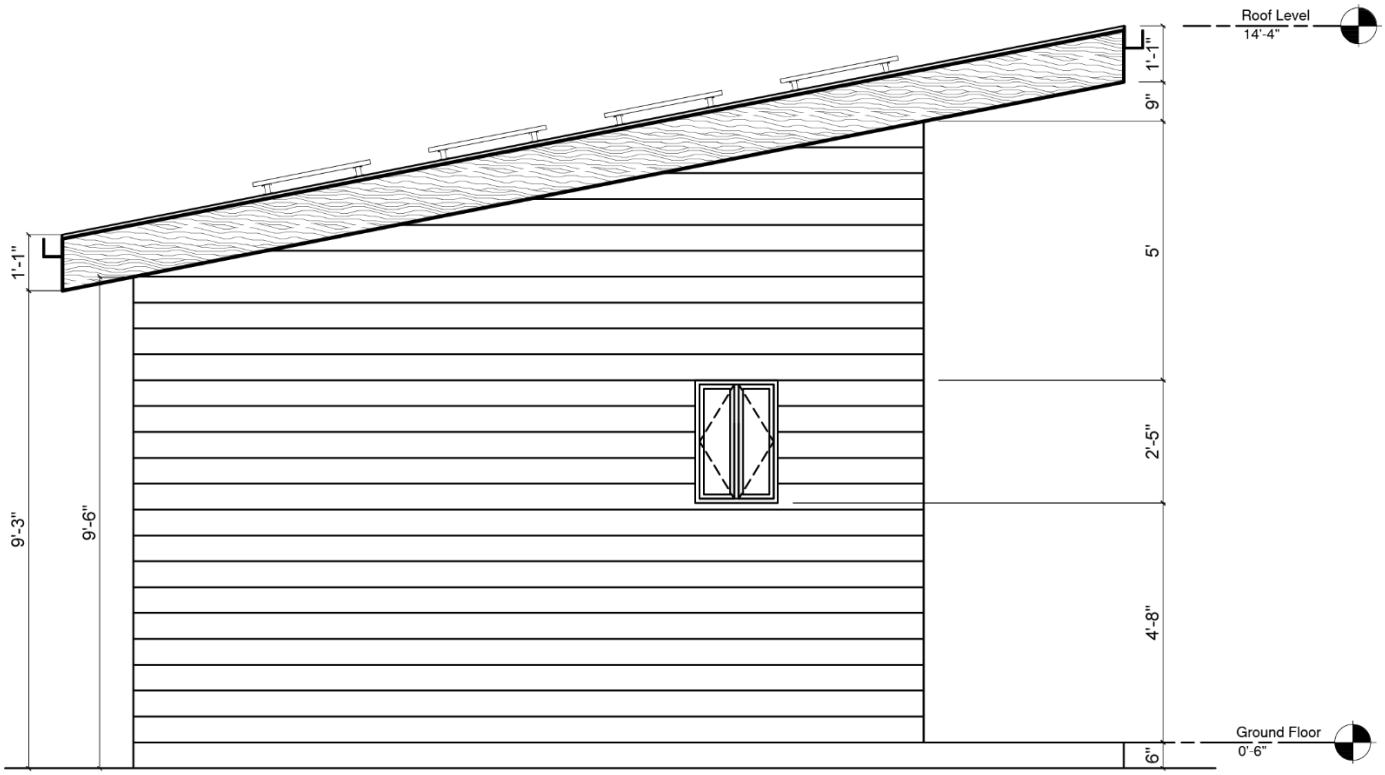


Floor Plan at 9' level

0 1' 3' 5'

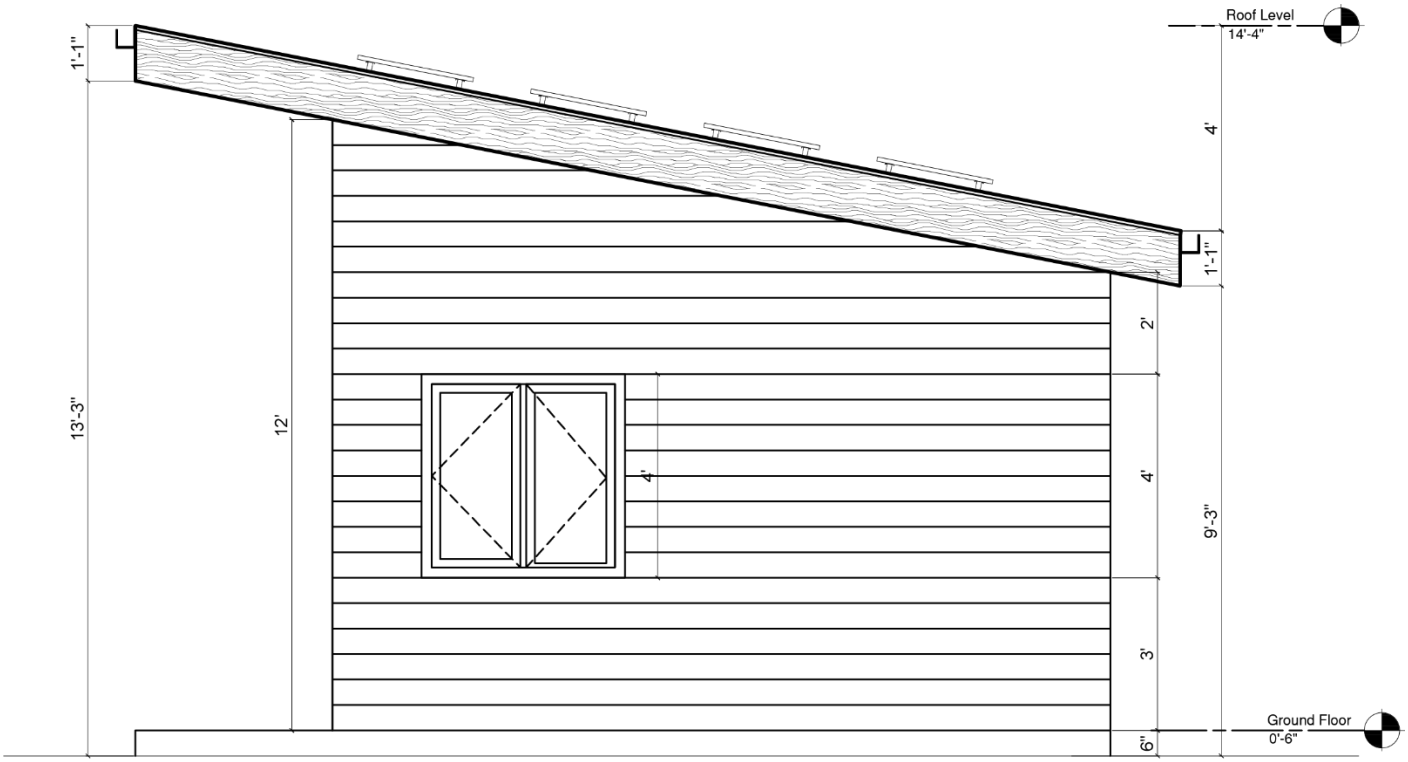


Foundation Plan



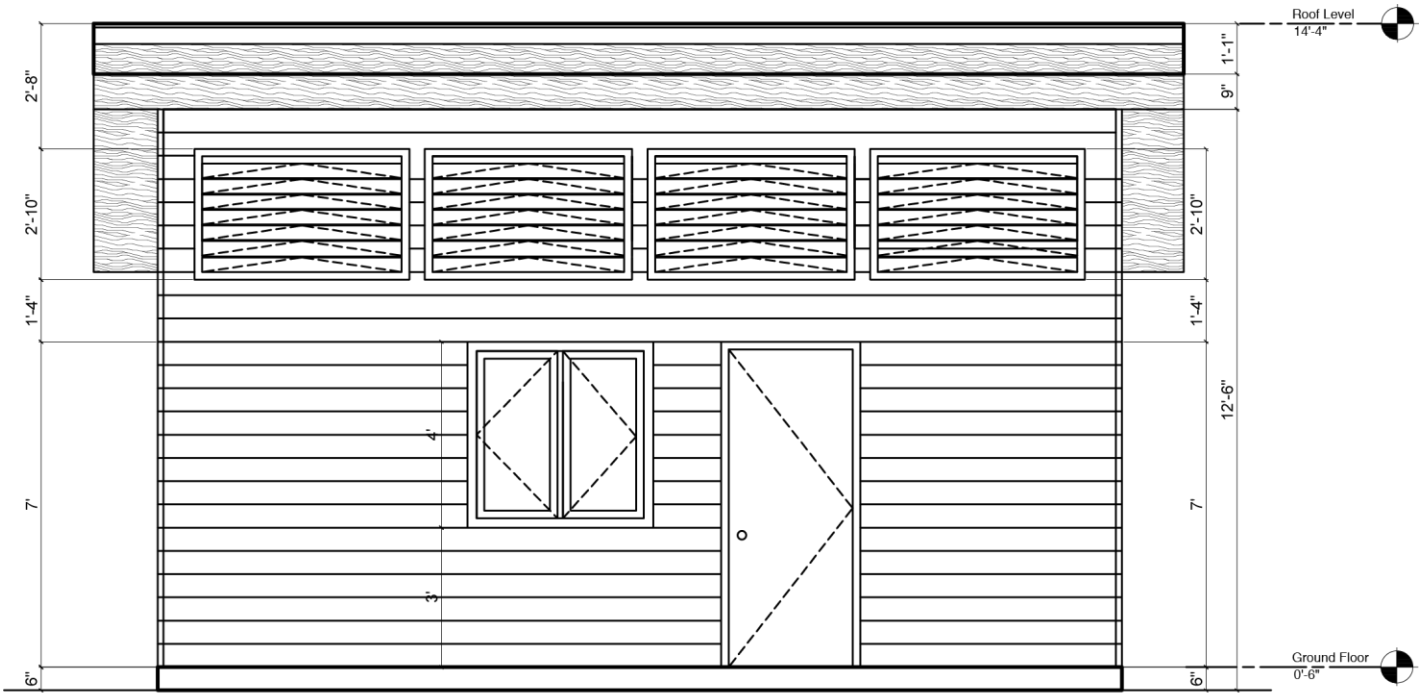
East Elevation

0 1' 3' 5'



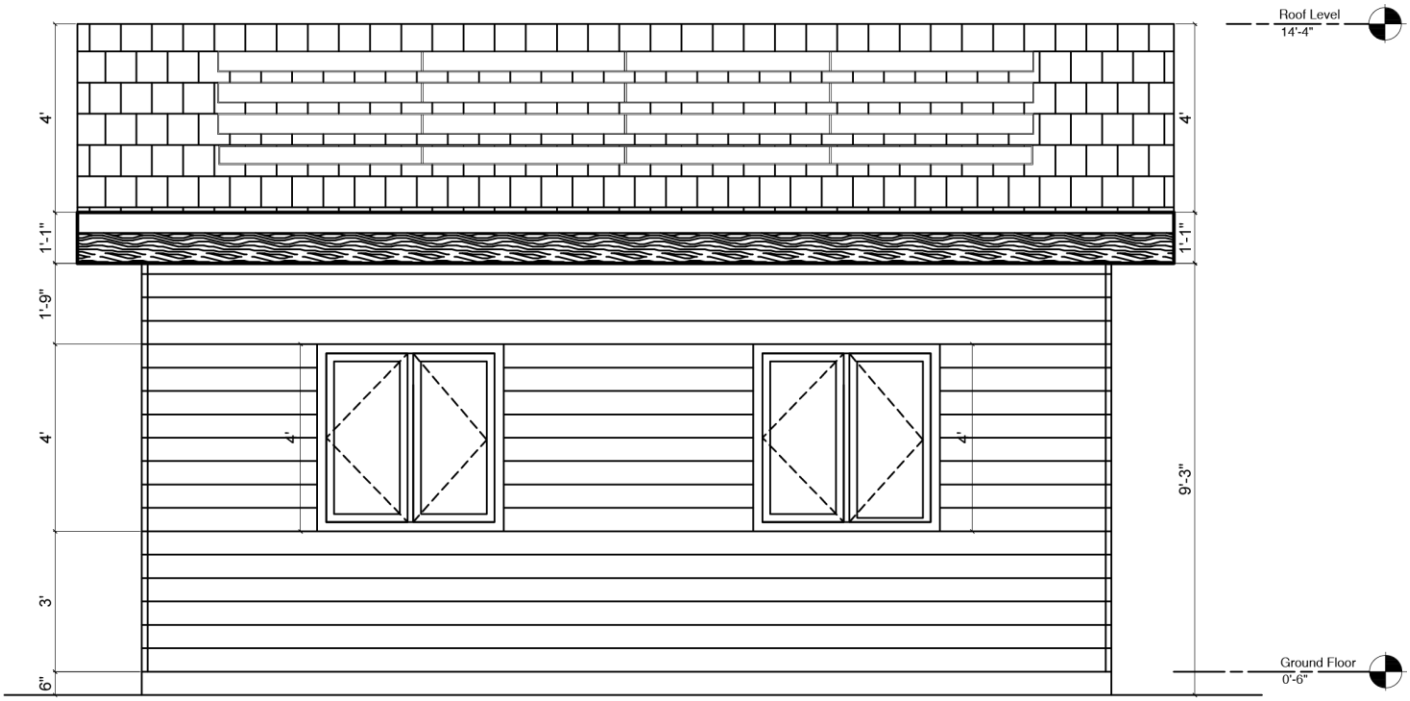
West Elevation

0 1' 3' 5'



North Elevation

0 1' 3' 5'



South Elevation

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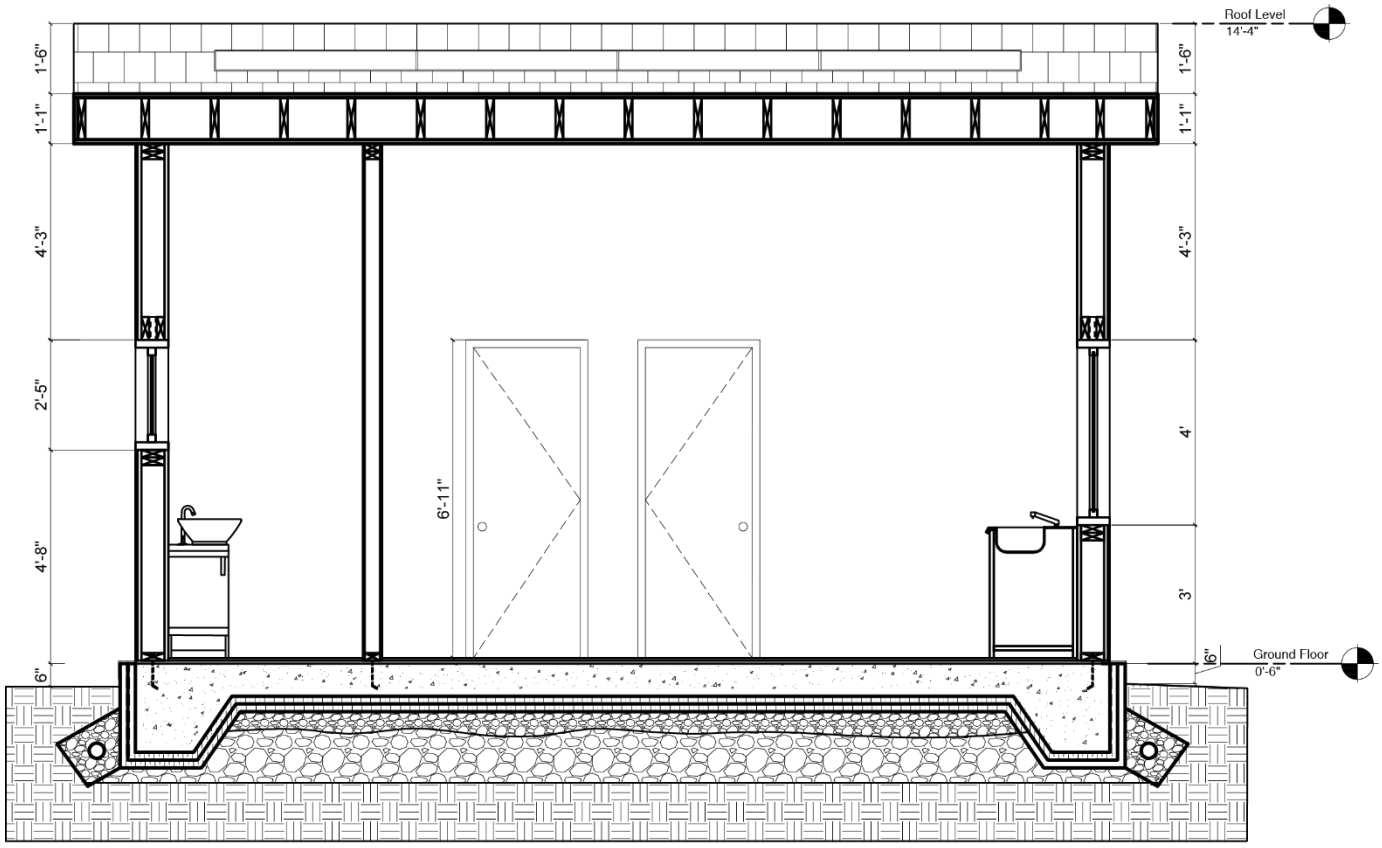

Section A-A

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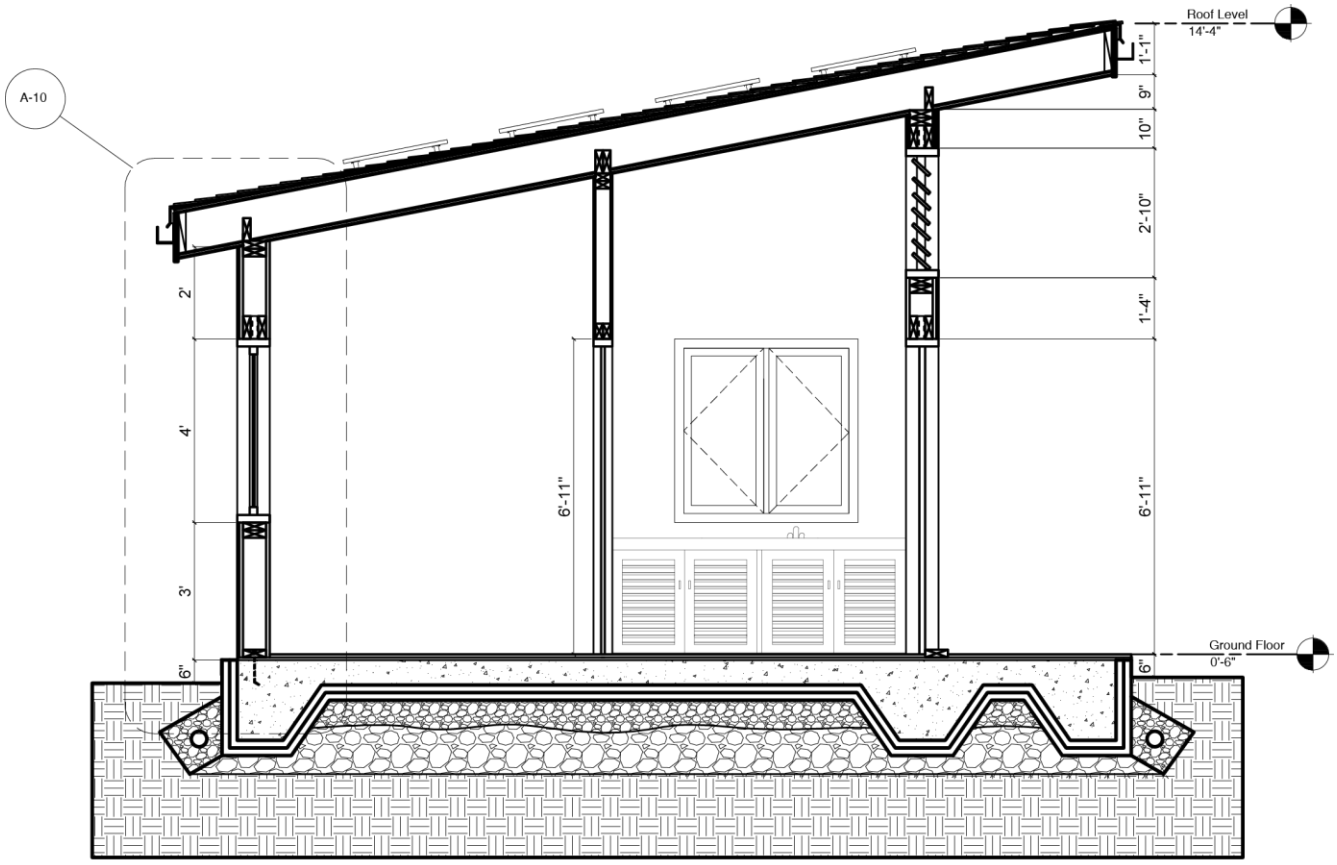

Section B-B

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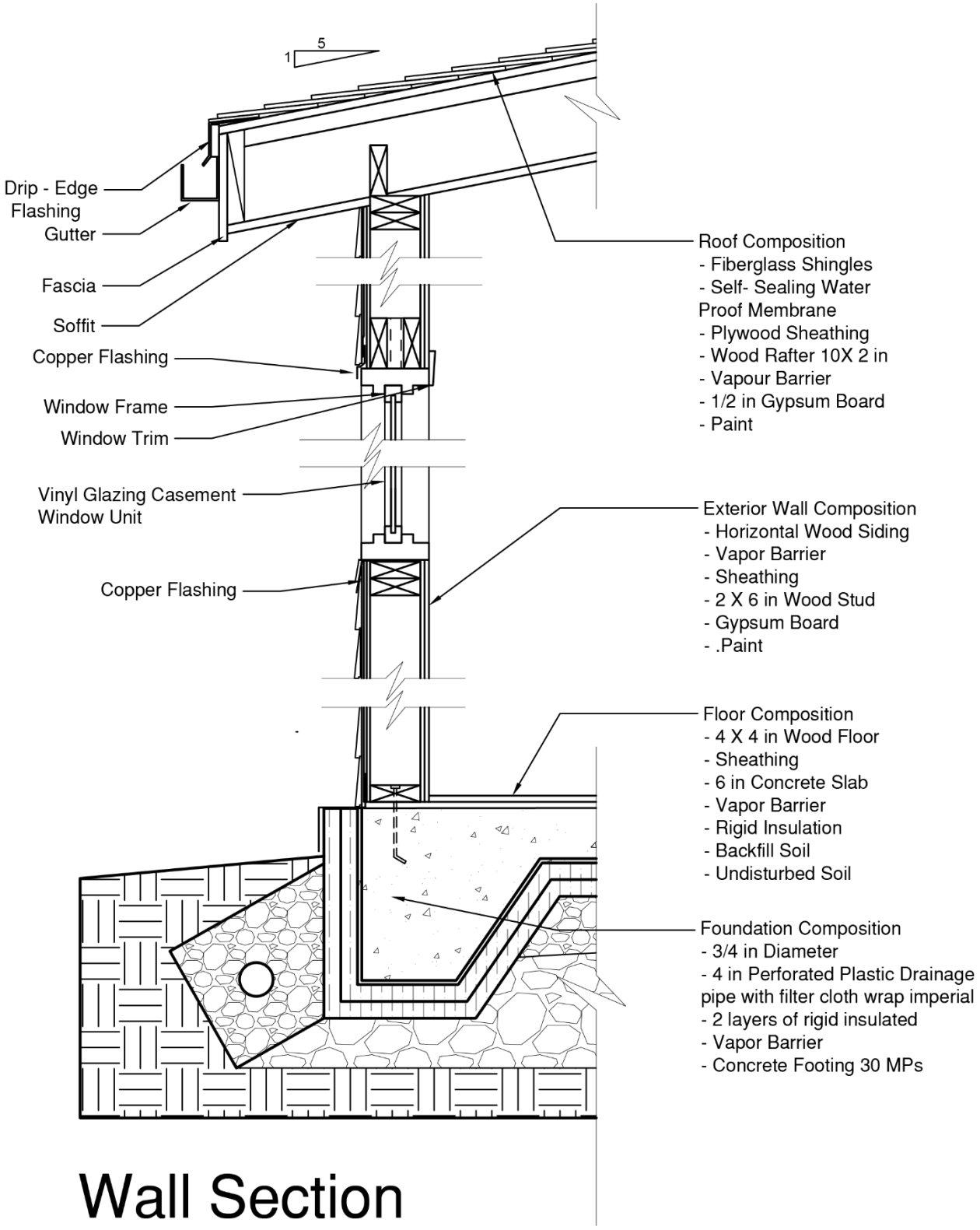
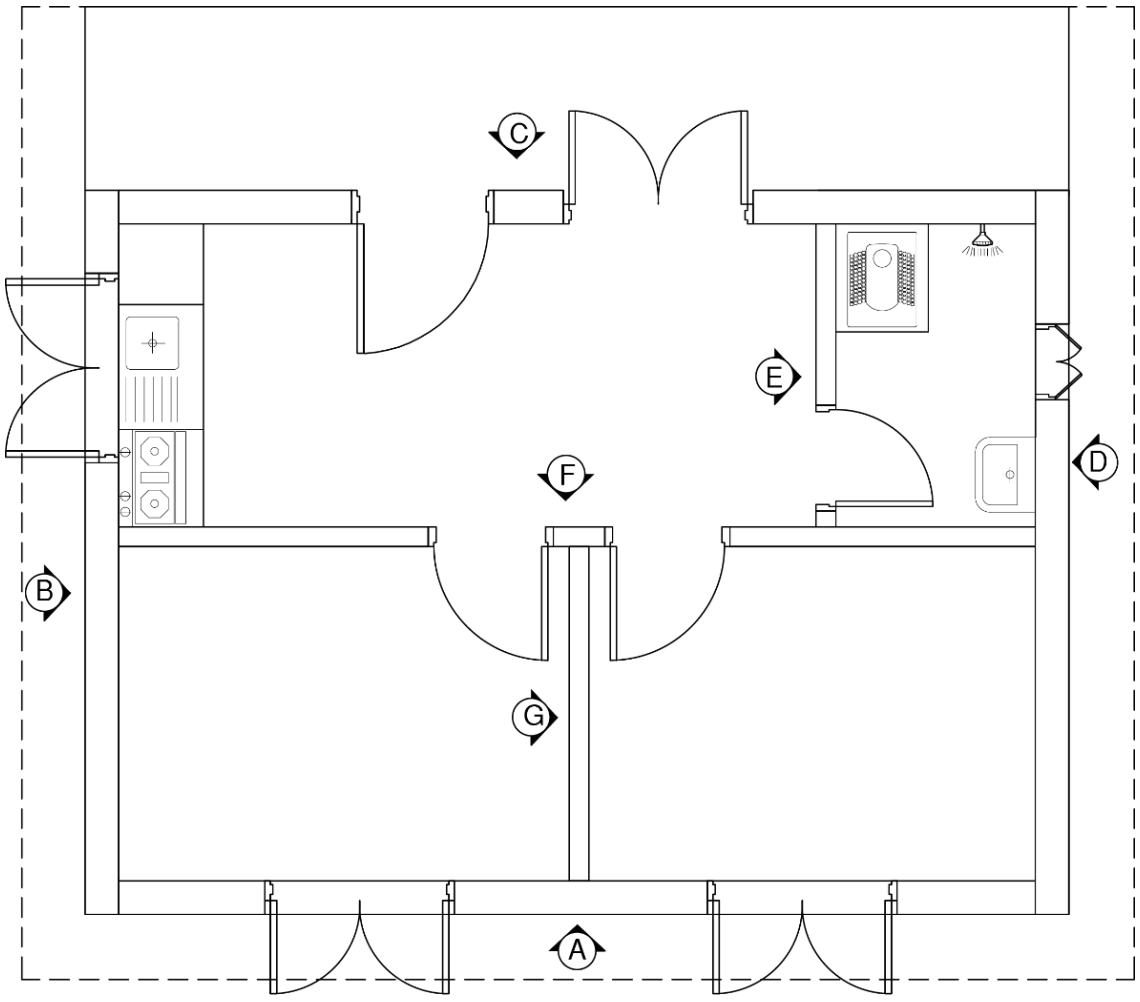
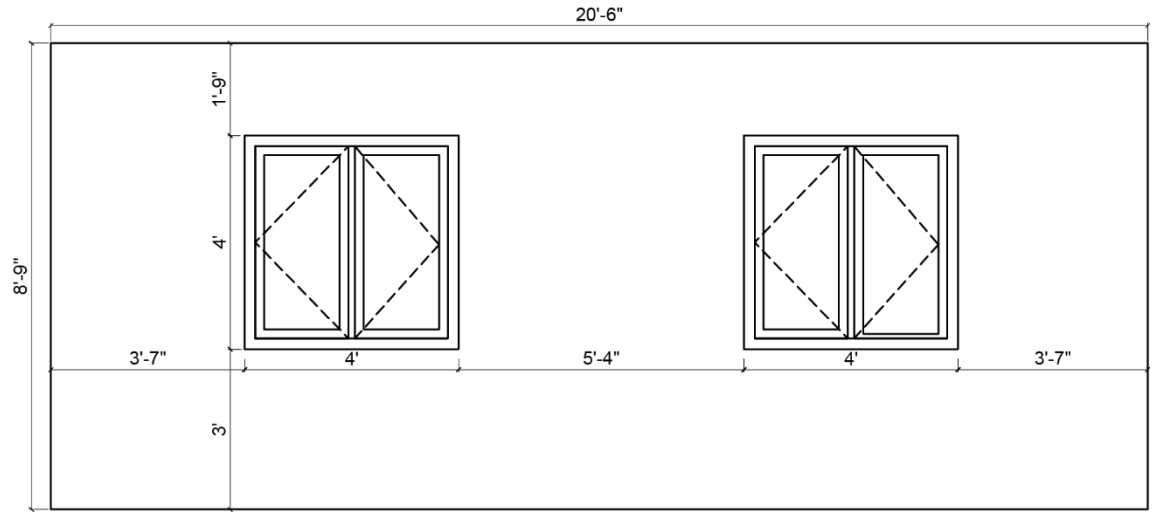


Wall Section

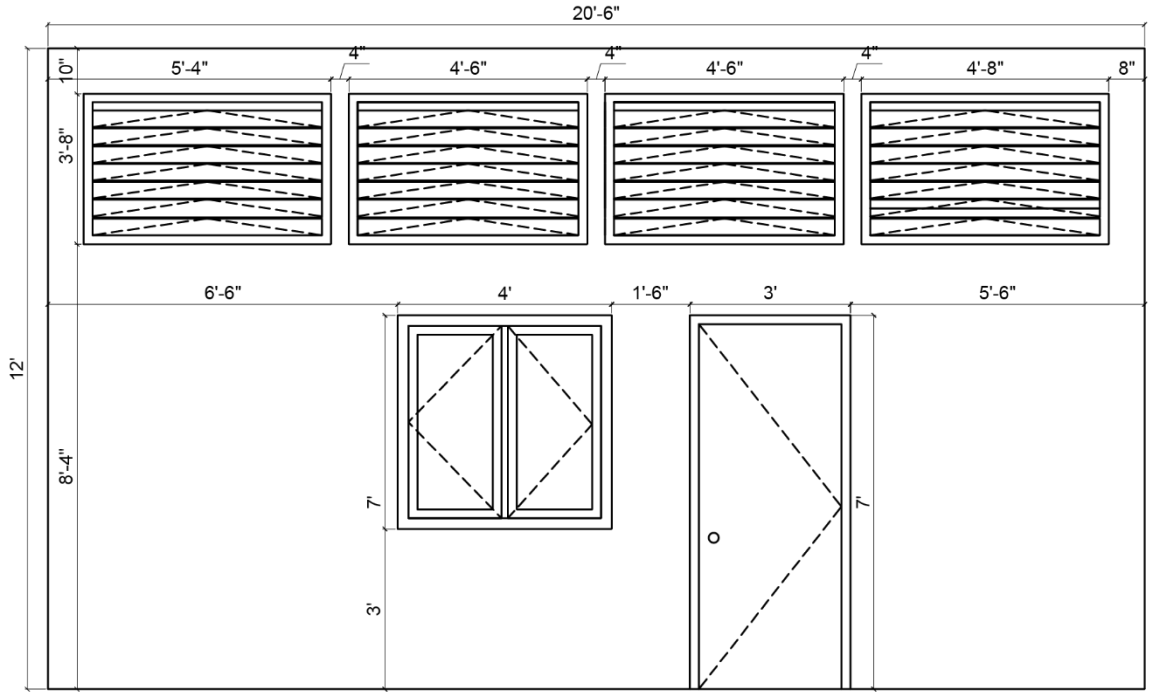


Prefabricated Panel Location in Plan

0 1' 3' 5'



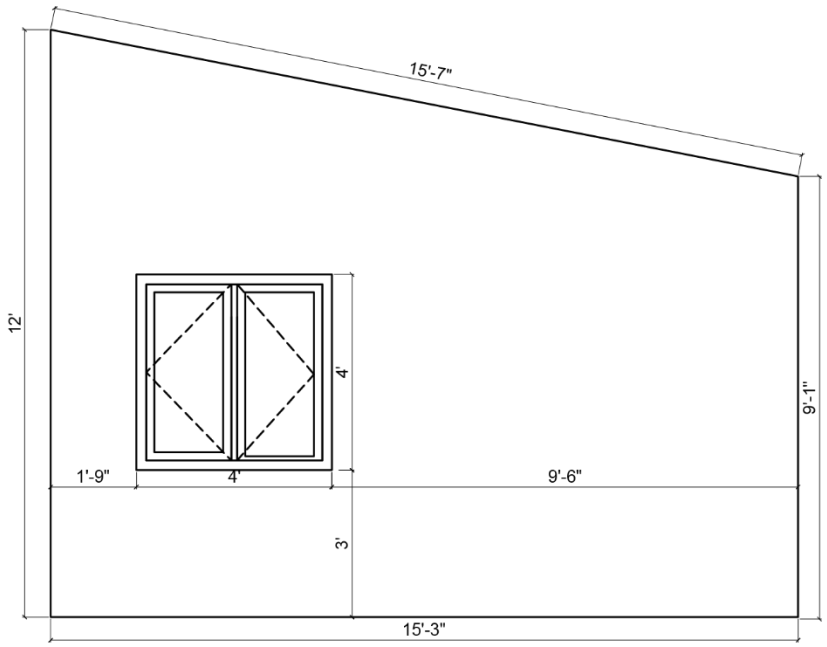
A



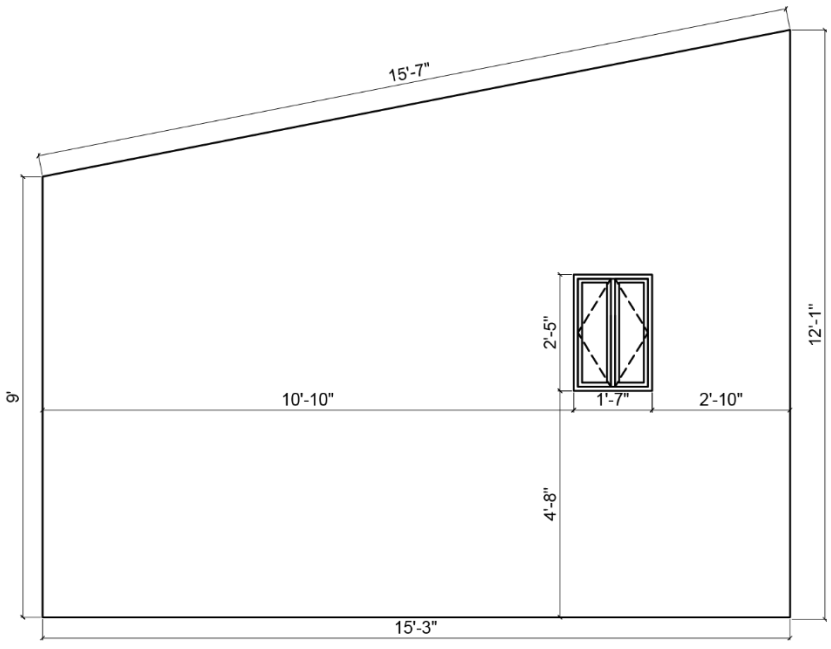
C

Prefabricated Panel Elevation

0 1' 3' 5'

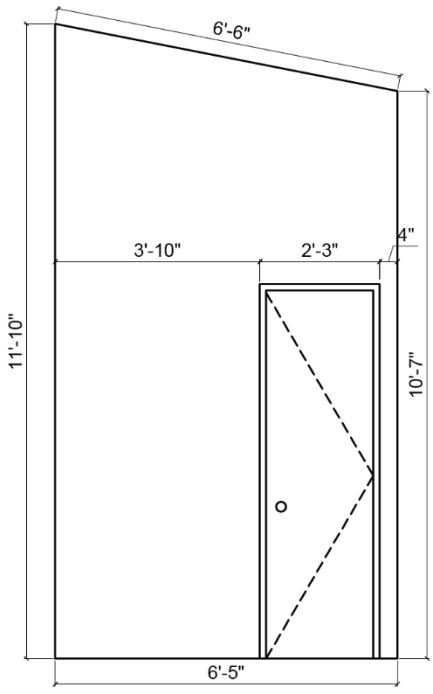


B

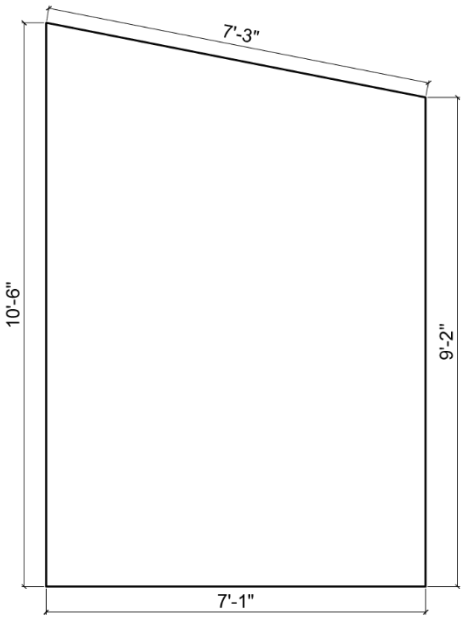


D

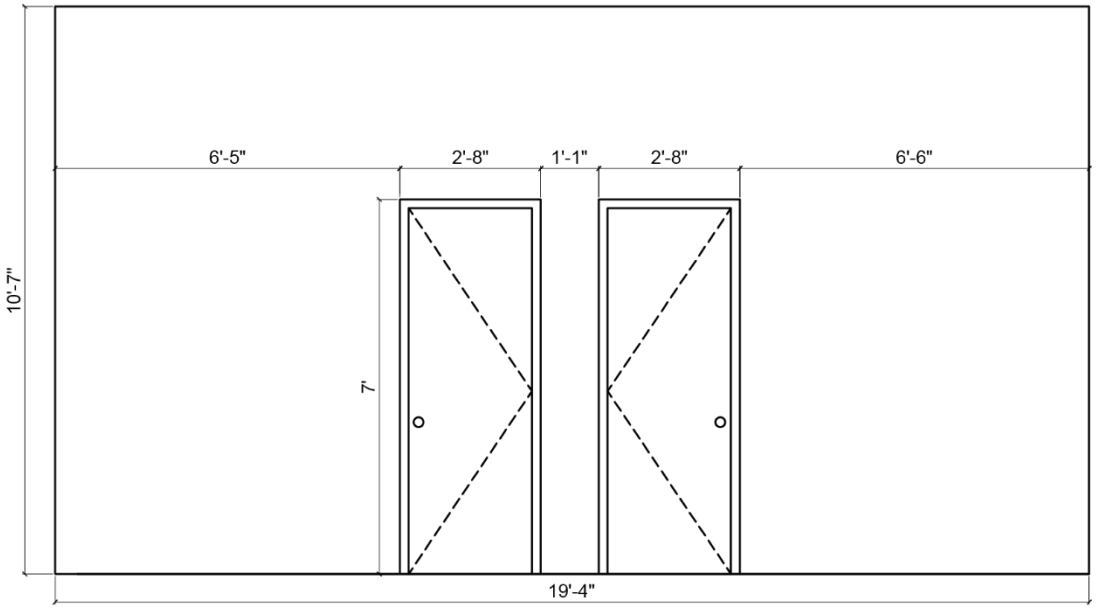
Prefabricated Panel Elevation



E



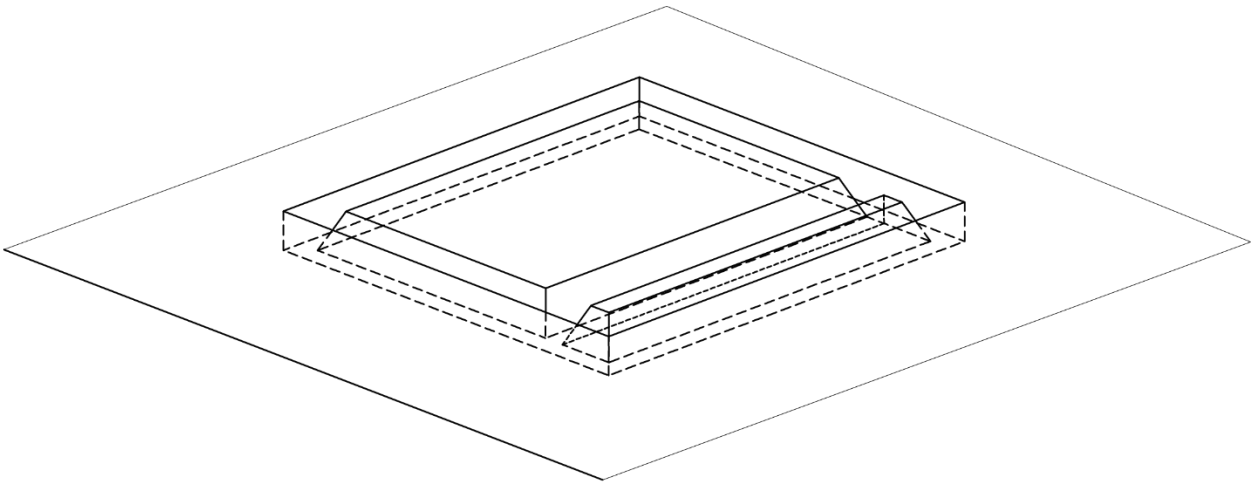
G



F

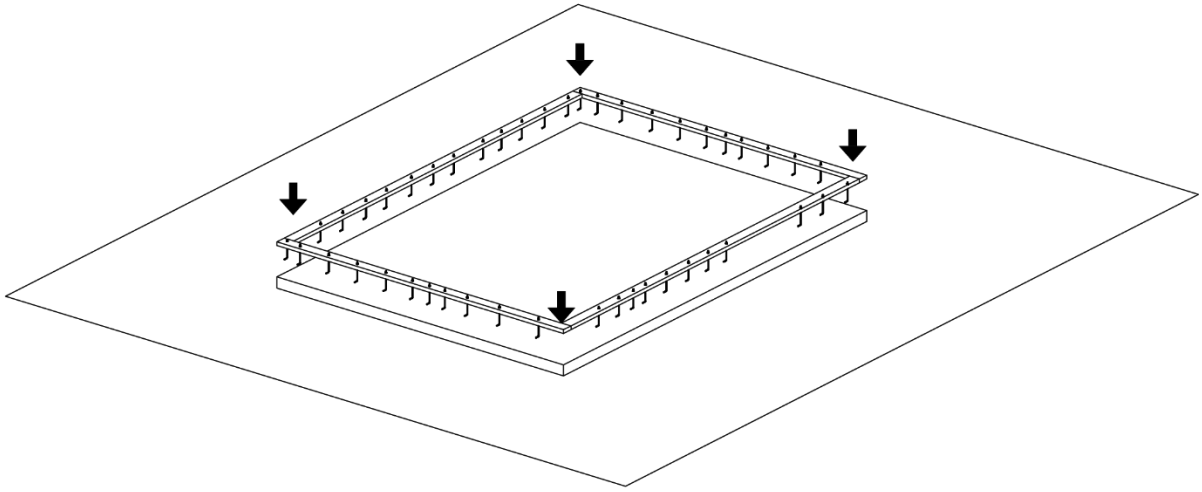
Prefabricated Panel Elevation

0 1' 3' 5'



Step 1- Excavation, Footing and Foundation

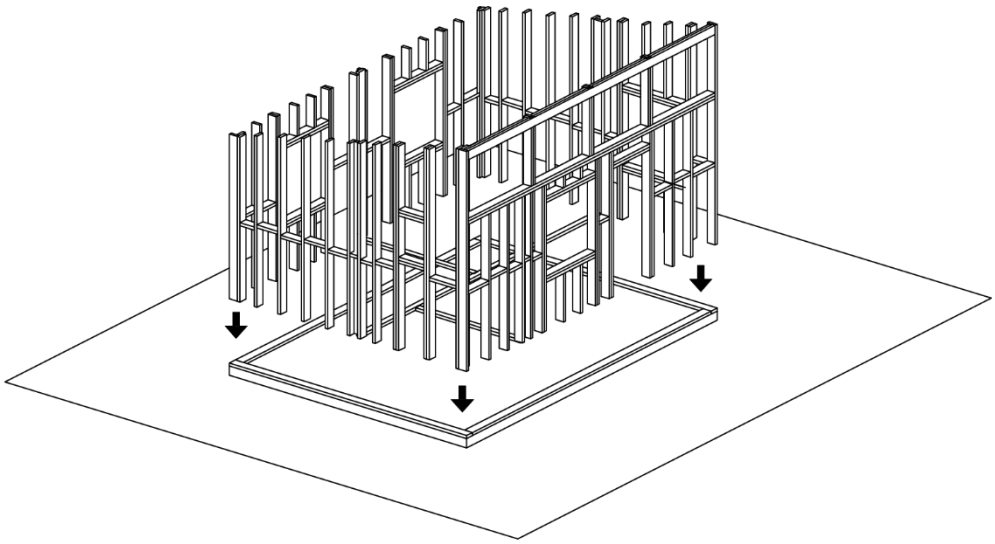
1. Determine how water will be drained away from the foundation
2. Excavate the site according to foundation plan
3. Pour concrete and ensure curing



Step 2- Securing anchor bolt to the foundation

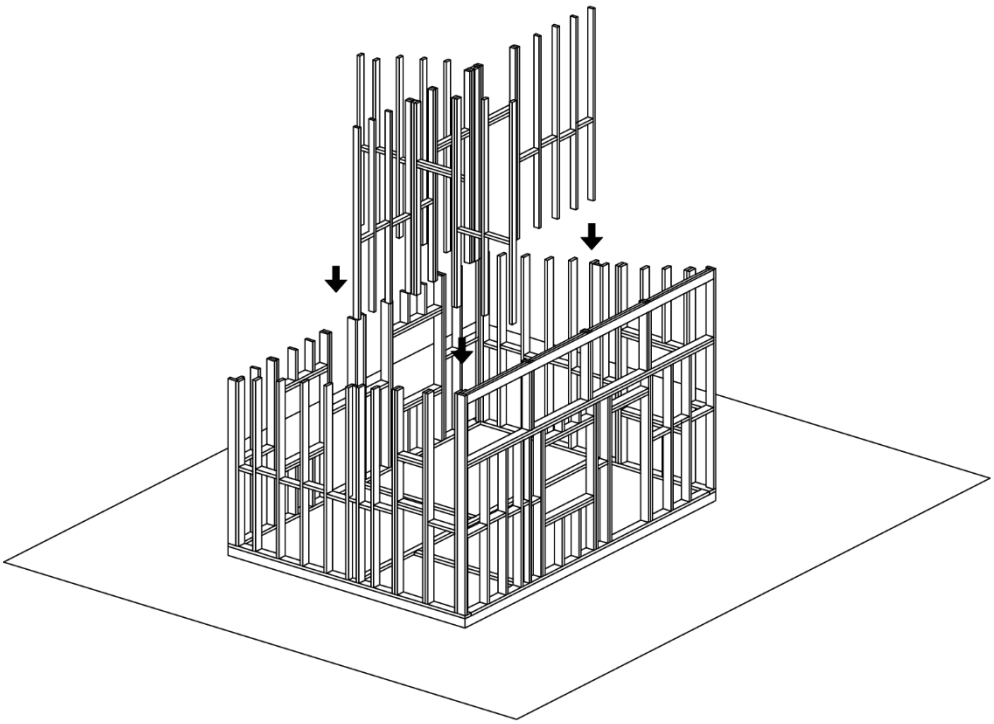
Determine the location of anchor bolts in the top of the foundation wall to secure the framing to the foundation.

Assembly Diagram



Step 3- External Wall Framing

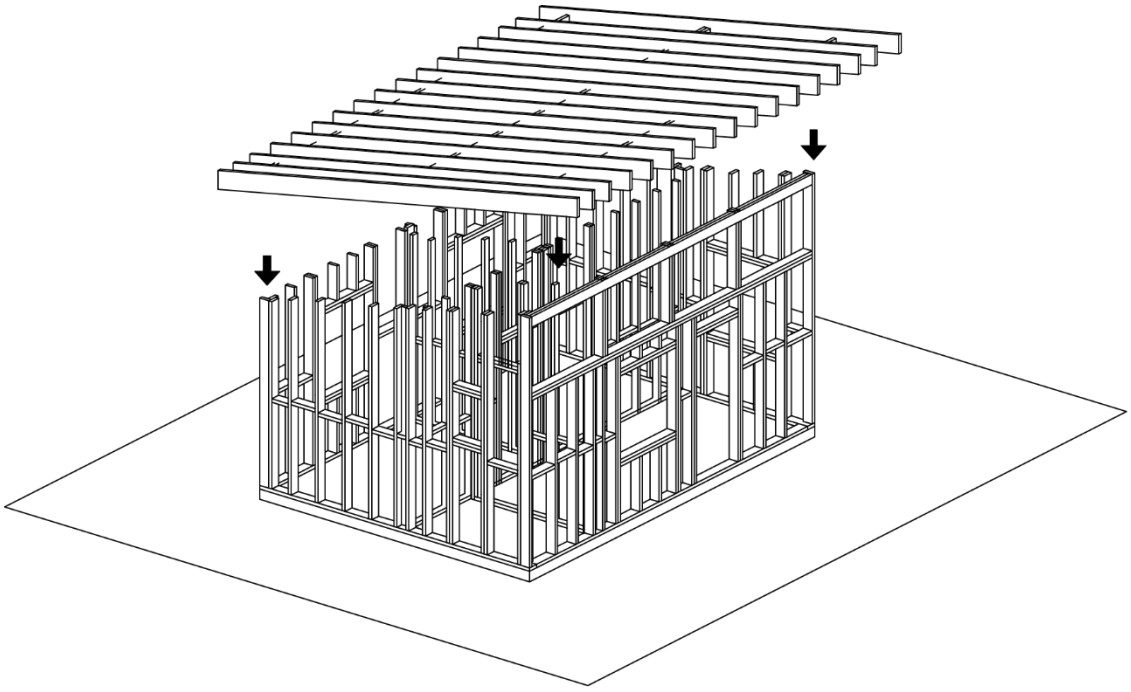
1. Exterior wall framing should be done according to plan
2. Wall studs should be nailed according to dry connection details
3. Use bracing temporarily to fix the wall studs



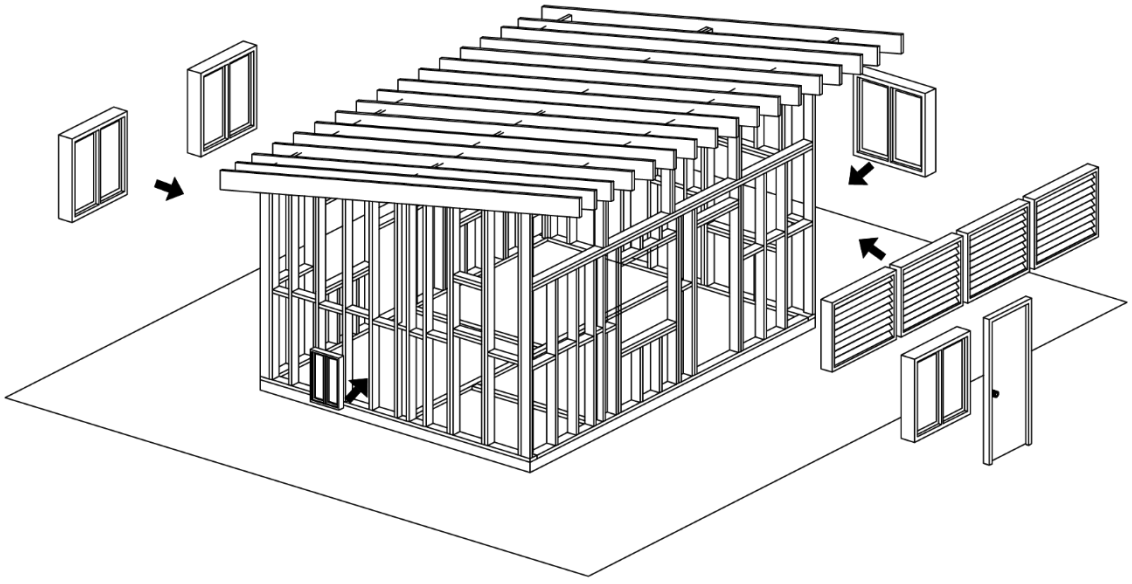
Step 4- Interior Wall Framing

1.After exterior, interior wall framing should be done according to plan
2. Locate pipes or ducts in the interior wall studs.

Assembly Diagram

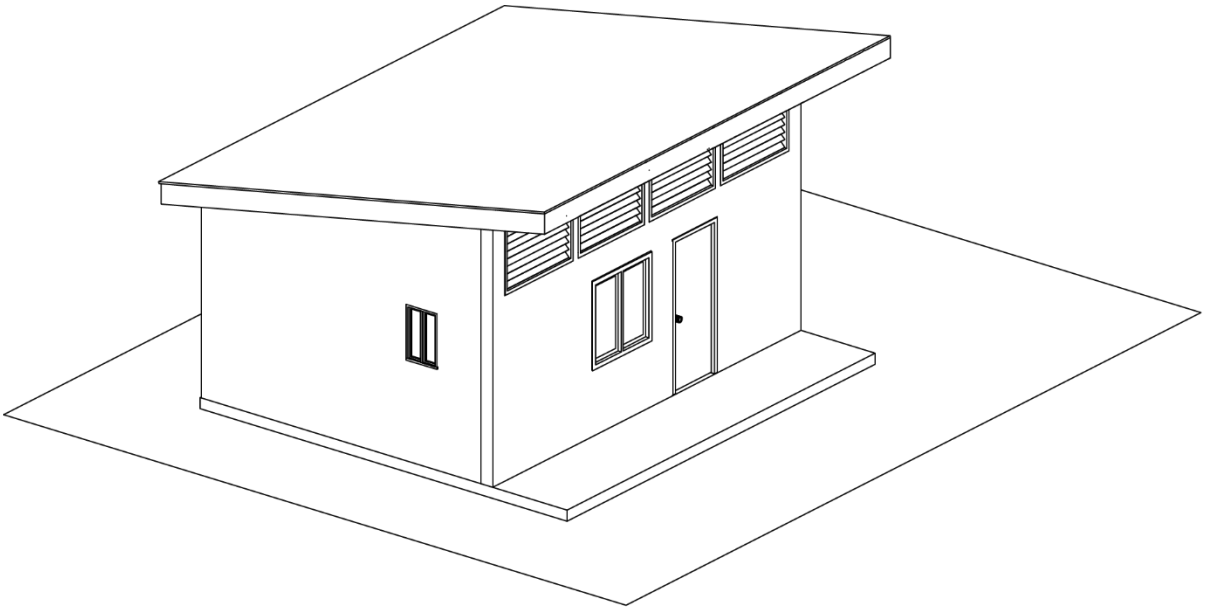


Step 5- Roof Framing
Roof framing can be done with wall framing



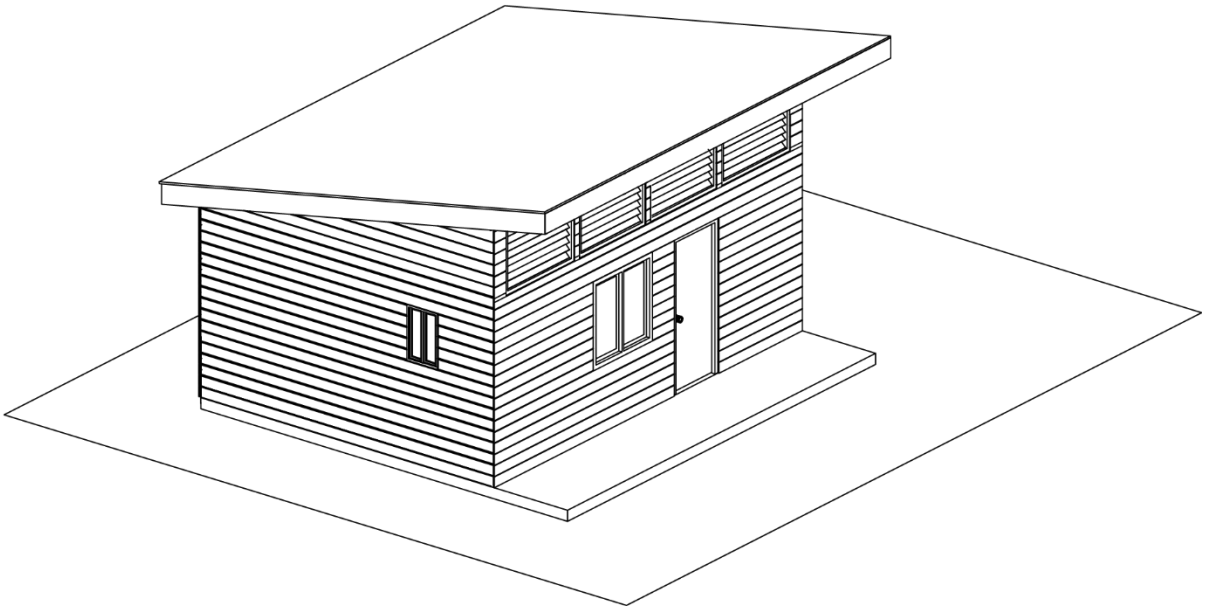
Step 6- Door Window
After Framing place doors and windows.

Assembly Diagram



Step 7- Sheathing and interior finish

Add vapour barrier and place plywood sheathing and finish material that covers the studs



Step 8- Exterior Finishing

1. Place exterior finish material
2. Add roof gutter and flashing to prevent water penetration
3. Place PV solar panel on roof

Assembly Diagram