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RETHINKING SHELTER DESIGN:
ZAATARI REFUGEE CAMP

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ABSTRACT

The issue of post-disaster housing for displaced people has become essential in international discussion due to an increase in displacement over the past decades.¹ There are inadequacies in the way we design for and respond to those situations.²

The Zaatari Syrian refugee camp was established in 2012, and currently has a population of 79,559 refugees. Housing in Zaatari consists of prefabricated tents and caravans.³ The shelters are fundamentally insufficient in serving the residents' needs, with one prominent issue being temporariness versus permanence.

This project explores the literature available on the temporary housing and the birth of the instant city. It also examines the living conditions of the Zaatari refugee camp, and proposes contextual response design elements for a shelter specific to the camp. The proposed design is shaped by specific criteria extracted from an extensive examination of proposed and implemented case studies.

¹ "Syria Crisis Factsheet." *European Commission Humanitarian Aid and Civil Protection* (2017).

² Sultan Barakat. "Housing Reconstruction after Conflict and Disaster." *Overseas Development Institute* (2003).

³ "Zaatari Refugee Camp Factsheet." *United Nations High Commissioner for Refugees* (2017).

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INTRODUCTION

There are about 65.3 million people who are currently forcibly displaced worldwide. This includes refugees, asylum seekers, and internally displaced people.¹ Syrians comprise the largest percentage of this figure.² More than half of Syria's original population of twenty three million has been displaced since the war started in 2011.³ Almost five million of these are now refugees in host countries. The Middle East has taken in the largest number of refugees globally, with Jordan currently hosting the largest number of refugees per capita in the world.⁴

Because displacement has increased exponentially in last decades – due to escalating conflict and war as well as natural disasters and climatic catastrophes - the issue of post disaster housing for displaced people has become an essential one in international discussion. A shelter is an essential need, especially since the loss of the physical home is

¹ *Global Trends: Forced Displacement in 2015*: UNHCR, 2016.

² Ahsan AKM Ullah. *Refugee Mobility: Causes and Perspective in the Middle East*, 2016.

³ Conduit Akbarzadeh. *The Syrian Refugee Crisis*: Ethos, 2016.

⁴ *Syria Crisis*: European Commission Humanitarian Aid and Civil Protection (ECHO), 2016.

often accompanied with more intangible loss – of privacy, dignity, and even identity.⁵

Providing shelter offers protection to inhabitants, and shields them from the outer world, including the natural elements. Moreover, it gives back some sense of privacy and normalcy, at least temporarily. However, the reality is that situations which require post-disaster shelters often demand action that is administered on a large scale and in rapid time frame, which inadvertently leads to an inadequate response.⁶

This thesis project explores the literature available on temporary housing, the urbanization of refugee camps, and the birth of the instant city. It examines the living conditions of the Zaatari refugee camp, and proposes contextual response design elements for a shelter specific to the camp. Those design elements are shaped by criteria for ethical and sustainable design extracted from an extensive examination of various conceptual and implemented case studies.

⁵ Sultan Barakat. "Housing Reconstruction after Conflict and Disaster." *Humanitarian Practice Network* (2003).

⁶ Daniel Félix, Jorge M. Branco, and Artur Feio. "Temporary Housing after Disasters: A State of the Art Survey." *Habitat International* (2013).

Finally, the proposed design elements do not stand on their own as a solution to the issues present in the Zaatari shelters, but rather attempt to highlight elements which are crucial to the process of rethinking shelter design in order to ultimately address those issues.

THE SYRIAN CIVIL WAR AND THE ZAAATARI REFUGEE CAMP

The Syrian Civil War has been ongoing since 2011, with this spring marking six years since the conflict began. In addition to displacing about half of the Syrian population, the crisis is intensified by the lack of funding to provide proper assistance. The international community has pledged to provide \$4.32 billion, but only half of that has been received.⁷

The Center for Refugee Studies at Oxford reports that the majority of funding which the international community provides to hosting countries goes to refugee shelters. It also reports that the majority of Syrian refugees does not live in camps but rather assimilates into urban locations. In Jordan, roughly 20% of the refugee population currently resides in camps.⁸

However, this small percentage still amounts to a very large number of vulnerable people. In addition, the Syria Response plan cites that in reality, only 32% of Jordan's budget for refugees goes into

⁷ *Refuge from Syria: Policy Recommendations*: Refugee Studies Centre, University of Oxford, 2016.

⁸ *Living on the Margins: Syrian Refugees in Jordan Struggle to Access Health Care*: Amnesty International.

the different camps, while 68% goes into the urban and rural hosting communities within Jordan.⁹ Moreover, even though various reports generically state that adequate shelter, healthcare, food, water, and education are accessible within the camps, the reality is different.¹⁰

The Zaatari camp, specifically, is home to 79,559 refugees according to the most recent camp factsheet published by the UNHCR in January 2017. The area that the camp occupies is about 5.3 square kilometers and over 450,000 have passed through since it's opening in July of 2012. The demographic overview shows a large percentage of youth. Moreover, one in five households is headed by women.¹¹

A lot of different entities are present in the camp, with the UNHCR and the Jordanian Government as joint administrators. Other organizations include but are not limited to the UNICEF, the Mercy Corps, Royal Police and Gendarmerie, and OXFAM.

There are 11 schools in Al Zaatari which provide educational services to 20,771 school aged-children. The camp also contains 27 community centers and 2 hospitals. Over 100 Syrian medical

⁹ *Jordan Response Plan for the Syria Crisis*: Hashemite Kingdom of Jordan, Ministry of Planning and International Cooperation.

¹⁰ *The Syrian Humanitarian Disaster*: Refugee Studies Centre - University of Oxford, 2015.

¹¹ *Zaatari Refugee Camp Factsheet*: UNHCR, 2017.

volunteers participate in providing care at these hospitals. The camp has an informal market formed from about 3000 shops and businesses. This is integral to the merchant and trade identity of much of the Syrian population present in the camp.

The situation in Al Zaatari is constantly shifting and changing which means numerical facts fluctuate regularly. Moreover, even informational data can be difficult to obtain. The UNHCR's factsheets provide a regular source of information, yet they do not seem to provide adequate information regarding the camp's actual conditions.

"Zaatari: The Instant City" is a publication by the Affordable Housing Institute which was published three years ago but still seems to be the most extensive body of literature which holistically reports the camp's conditions. The "Instant City" aspect of it is particularly relevant, bringing up the question of urban settlement and its relationship to displacement.

Refugee camps now have an average lifespan of 17 years. Yet, the design and implementation of the services within these camps - especially when it comes to shelters - is not synonymous with this lifespan. The elusive concept of "temporary" still largely defines the way we approach displacement; leading to major flaws in our response.

The Zaatari itself was hastily developed on desert land which had been previously owned by the Jordanian armed forces. The initial housing units consisted of tents that were slowly replaced with prefabricated caravans. There is still a mix of both.¹²

The caravans - which are essentially prefabricated one room structures - are preferred over tents primarily because they offer better protection from the elements. They caravans are still problematic, however, as they remain lacking in the way they address essential needs by continuing to conform to a one room non-adaptable structure.

Services in the Zaatari camp are limited. Water and waste are transported out using trucks. Electricity was only initially available in hospitals and schools, but an illegal electricity grid developed soon after. A solar power plant is currently being constructed and is expected to be functional by the end of 2017. Until the plant is running, the current haphazard grid is the only source of irregular electricity that the inhabitants receive.

Most of the services which refugees need are provided by the aid organizations on the ground. They distribute food and shelter to registered individuals in the camp.

¹² Alison Ledwith. *Zaatari: The Instant City*: Affordable Housing Institute, 2014.

Most work in the camp is illegal, yet most of the refugees own small shops and businesses which provide them with some income. This is likely due to the fact that a large percentage of the demographic is from southern Syria where merchandising is typical.

Zaatari, the camp that turned into an instant temporary city, is quickly developing into a permanent one. The future plans for the camp seem synonymous with this direction, with the Netherlands Association of Municipalities planning to move the camp towards self-government, proper services including electricity, water and sewage, sanitation, paved streets, as well as green areas.

In refugee camps, the issue of permanence is often debated, and regulations tend to direct efforts away from any measures which can make the stay less temporary. There are no formal building codes regarding refugee camps in Jordan which state what can and cannot be implemented. However, limitations do exist. There are prohibitions on paving roads and surfaces and planting trees. The only exception is the main road running through the camp. Regarding shelter, everything is prefabricated and shipped to the camp.

Initially, the camp management had organized housing units in rows, primarily for space saving, fire safety, and sanitation purposes. However, as demonstrated in previous camps, refugees took their conditions into their own hands and started rearranging the units.

Their modifications included the creation of U-shaped configurations and makeshift courtyards shared with extended family members - elements which are central to the Syrian culture. On the micro scale, camp residents often attempt to adapt their caravans to better fit their personal needs, as well as to create space for their social and commercial activities.

One other area that refugees have taken control of is communal space. This interference comes in a more negative manner because these spaces are often damaged in the process. Residents dismantle things like toilet components and fences to appropriate for their own personal use. This communal turned private phenomenon also includes water tanks.¹³

Water is bought in using trucks -- about 200 a day. So many trucks enter the camp that residents of nearby towns have complained of road damage. There is also fear of polluting the aquifer present beneath the Zaatari since it's an important source for a country as poor in water resources as Jordan. There is no waste infrastructure or sewage system, only blocks of latrines. Most residents have built in

¹³ *A Day in the Life: Zaatari - Episode 2: Theft Or Privatization*. Documentary. Directed by UNHCR. 2013.

home pit latrines – something that threatens sanitation because of the rainwater run off system.

In regards to electricity, the UN is the funding and managing entity. Streetlights were intermittently available around the camp which resulted in safety issues and led to an attempt to provide more consistent lighting around different areas of the camp.

Using those electrical connections, refugees, specifically electricians, began illegally tapping into those sources in order to obtain electricity, making the system a dangerous one. About 70% of the residents have illegally connected to the public grid. The UN's initial aimed to introduce metered electricity by 2014. There are no reports that this has been accomplished.

Housing in Zaatari consists of the aforementioned tents and caravans. Many residents utilize these same two units for housing as well as for commercial space and to open shops. By the end of 2013, there were 17,000 caravans, 8,000 tents, and 3,000 shops.

When the camp opened, it was visualized as a short term solution and so tents were the only available form of housing. As the crisis went on, caravans were slowly inserted into the fabric of the camp to provide more permanent shelter. Between tents and caravans, the better choice is obvious. Caravans are more permanent, and offer

more privacy and stability. The caravans are pre-fabricated abroad, usually in Gulf States like Saudi Arabia.

Space allocation is problematic because of the discrepancy in family size. Even though larger families reportedly receive a tent in addition to a caravan, a report discredits that and claims that each caravan is shared by six people. A lot of refugees try to trick their way into receiving a second caravan, either to use for additional housing or commercial space.¹⁴

As mentioned, the residents adapt the spaces they occupy to their needs, both legally and illegally. Paving courtyards, though illegal, is another thing that Syrians do to bring back some semblance of home and belonging.

The commercial shops that refugees adapt the caravans to are essential to the way the Zaatari's economy has developed. Most of them are located on the Champs-Élysées, a street taken up by the hundreds of technically illegal shops selling everything from food to clothing. As mentioned, a large percentage of Zaatari's original population in Southern Syria were merchants, and a lot of them have begun over and reintroduced their same businesses to the camp.

¹⁴Alison Ledwith. *Zaatari: The Instant City*.

Similar to other spaces that they transform to align with their needs, open spaces are another domain which refugees adapt. This is through traditional architectural elements which they bring like fountains, courtyards, football fields, and game areas.

LITERATURE REVIEW

A report examining refugees and housing in Australia presented an extensive literature review in a manner which shed light on three integral components: demographic trends and characteristics of refugees, government approaches to refugee resettlement, and the experience of housing and resettlement.

The findings indicated that all migrants included were faced with challenges when adapting to a new environment, and that resources either helped minimize or amplify these challenges. Those resources were very much related to housing and accommodation. An example is the Humanitarian Settlement Services program, which equips refugees with skills necessary to navigate new systems. This involves understanding tenancy, the process of property search, and the specifics of rental properties and leases.¹⁵

A study conducted in 2013 examined the construction workflow of a United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) sponsored project known as the Camp and Shelter Rehabilitation Project. In Lebanon, camps constructed in 1948

¹⁵ Paul Flatau, Val Colic-Peisker, Alicia Bauskis, Paul Maginn, and Petra Buergelt. *Refugees, Housing, and Neighbourhoods in Australia*: Australian Housing and Urban Research Institute, 2014.

were expected to be temporary for Palestinian refugees. However, those camps still exist and have proved to be a challenge because of poor conditions. The camps, which started off as tents, eventually evolved into concrete block shelters with zinc roofs followed by concrete-roofed shelters. However, the poor living conditions remain a prevalent issue that has contributed to chronic illness in the camp. The Camp and Shelter Rehabilitation Project was presented as advantageous largely because of the self-help approach it employs which decreases the unit cost per shelter, teaches families basic craft skills and involves the community in the process. ¹⁶

Another paper also discusses the effect of humanitarian policies of protection on refugee camp development, particularly, the concept of informal housing. It studies four different urban camps in Lebanon: Mar Elias, Burj al-Barjaneh, Shatila, and Dbayeh. Through interviews, the paper attempts to unveil how government policies inform these informal practices by refugees, and how these practices become part of refugee identity. ¹⁷

¹⁶ Mahmoud S. Eljazzar, Abdullah A. Beydoun, and Farook R. Hamzeh. *Optimizing Workflow for Shelter Rehabilitation: Projects in Refugee Camps*: Production System Design, 2013.

¹⁷ Romola Sanyal. "How Refuge Creates Informality: Shelter Politics in Refugee Camps in Beirut." *Jerusalem Quarterly* 60, (2014).

During interviews, refugees were asked about their building practices in early years of displacement. The responses often included the early move into camps, then restricted movement and travel as the time passed. This was especially prevalent in people with low socioeconomic status. Eventually, the increasingly difficult living conditions forced people to attempt modifying their living spaces themselves.

The refugees noted that the tents were not sturdy, offered little privacy, and little space. Expansion took up space that did not exist in the first place. Tents also did not perform well against the elements, especially rain and wind in the winter. Many of the refugees had to cook and wash outside because of these limitations. The poor quality and limited space seemed to be the main two motives behind reconstructing or modifying shelters.

Because building, which implied permanence, was banned for Palestinian refugees in Lebanon due to political reasons, they aimed for secrecy and covertly engaged in these activities. Refugees report that these included building stone walls and beating food tins into flat metal strips. The paper concludes with looking at the ongoing Syrian war and how the influx of refugees who have come into Lebanon is creating a situation similar to the Palestinian camp. This invites an urgent engagement with more questions about the relation between

humanitarianism and informality through the lens of temporary housing.

Recently, the international community has begun to pay attention to housing even outside the walls of humanitarianism or refugee aid. An exhibition at the Museum of Modern Art in New York has been devoted to shelters in crisis zones. “Insecurities: Tracing Displacement and Shelter” examined recent prominent shelter designs and aimed to bring up questions about the role which architecture plays in temporary housing. It attempted to explore conditions of transit and the manner in which architecture affects geospatial identity.¹⁸

The exhibition focused on real applications of structures, while including some conceptual ideas as well. It included shelters from refugee camps in Kenya, Jordan, Turkey, and Rwanda. The curator, Sean Anderson, identified traits essential to achieve a successful shelter. Those are being *rapidly deployable*, *contextual*, and *mutable*.

Rapidly deployable refers to the ability to easily and quickly assemble the shelters. It also implies that the materiality and design are thought of in a manner that allows for easy transportation and assembly. Having a *contextual* design means insuring site sensitivity

¹⁸ Diana Budds. "Refugee Architecture gets its First Major Museum show." Fastco Design. <https://www.fastcodesign.com/3064162/refugee-architecture-gets-its-first-major-museum-show20116>).

and attention to region building styles, something the curator thought was completely lacking in his trip to Jordan, Sri Lanka, and Italy to witness some of the designs in action. Anderson emphasized that the intriguing part was how the refugees themselves responded to the space and attempted to change it based on their own knowledge and to suit their personal comfort.

Mutability sheds light on the fact standardized or mass produced cookie cutter designs neglect to be culturally sensitive and do not take into account that different types of temporary housing can serve different functions for varying periods of time. Thus, mutable housing should not only be strong enough to last and not deteriorate with time, but also be flexible enough to give the inhabitants themselves the ability to adjust it to fit their needs. Finally, Anderson emphasizes that the ability of these designs or structures to transform the site into a functioning city which meets its inhabitant's needs remains a problem that has not been solved.

Because the past few years have seen a lot of attention suddenly being paid to temporary housing, different organizations and designers have come together and have begun experimenting with more effective shelter designs. It is difficult to determine whether the designs are as effective as each one claims to be because of the contextual and specific

nature of their employment. Moreover, feedback on performance after being deployed to real life applications is scarce.

REFUGEE SHELTERS AND THE ISSUE OF THE TEMPORARY

The terms *shelter* and *housing* have been used interchangeably in the past and are still often not clearly defined in literature addressing displacement.¹⁹ The two terms were first distinguished around 1995, when it was proposed that *shelter* referred to a place to stay after the immediate onset of a conflict, while *housing* referred to a more permanent place where one was able to resume normal daily-life activities.²⁰

This definition was developed further and divided into four categories that differ primarily by predicted time span or stay. *Emergency shelters, temporary shelters, temporary housing, and permanent housing.* *Emergency shelters* are where displaced people stay for a very short period of time, usually only a few days. *Temporary shelters* usually last a few weeks and may take the form of a tent. *Temporary housing* is anticipated to last between six months to three years and may take the form of a prefabricated structure or a rented

¹⁹ Daniel Félix, Jorge M. Branco, and Artur Feio. "Temporary Housing after Disasters: A State of the Art Survey."

²⁰ Cassidy Johnson. "What's the Big Deal about Temporary Housing? Planning Considerations for Temporary Accommodation after Disasters: Example of the 1999 Turkish Earthquakes." (2002).

house. Finally, *permanent housing* is defined by the return to the rebuilt original house or finding a new permanent one.

Refugee shelters seem to fall roughly in the category of *temporary housing*, though the time span is often a lot longer than the suggested three years. As a matter of fact, most refugee shelters seem to have specifications of a *temporary shelter*, but the time span of *permanent housing*.

Criticism directed at *temporary housing* has mostly been focused on issues of both sustainability and cultural inadequacy. Problems in the sustainability refer to both high cost and environmental impact. Some of these issues revolve around the fact that proposed temporary housing solutions are often visualized as well as produced abroad. This adds to the cost because it requires long-distance shipping, which is problematic because it diverts funds that could be redirected towards building better permanent housing.

This turns into a cycle because it perpetuates the inability to construct appropriate permanent housing due to lack of funding. In turn, the lack of funding for permanent housing leads to temporary housing exceeding its intended maximum life span. Temporary housing then exhibits serious problems in function due to its overuse, which creates problems for the community.

Environmentally, pollution is a serious issue in sites where temporary housing is provided. This is due to the initial hasty creation or adaptation of infrastructure, but also to the condition of the site after its use is over. Moreover, many structures may need to be removed or dismantled afterwards. This is not only an unsustainable approach to dealing with the resources which went into the creation of the structure, but also emphasizes the lack of a proper method to deal with them or benefit from them after their initial usage.²¹

The problematic design and production of temporary structures occurring abroad does not only negatively impact sustainability but also makes them culturally inadequate. Because these structures are often fabricated abroad, mass produced, and imported, they almost always fail to pay any attention to the culture or the climate. This may cause displaced people to have a longer and more difficult recovery process.²²

Research suggests that inhabitants are usually dissatisfied with their temporary housing in large part due to cultural inadequacy and the fact that there is no room left for incorporating traditional practices. This can be seen on both the individual housing unit scale as well as the larger site scale in terms of organization. The dissatisfaction often leads inhabitants to take matters into their own hands by attempting to

²¹ Daniel Félix, Jorge M. Branco, and Artur Feio. "Temporary Housing after Disasters: A State of the Art Survey."

²² Sultan Barakat. "Housing Reconstruction after Conflict and Disaster."

adjust or adapt their own houses and the community as a whole. The skills needed to perform these adjustments are inadequate, especially because the production and materials of the housing are not local or familiar to the inhabitants.²³

Initially, physical heritage – traditional patterns and practices of living – was a component that needed protection from disasters. However, that focus has recently shifted to attempting to integrate it into the recovery process. Heritage is now seen as an element that can inform post disaster shelter and housing design, as well as approaches to infrastructure and the environment. By employing heritage in the recovery process, it is possible to enhance the ties between the communities through the implementation of familiar elements.²⁴

Temporary housing has also been recently associated with informality. The idea of informality is loosely defined, but generally refers to activities that occur outside of regulations, usually not only affecting economy but also housing and inhabitation practices. Moreover, informality may be seen as one of the organizing factors of

²³ Jigyasu Boen. *Cultural Considerations for Post Disaster Reconstruction: Post-Tsunami Challenges*: Asian Disaster Management News, 2005.

²⁴ Joseph King, Gamini Wijesuriya, and Jennifer Copithorne. "Integrating Traditional Knowledge Systems and Concern for Cultural and Natural Heritage into Risk Management Strategies." The World Heritage Centre for the International Disaster Reduction Conference (IDRC), 2006.

urban transformation in general. Urbanization has become an integral component in human's lives, with just as important an effect on displaced people and refugees. This effect of informality on urban organization is seen within large camps, especially when the needs of the refugees might not necessarily align with the geopolitics of the hosting country, leading to them taking matters into their own hands and adapting their environment.

Informal housing is often produced through self-help and lacks services like water, sanitation, proper roads, consistent electricity, medical care, and education. Houses are also built in many phases because of the financial strain. Refugees occupying these houses often get stuck there for a much longer time than anticipated, something that started with Palestinian refugees and has become more and more common.²⁵

²⁵ Romola Sanyal. "How Refuge Creates Informality"

CASE STUDIES

Below is an overview of sixteen shelter case studies which were carefully examined. Some of the designs presented in these case studies were entirely conceptual, while others were implemented designs that were constructed, tested, and employed in real life situations.

1) FARE Summerization

Description: FARE Studio Summerization Project was a project aimed at updating and adapting prefabricated shelters in the Zaatari refugee camp in Jordan to better respond to the Jordanian summer. The original shelters were problematic because they neglected to address ventilation, shade, as well as outdoor space. Improving comfort and privacy were two of the main goals from the upgrade.

Materials and Construction: The changes included a canopy which was created using water pipes, ropes, and plastic sheeting which lies on used car tires – this provided shade. Moreover, a simple lightweight veranda was added, with the ability to combine it with a neighbors' veranda and create an even larger shaded communal outdoor space.²⁶

²⁶ Joana Dabaj and Alberto Piccioli. "From Chaos to Dignity – the New Face of Shelter Design." Impact Design Hub. <https://impactdesignhub.org/2016/03/23/the-new-face-of-refugee-shelter-design/>.

2) SURI

Description: The Shelter Unit for Rapid Installation (SURI) is a modular housing system designed by Suricatta Systems. Initially, the unit was developed as a response to earthquake displacement, but recently it's been used for displaced communities due to conflict in the Middle East and Africa.²⁷

Life Span: 10 years

Materials and Construction: The unit is transportable and easy to assemble, with a design which consists of sections which open and attach together allowing for a high level of flexibility in form and function. SURI utilizes a lightweight framework surrounded by a UV-resistant breathable membrane called DuPont Tyvek.

To make the unit more permanent and include additional insulation, the exterior has gaps which could be filled with natural local materials. There are apertures for adjustment of interior lighting. The roof has a rainwater collection system with a filter to make it drinkable, and a

²⁷ Emma Tucker. "SURI Modular Housing System Provides Emergency Shelter for Refugees." Dezeen. <http://www.dezeen.com/2015/09/15/suri-modular-refugee-housing-system-emergency-shelter-suricatta-systems-urbana-de-exterores/>.

solar panel for powering domestic appliances. All materials used in the habitat are recyclable or biodegradable.

3) Better Shelter

Description: Ikea's Better Shelter - previously known as the Refugee Housing Unit – was developed in partnership with the UN attempted to address multiple aspects lacking in current temporary housing. One of the essential goals was to build something that resembled a house and which had the strength to last against the elements for several years. There was a focus on finding a durable, lightweight and inexpensive material.^{28 29}

Location: Iraq, Jordan

Size: 88 square feet

Cost: 10,000\$, 1000\$ with mass production

Life Span: 3 years

²⁸ *Better Shelter Unit (Refugee Housing Unit)*: UNHCR, 2015.

²⁹ Dan Howarth. "IKEA's Flat Packed Refugee Shelters Go into Production." Dezeen. <https://www.dezeen.com/2015/03/24/ikea-flat-pack-refugee-shelters-go-into-production-better-shelter-unhcr/>.

Materials and Construction: A plastic known as polyolefin foam offered a light yet durable alternative to plastic which usually disintegrates because of the sun's ultraviolet rays. This lasts 10 times longer than the canvas tents that have been the only alternative to date. The polyolefin foam is mounted on a steel structure. A new polymer called Rhulite which allows light in during the day yet blocks it during the night for privacy.

Moreover, the roof has an external screen, which provides reflection and cooling during the day and heating during the night. The shelter adjusts to the time of the day through a metallic fabric cover that reflects the sunlight during the day and traps the heat during the colder night.

Better shelter also provides electricity, generated by the roof's solar panel, to power a light and a USB outlet.

One final integral aspect is that the pieces of the shelter are flat packed into a box and meant to be assembled on site, presumably by the refugees themselves after receiving some guidance. The assembly

process is estimated to take no more than four hours. Different pieces can also be replaced individually.³⁰

4) Sandbag Shelter

Description: Nader Khalili's Sandbag shelters were designed at the Cal-Earth Institute. The sandbags form arch-shaped adobe housing, which is structurally stable, withstands the elements, and makes use of available war materials. The arches, domes and vaults are used to create single and double curvature shell structures. The shelters can not only be hastily built with high insulation values, but have forms which are stable in structure, sensitive to the culture, and flexible in construction. Finally, they can vary in scale and be organized in different configurations on the larger site scale, and the occupants themselves can assist with the simple building process.

The Architect, Khalil, was inspired by principles of Iranian architecture but also by Sufi philosophy. He aims to bring together the natural elements of earth, water, air, and fire, but also achieve sustainability through the use of sun and shade. Other qualities that

³⁰ Amy Barth. "Building a Better Life: A New Kind of Shelter Inspired by IKEA Furniture is Improving Living Conditions for Refugees in the World's Hot Spots." *Junior Scholastic* 118, no. 4 (2015).

come through in his designs are symmetry and geometry as well as tension and compression.³¹

Location: Iran

Size: 14 square meters

Cost: 4\$

Materials and Construction: The sandbags are filled with earth from the site itself, then placed in layers. Barbed wires line those layers and acts as mortar. For further stabilization, materials like cement and lime are added.

5) Nepal Shelter Project

Description: The Nepal Shelter project, based on Shigeru Ban's design – looks back to traditional Nepalese construction methods. The design proposes a timber structure which is used in combination with disposed brick. The brick usually comes from collapsed houses nearby. The advantage to utilizing this method is speed. Once the initial timber structure is up and the roof is present, displaced communities

³¹ "Sandbag Shelter Prototypes." Aga Khan Award for Architecture.
<http://www.akdn.org/architecture/project/sandbag-shelters>.

can immediately move in, as the hollow walls can be slowly filled in with brick over time.³²

Location: Nepal

6) Rapid Deployment Module

Description: Visible Good has designed its' Rapid Deployment Module, which has been used as a shelter, as well as for the U.S. military.³³

Location: Oklahoma, U.S. military

Cost: \$15,000

Materials and Construction: The RDM is an insulated, secure and semi-permanent shelter for areas with displaced people. The module consists of 40 pieces that can be easily transported and assembled with no need for special skills. The Module boasts an integrated wall structure, which makes it slightly higher than the ground – something which helps with either having a wet ground or insects. The RDM is valuable because it matches the speed of transporting and assembling tents, but it offers more in terms of durability, security, and climate

³² Joana Dabaj and Alberto Piccioli. "From Chaos to Dignity – the New Face of Shelter Design."

³³ "Shelter: The RDM." Visible Good. <http://visible-good.com/shelters/>.

sensitivity. It has hard walls, doors with locks, and windows. The interior is well insulated and the roof is vented. In addition, a shade fly is provided and assists with passive cooling and heating. The setup takes 2 people about 30 minutes, which is very quick. Finally, it has multiple configurations within the one unit and the different units can be attached to form larger units.

7) Agrishelter

Description: “Agrishelter,” was designed by Nagres Mofarahian from Italy. It won the The What Design Can Do Refugee Challenge, a global design competition which opened the door for community members to innovate ideas and designs in order to aid in the development and accommodation of refugee housing. The design proposed a solution grounded in social, urban, environmental, and economic factors.³⁴

Location: Europe

Size: 35 meters square

Materials and Construction: The materials are available, biodegradable, and durable. Similar to other recent shelter designs, it

³⁴ Anna Winston. "What Design can do Launches Design Challenge to Create Solutions for Refugees." Dezeen. <http://www.dezeen.com/2016/02/19/what-design-can-do-launches-refugee-challenge-ikea-foundation-democratic-design-days/>.

can be constructed within a few hours as well as easily reconstructed and refugees can help even if they have minimal skills. The frame foundation is made from prefabricated wood and the walls themselves are made out straw bales, which are readily available in European cities. The structure is also equipped with wooden doors and window frames. A folded canvas roof has a cistern on the north side for rain collection. The shelter is specifically meant to be built on urban sites.³⁵

8) winterHYDE

Description: The billionBricks non-profit architecture and design group has developed a lightweight shelter called winterHYDE. The shelter is fully insulated despite its minimal weight, and is designed to house a family of five. The main aim of the project was to serve the urban poor but it has expanded to incorporate refugees and displaced communities. One special and often neglected facet that winterHYDE addresses is waste. All the pieces which makeup the

³⁵ "What Design can do: Agrishelter." What Design Can Do.
<http://www.whatdesigncando.com/challenge/project/fast-housing-around-the-city/>.

structure can be reused – this includes repurposing for plumbing, electric coverings, and even blankets.³⁶

9) Tentative

Description: In 2011, an earthquake with a magnitude of 7.2 hit eastern Turkey leaving thousands displaced. What became known as “tent cities” spread around Turkey but shelters were inadequate and did not withstand the elements. The Turkish design firm, Designnobilis, noticed the underperformance of the tents being used and came up with the design for the “Tentative”. The purpose was to provide a smart compact flat packed shelter for easy transport and assembly.

Location: Turkey

Size: 86 square feet, height of 8 feet

Cost: \$2500

Life Span: 3-4 months

Materials and Construction: The firm identified the thin material of the tent and the direct placement on the ground as two of the problematic factors. Designnobilis’s solution involved elevating the

³⁶ Joana Dabaj and Alberto Piccioli. "From Chaos to Dignity – the New Face of Shelter Design."

structure, as well as replacing the thin material with perlite filled stretch durable fabric that provides adequate weather resistance and makes use of naturally abundant materials in the area. Each tent has a proper door and window, and its assembly takes under an hour with no special tools or skills. The whole structure can be folded down to a thickness of under a foot and transported easily. The shelter is designed to support displaced people for three to four months, but also assumes it would be inhabited longer.³⁷

10) **Quick Hab**

Description: Green Horizon Manufacturing has developed a shelter known as QuickHab. The main goal of QuickHab is to restore a sense of privacy, one of the losses experienced constantly by displaced people even after the initial displacement.

Location: Trinidad, India, and Peru

Materials and Construction: The entire shelter can be transported in pieces, which include a lock and key, and assembled in under four hours. It has a single frame on which the panels are fitted and the residents can choose which material they want for siding. The interior

³⁷ Diana Budds. "Refugee Architecture Gets its First Major Museum show." Fastco Design

is also split into different spaces, including a shower, toilet, and kitchenette.³⁸

11) U-Domes for Haiti

Description: An originally existing design was altered by Lebel in order to fit different needs in a different climate. Peacebuilding Solutions is now partnering with World Shelters to produce an altered version of U-Domes intended for Haiti.³⁹

Location: Haiti

Size: 200 square feet

12) Intershelter Unit

Description: Intershelter has designed a unit with circular shingles and a dome. The design is meant to withstand up to 200 mph winds. The CEO of Intershelter said that the dome contributed to the design

³⁸ Laura C. Mallonee. "Homes for Refugees: Eight New Designs for Conflict Housing." The Guardian. <https://www.theguardian.com/sustainable-business/2014/jul/30/refugee-shelters-new-designs-ikea-fema-military-haiti-jordan-syria-iraq>.

³⁹ Laura C. Mallonee "Homes for Refugees: Eight New Designs for Conflict Housing."

by adding a sense of comfort, and not allowing someone to feel cornered.⁴⁰

Location: Los Angeles, Japan

Size: 196 square feet

Cost: \$7000

Life Span: Up to 30 years

13) U-Domes

Description: In the 1970s following Hurricane Katrina, the founder of the World Shelter, Bruce Lebel, utilized modular geometry developed by the architect Buckminster Fuller to create a lightweight shelter for disasters.

Location: Ventura, California

Cost: As low as \$1,500

Life Span: Up to 10 years

⁴⁰ Laura C. Mallonee. "Homes for Refugees: Eight New Designs for Conflict Housing."

14) **Exo Shelter**

Description: Exo Shelter is a unit developed by Reaction Housing and designed by the international design firm Frog. Its stacked design is inspired by the Styrofoam coffee cup.

Size: 85 square feet

Cost: \$5000 (if full production is reached)

Life Span: 10 years

Materials and Construction: The outer shell is fastened to a base similar to how a cup and its lid snap together. The interior contains four bunk beds that can be mounted on the wall to save space or lowered to horizontal position and used.⁴¹

15) **Re:Build Project**

Description: Piosio Building Peace has collaborated with architects Cameron Sinclair and Pouya Khazeli to develop the Re:Build project – a scaffold based construction system for temporary structures. The design is meant to be flexible in function – it can transform into a house, school, clinic, or other structures. It is also meant to integrate

⁴¹ Laura C. Mallonee. "Homes for Refugees: Eight New Designs for Conflict Housing."

community interaction through a simple and short assembling process of two weeks – assuming ten people participate.

Location: Syrian Refugee Schools in Jordan, also will be used in Somalia for a refugee camp's school and market.

16) Wearable Shelter

Description: In cases when refugees make the trip to Europe, they often have to sleep outdoors. This prompted graduates from the Royal College of Arts in London to collaborate with Médecins Sans Frontières to design a coat for refugees, which could easily be transformed into a sleeping bag or a tent. The coat is called the Syrian Refugee Wearable shelter.

Location: Europe

Cost: Unspecified low cost, distributed for free.

Materials and Construction: The material used is Tyvek with mylar for lining and insulation. The low cost allows for mass production and free distribution to refugees.

When in coat form, it operates like a parka with a hood that also has pockets. When unzipped, it can be transformed into a sleeping bag, or into a tent with the additional use of kite rods. The capacity of the

sleeping bag is one adult and one child, while the tent can fit four people.⁴²

⁴² John Brownlee. "This Coat Doubles as A Shelter for Syrian Refugees." Fastco Design. <https://www.fastcodesign.com/3056042/innovation-by-design/this-coat-doubles-as-a-shelter-for-syrian-refugees>.

STUDIO DESIGN PROCESS

Following a close examination of the aforementioned case studies, specific criteria contributing to a successful design were extracted. The different criteria are as follows:

- Sustainability
- Adaptability
- Security
- Privacy
- Cost
- Local Materials
- Life Span
- Exterior Space
- Site Sensitivity
- Waste
- Electricity
- Water

Many of these elements are fluid and intersectional within design, but each is vital as an individual criterion in an ethical design. For example, local materials and waste may both intersect with sustainability, and exterior space can be considered a component of

adaptability. However, they were individually categorized for their relevance as separate entities.

Following this, a scale of 1-3 was developed. The scale was proposed based on how different criteria manifested across the case studies and then applied to each of the extracted criteria. The breakdown can be seen in Table 1 in Appendix A.

The case studies which scored highest seemed to focus on maximizing the quality of a smaller number of criteria, so taking four or five criteria all the way to the sufficient level rather than attempting to satisfy all of them.

This is likely because including a larger number of criteria becomes tricky because of tradeoffs. For example, attempting to increase the life span will make the cost higher, thus bringing the score down. Similarly, pushing adaptability could diminish security and privacy, and vice versa.

Figure 1 in Appendix B shows the visual representation of the case study overview and the criteria.

The top four scoring case studies were FARE, SURI, Better Shelter, and the Sandbag Shelter. Interestingly, FARE is in fact a summerization fit. It adapts the existing caravans present in the Zaatari camp to make them more effective for the summer months.

The reason FARE is so successful is because it does something very few designs on the list does – it pays close attention to the needs of a specific location.

By identifying some problems specific to the existing caravans on the site, the addressing solutions are simple yet highly effective. In this case, the two issues were overheating (likely because of the use of metal as a material), as well as the lack of shaded exterior space. The kit basically provides materials and tools for setting up a simple lightweight shaded roof and a verandah with a tensile covering to address both issues. Some of the secondary materials in the kit are also meant to be locally available ones which further elevates the project.

SURI's biggest strengths are its adaptability and its expected life span. No other model offers the same level of flexible attachments within its units. Each unit can attach to another from the two sides, and the wall structure is designed to fold giving an additional layer of flexibility.

Looking further at SURI, the design offers various other elements which include natural lighting and solar panels, walls which can be filled with natural materials, rainwater collection, and recyclable/biodegradable materials. However, SURI does have one

major flaw. It is still not location or site specific which means it will fail to use local materials and pay attention to the local architecture.

IKEA's Better Shelter is an interesting case. The design was named the 2016 Beazley Design of the Year and has received the most attention from the architectural and humanitarian worlds. It boasts the use of recyclable plastic, a solar panel, and a short assembly time of as little as four hours.

Even though it has actually been used in the Zaatari camp, among others, the shelter is similarly still not adapted or designed for a specific location. Moreover, the shelter offers no flexibility in its assembly other than the placement of the doors and the panels seem to sag in the deployed physical models in comparison to their perceived rigidity in the digital renderings. Finally, a recent report states that the shelter is to be redesigned due to safety issues and design flaws, including fire risks and accessibility issues with the door placement.⁴³

Finally, Nader Khalili's Sandbag Shelters is one of the top four, primarily because it shares one rare quality with the FARE summarization project – it is location specific. Because it pays attention to the vernacular architecture of Iran, it manages to

⁴³ "Ten Thousand IKEA Refugee Shelters Left Unused Over Fire Fears, United Nations Admits." Dezeen. <https://www.dezeen.com/2017/04/29/united-nations-admits-10000-ikea-better-shelter-refugees-mothballed-fire-fears/>.

successfully create an adaptable unit which suits the climate and serves the residents' needs well. In addition, the sandbag shelters second prominent strength is its incredibly low cost – 4\$. It achieves this by utilizing sandbags left over from the war as primary building materials.

Following the analysis and reexamination of strengths within the four highest rated shelters, the design process began. Because of my limitations as an architecture undergraduate student, I decided to forgo attempting a comprehensive technical design, and to instead put forward a set of conceptual design techniques that are formed based on the aforementioned process and criteria.

This decision proved valuable because it makes sure this is not presented as a design which stands as a solution on its own, but rather the beginning of the process of rethinking the way we design for refugees.

This also allowed me to address issues outside the sphere of design which directly affect it, like infrastructure for electricity and water. It is fruitless to incorporate those elements into a design when the infrastructure for them is not available. Moreover, it is crucial to bring these issues up from the policy angle because that is truly what determines their availability.

Design fails when it imprisons itself within its own discipline and in order to effectively address an issue as complex as a refugee shelter, the design itself needs to transcend the boundaries of its own limitations.

The design process commenced with the adaptability criterion because it presented itself as something the current shelters in Zaatari truly needed. The first step was the floor plan, which attempted to address the amount of space one person needs, as well as pay attention to international guidelines. The goal was to provide the maximum amount of space possible while keeping cost and site limitations in mind, as well as to cater to families with different numbers of individuals and different needs.

I began going through different iterations of plans and quickly realized that my design needed to have units which could attach to other units. Wanting to avoid creating another enclosed box – something I felt the caravans and the Ikea shelters were doing – I attempted to incorporate some interior accessible courtyards. This caused the components I was attempting to design to have multiple corners which was very problematic to cost. This can be seen in Figure 2 in Appendix B.

From there, I began transforming and simplifying the design until I ended up with two perfect squares, one for a core unit, and one

for a supplementary unit. Both have an area of 16 square meters. The final plan can be seen in Figure 3 in Appendix B.

It stemmed from experimenting with coming up with the least number possible of components that could offer the greatest number of variations. With a square plan, I was able to not only break apart my components into a core and supplementary unit, but also break down the walls of those units and have multiple variations with similar sized wall panels. A solid panel, door panel, and window panel. This can be seen in Figure 4 in Appendix B.

From this initial flexible unit which could be adapted to fit different configurations and serve various needs, I began applying each of the criteria I had extracted from the case study in a way I thought was sensitive to the needs of Zaatari, and without compromising other criteria.

For sustainability, the core unit has a tilted roof to install solar panels and utilize the solar power which will be provided by the solar power plant currently being built in Zaatari. For security comes the installation of doors, as well as the flexibility to decide where those doors would be placed.

For privacy, the core unit has one embedded southern facing window for natural light and ventilation, and the window could come

with some form of shades or shutters. Other window panels can be placed if and where the residents want them, so in cases where they might want a more private room, they could utilize solid walls for all the exterior facing walls. Similarly, if they want a more open room – possibly for commercial space or a shop – they could place more window or open panels. This helps cater to the separate private and public spheres of their lives.

In terms of exterior space, the tilted roof extends out on the southern side to provide a shaded small area for sitting outside when desired. It is not as effective as an interior courtyard would have been but this is one tradeoff where the cost and space sacrifices would have been too high.

However, one additional way exterior space can be cultivated is through the different configurations of the units themselves, where extended families could place their differently sized and shaped shelters next to each other in a specific way creating an interstitial space between that can become a community space that is semi-public, semi-private. This could become problematic when looking at the lack of infrastructure as sanitation and health risks may arise so that is definitely a concern. Still, the option to have those different configurations could prove beneficial for fostering different exterior spaces. This can be seen in Figure 5 in Appendix B.

As mentioned previously, electricity and water issues are more relevant to address in policy recommendations rather than design. With the flexibility of the supplementary unit, it could be adapted to become either a bathroom or a kitchen. Both of those would be beneficial in Zaatari, due to the aforementioned dismantling and privatization of things like communal bathroom components.

Even though some reports state that the long term plan is progressing towards a permanent city with proper paved streets, electrical grids, and waters and sewage systems, there are no specifics available on when or how that will occur. Moreover, the little documentation available on formal building codes does report limitations on tree planting and road pavement. Thus, those codes certainly need to be revised and a comprehensive code for this camp as well as other camps should be introduced.

A detailed plan for building this infrastructure in Zaatari would be valuable. Displacement is not an issue that is going away any time soon and we would do better to begin properly providing support to these camps rather than force them into poor conditions because of regulations and pretend their temporariness – which we know now it not the case – is reason to not properly supply them with the necessary amenities.

Two of the criteria that I do not address are site sensitivity and waste. Even though I've examined multiple maps of the site and read all the literature available on the dynamics within, I feel like I do not have an understanding of the conditions that is coherent enough for me to say I've addressed it. The one way I think I begin to approach that is my proposal of using the different panels to create a commercial space that can be separate from the living quarters but attached to the unit. Since the 3000 stores and the merchant nature of the camp are central to Zaatari's identity – the one that the refugees themselves have brought about – allowing that to be integrated into the site is a preliminary step to start addressing those conditions. However, this takes a social angle of the conditions, not physical. The physical site conditions remain largely unaddressed.

Local materials proved to be the biggest challenge in the design process. Primarily, material choice directly affects cost and life span. Cost is so important because it impacts feasibility. If the cost is too high, everything else is futile because the project cannot be realistically implemented. Life span is similarly vital because it revolves around the issue of temporariness vs. permanence, a concept at the center of the issue of our inadequate shelters and insufficient responses to temporary housing.

One determinant in the material process is also location of production and the details of construction and assembly. Due to space and safety issues, construction cannot take place on site. Thus, prefabrication followed by transportation to and assembly on site seems like the only viable option.

The most common local material is stone but that is too heavy to work with an adaptable design, too difficult to transport, and cannot be prefabricated. Next to stone, fabrics are seen in Bedouin tents, which are traditionally woven from goats' hair.

In order to address the prefabrication aspect and still utilize a local material, it became necessary to imagine a surface made of two rigid layers with a layer of insulation on the inside.

Pulling those elements together made the general category of woven cloth/thread made tensile the most viable option. This stemmed from looking at what's available locally as well as paying attention to desert architecture and the design of the Bedouin tent.

The material can be prefabricated, stretched, and made rigid in a process similar to that in fiberglass production. Then the insulation layer - something light and thick like foam – can fill the middle part between the two rigid panels. This whole wall panel can then attach to the core or supplementary unit which would have the posts, likely with

a structural system using bolts. This can be seen in Figure 6 in Appendix B.

This design would utilize local materials, be relevant to the architecture of the desert (the Bedouin tent), appropriate for the climate, light in weight, possibly organic, and would avoid importing from abroad and shipping in. Even if it's pre-fabricated outside the walls of the camp, it still utilizes local materials and manufacturing resources and redirects the funds appropriately.

Moreover, while the IKEA design is struggling, the company just announced that it plans to hire and 20,000 refugees from Zaatari to work in production centers that it will open in Jordan. The project aims to combine IKEA's resources and technical skills with the refugees own crafts and skills. This could be a wonderful opportunity to facilitate the production of the building materials for the shelter.⁴⁴

⁴⁴ Marcus Fairs. "IKEA Aims to Take 200,000 People Out of Poverty in Massive Social Sustainability Drive." Dezeen. <https://www.dezeen.com/2017/04/18/ikea-massive-social-sustainability-drive-production-centres-refugee-camps-jordan/>.

CONCLUSION

Rethinking refugee shelter design is necessary. The reality is that displacement is and will remain prominent in our society, and that it will continue to affect millions of people.

In order to better assist those vulnerable communities, we need to start building better shelters and better infrastructure to last longer and serve their needs better. The term “temporary” has changed and our response needs to change with it in order to prepare better for the birth of these instant cities.

To build ethical shelters, we need to pay attention to things like adaptability, sustainability, and local materials and resources. This allows us to design in a more sensitive way that attempts to sufficiently address the needs of the inhabitants in a more humane manner.

For the Zaatari refugee camp, this begins with creating an adaptable shelter that allows different families to have different amounts of space, and leaves room for fostering different types of space as well, particularly commercial ones which refugees have brought into the camp.

Moreover, it begins with a clear plan for creating the proper infrastructure – paved streets, electricity, water, and greenery – in

order to elevate the health and sanitary conditions of the camp, and to then allow the design to begin addressing functions like bathrooms and kitchens within its units.

It continues with utilizing local materials and resources to not only design with lower cost and a longer life span, but be sensitive to local architecture and the climate.

Finally, one must realize that this is all the beginning of a very complex journey that will take time and commitment from many individuals and organizations, but change is necessary and design needs to inform as well as be informed by its surrounding sphere.

Design can only go so far when challenged by the limitations of politics and regulations. While as designers, we must continue to develop more viable solutions, we must also realize that the political will and proper regulations need to be established before we can truly rethink the way we design shelters.

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APPENDICES

Appendix A: Shelter Design: Extracting Criteria

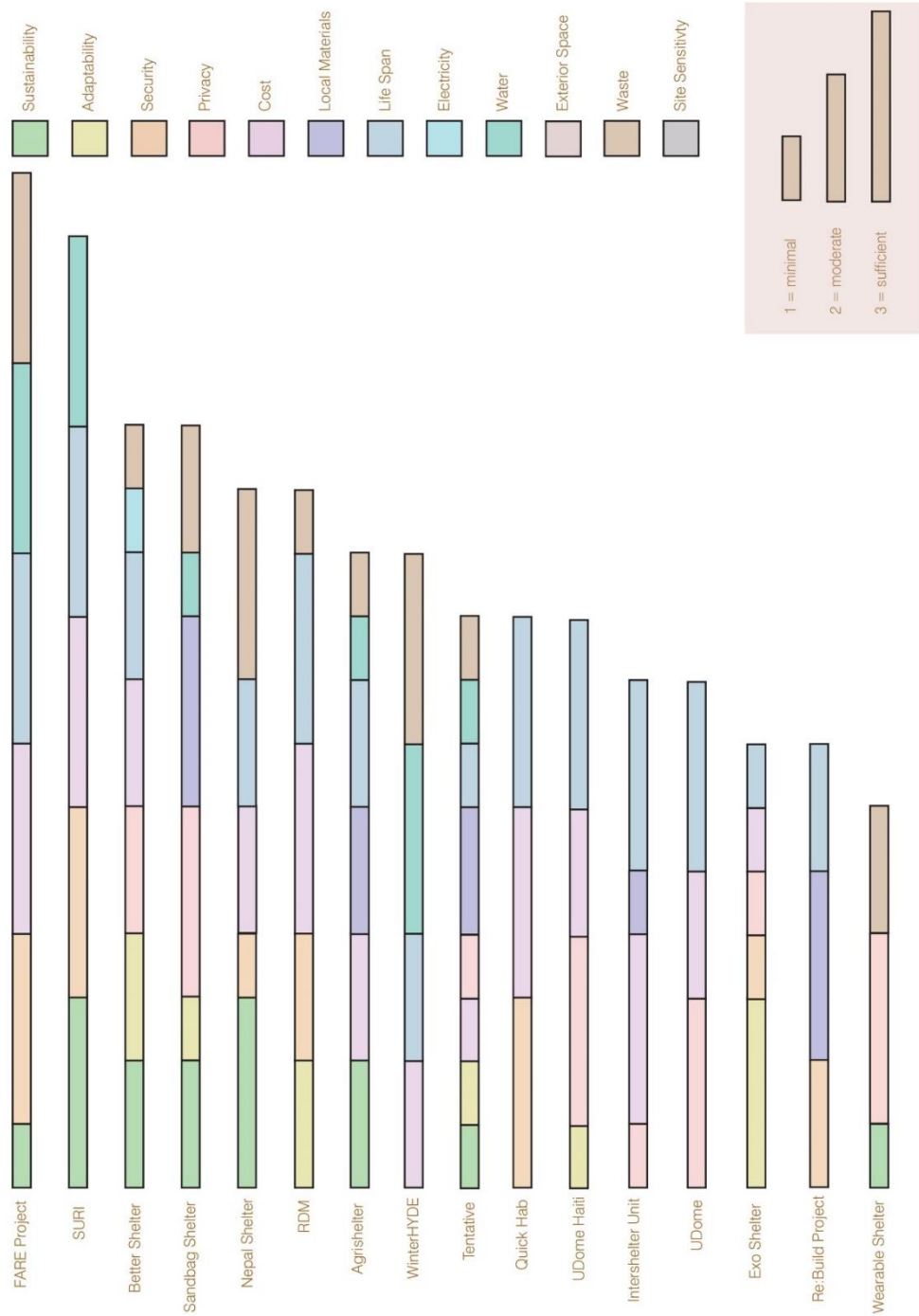
Table 1.

Criteria/Scale	1 (minimal)	2 (moderate)	3 (sufficient)
Sustainability	passive heating and ventilation techniques	solar power or other forms of renewable energy to produce a small amount of power, combined with passive heating and ventilation	solar or renewables to provide a considerable amount of the inhabitants power needs
Adaptability	Different placement of doors, windows, exterior walls	Different interior breakdowns, partitions	Entire unit expands and connects to other units for different amounts of space and different configurations
Security	Zipper/latch for fabric opening	Door with interior lock	Door with interior and exterior lock, protection for windows
Privacy	Fabric/non rigid walls	Rigid walls, not opaque at night	Rigid walls, no opaqueness, shades for windows
Cost	Over \$5000	\$1000-\$5000	\$1000 and under
Local Material	Attempts to use one local material for any part of the shelter	Uses more than one form of local materials	Local materials are integral to the design and

			compose a large part of it
Life Span	Under 5 years	5 to 10 years	Over 10 years
Exterior Space	Extended roof/canopy/platform	Veranda or courtyard	Veranda or courtyard with connections to separate units
Site Sensitivity	Considers site conditions	Considers site conditions and infrastructure	Site conditions, infrastructure, and urban organization are integrated into the design
Waste	Considers waste as a factor	General waste and recycling plan is presented	Detailed waste and recycling plan, use of biodegradable materials
Electricity	Enough to power one outlet/provide light during the night	Enough to power several outlets/provide light for the majority of the day	Enough to sufficiently satisfy complete power needs, assuming electricity is renewably produced (i.e. solar)
Water	Water trucked in and out	Partial system for plumbing	Sufficient plumbing, filtration of drinking water

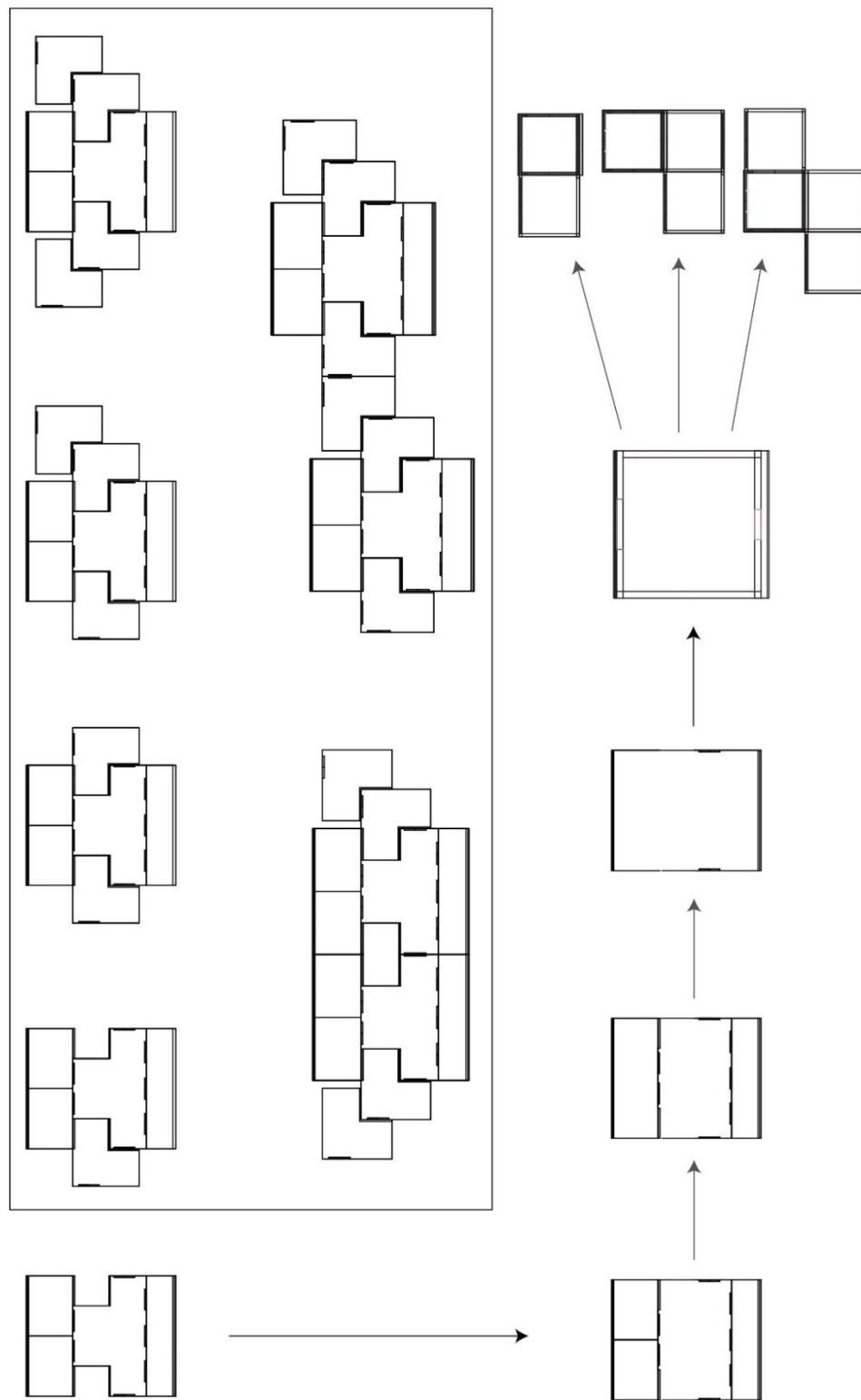
Appendix B: Shelter Design: Diagrams and Drawings

Figure 1.



Evaluation of Case Studies Based on Extracted Criteria: Visual Representation

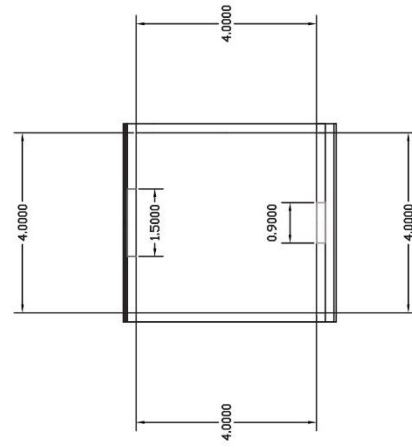
Figure 2.



Simplification of Plan: Design Process

Figure 3.

PLAN



The supplemental unit is identical in size to the core unit, but stripped down further. There is no tilted roof or window wall - it is merely a floor, roof, and four posts that the panels can attach to.

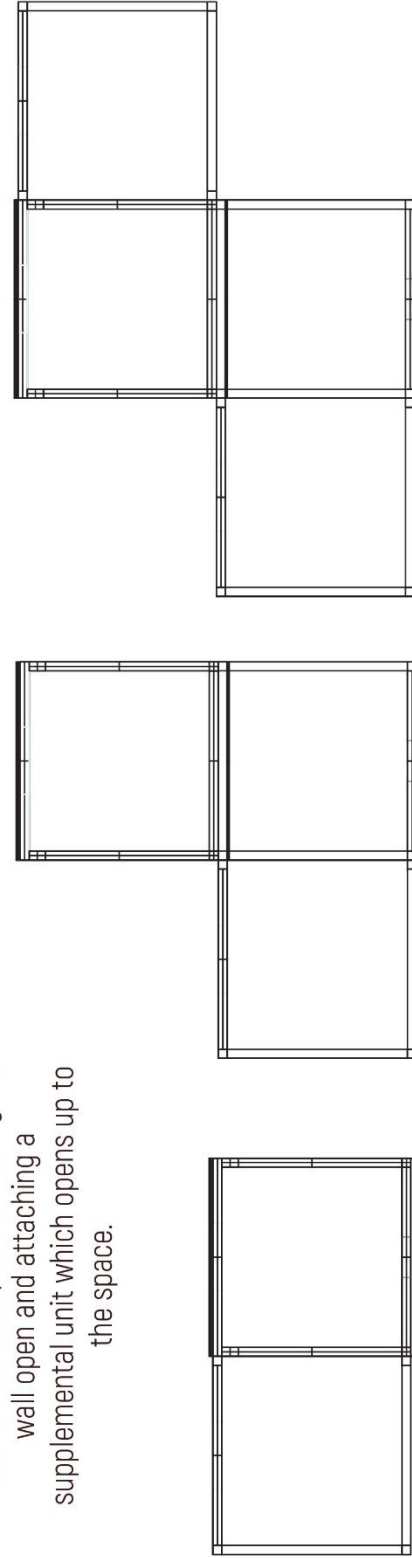
This allows for flexibility in choosing the placement of the panels into each unit, which translates into flexible overall units that attach together in various different ways according to individual needs.

The plan for the core unit is stripped down to its essential basics. A floor, one wall with a southern facing window, and a tilted roof for solar utilization.

The three open walls can be filled with either of the three options:

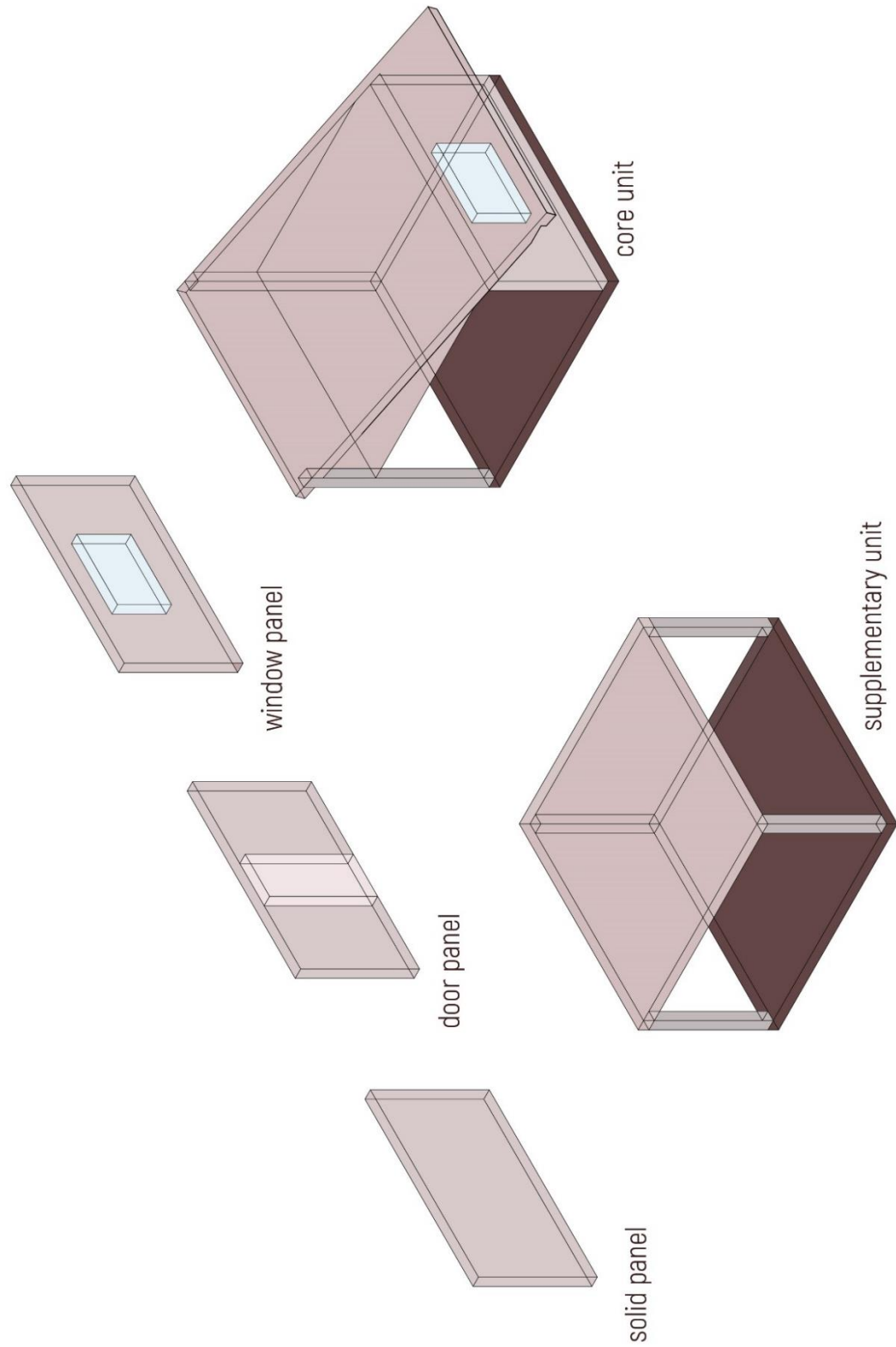
- A solid wall
- A wall with a door
- A wall with a window

There is also the option of leaving the wall open and attaching a supplemental unit which opens up to the space.



Final Plan (not to scale)

Figure 4.



Wall Panels, Core Unit, Supplementary Unit

Figure 5.

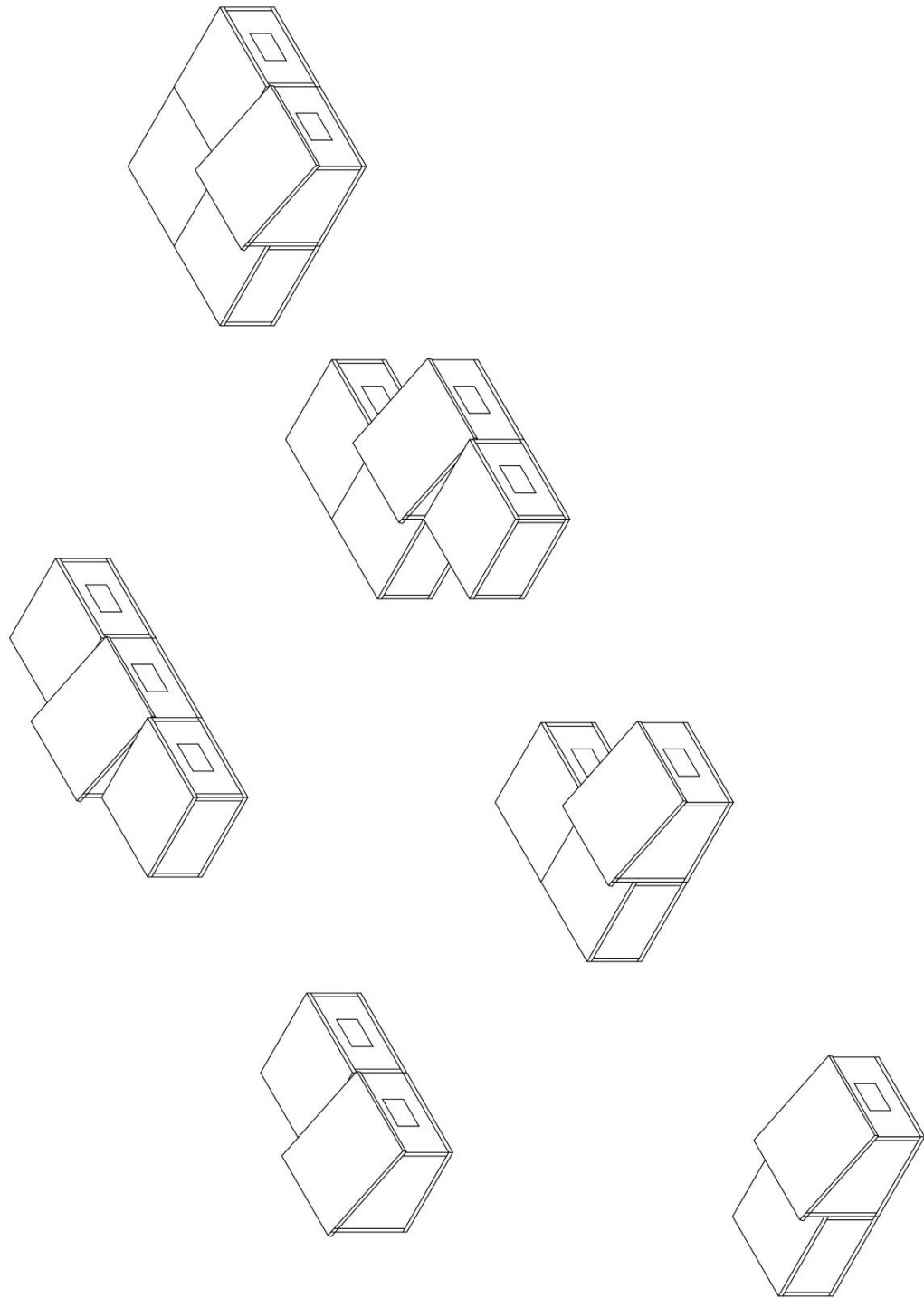
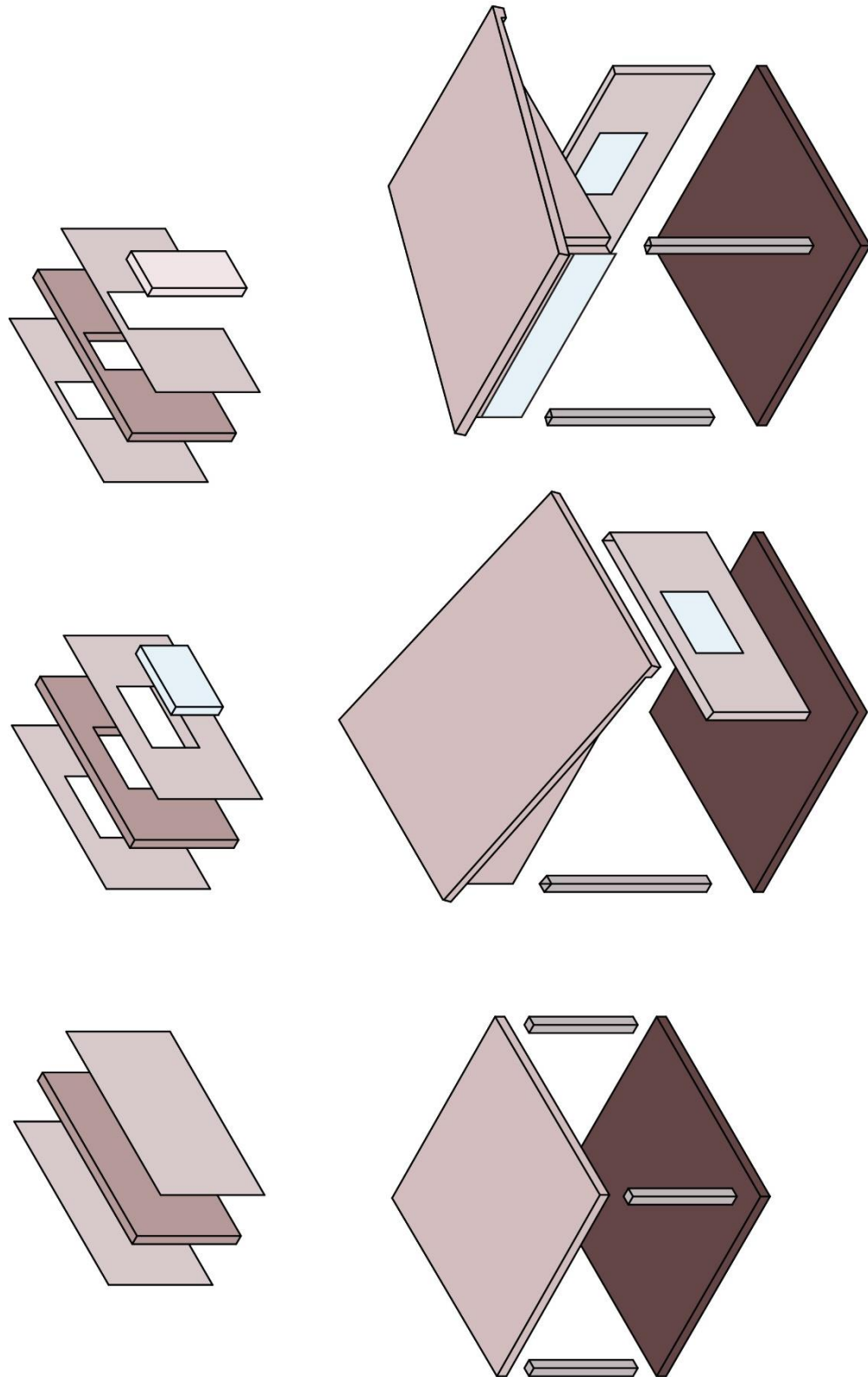
*Configurations and Alignments of Different Units*

Figure 6.



Breakdown of Wall and Unit Components