

PORTABLE POST-DISASTER HOME

Providing a long-term temporary solution for the displaced people affected by
natural disasters

by

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presented to the University of Waterloo
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Master of Architecture

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

According to the United Nations statistics, an average of 26.4 million people have been displaced per year because of natural disasters. In other words, one person loses his/her home every second. This is while these figures do not even include the number of people who have become homeless or are forced into living in terrible conditions because of wars and violence, or other issues such as financial difficulties. Sadly, the number of displaced people are increasing every year; this is while so many critical issues such as lack or shortage of proper housing or shelter, food, water, sanitary facilities and many other problems have still been left unresolved for those who have been displaced years ago. Because of the importance of the living environment on one's mental and physical health, my thesis is focused on designing a portable dwelling unit that would be used as a long-term temporary solution primarily by the displaced people who have lost their home due to natural disasters. The proposed dwelling unit would be transportable and would include basic sanitary facilities such as toilet, wash basin, shower, and a mini kitchen, along with other spaces needed for a comfortable life. It would also be able to operate on the grid as well as off the grid for sites where no or little infrastructure is provided. The main goal of this thesis is to propose a light-weight, cost efficient, and compact dwelling unit by exploring the concept of "expandability" and to provide the displaced people with a safe, healthy, and comfortable living environment.

ACKNOWLEDGEMENTS

I would like to thank John McMinn for his constructive criticism and technical comments. Thank you for your tremendous patience and wisdom. Thanks to Rolf Seifert for believing in my work from the very first day we met. You have been an incredible open-minded advisor with wide ranging, keen insights. I would also like to thank Ila Berman who pushed me to explore as many ideas as possible and who has been always a firm believer in human rights for everyone. Thanks to my mother, my brother, my late uncle and grandfather who made me believe in myself ever since I was a little child. Mom, you have dedicated your whole life to me. You gave up all your dreams to take care of me and give me a better life. You are the reason for everything I do. Mahdi, you have always made me feel safe and protected. Thank you for encouraging me to continue my education and pursue my dreams. Dear Dayi and Pedar, thank you for making me believe I am capable of achieving the biggest dreams in the world. Your strong belief in me always made me feel special.

DEDICATION

This thesis is dedicated is to my mother who gave up all her dreams and stayed beside me every step of the way. It is also dedicated to all innocent families who lose their beloved home, family members, and friends to natural or man-made disasters but stay forgiving, caring, and kind-hearted.

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Fig 1.02 <http://blogs.ft.com/photo-diary/tag/earthquake/>

Fig 1.03 http://www.thegospeltruthnewspaper.com/01_04_2015_archive.html

Fig 1.04 <https://pumabydesign001.com/fema-please-help-us/>

Fig 1.05 By Author

Fig 1.06 By Author

Fig 1.08 By Author

Fig 1.09 By Author

Fig 1.10 By Author

EMERGENCY SHELTER

Untitled Image <http://www.wbur.org/npr/491328153/rescue-crews-race-to-find-survivors-in-rubble-of-quake-hit-italian-towns>

Fig 2.01 <https://bridgeofpeacesyria.wordpress.com/01/01/2016/building-a-house-to-make-a-home-at-al-waleed-refugee-camp-syria/>

Fig 2.02 <http://www.pri.org/stories/22-03-2012/fault-line-haiti2011->

Fig 2.03 <https://tomostyle.wordpress.com/tag/earthquake/>

Fig 2.04 http://www.michelepero.it/dt_gallery/syria-the-forgotten-refugees-of-azaz/

Fig 2.05 http://www.michelepero.it/dt_gallery/syria-the-forgotten-refugees-of-azaz/

Fig 2.06 By author

Fig 2.07 <http://www.clairemartinphotography.com/photo-essays/haiti-aftermath/petitionville-club-life-in-haitis-tent-cities/Untitled10-fuji/>

Fig 2.08 <http://wypr.org/post/-5years-after-haitis-earquake-where-did-135-billion-go#stream/0>

Fig 2.09 <http://www.jagaranepal.org/case-studies-on-immediate-impact-of-earthquake,-jaisithok,-kavre>

Fig 2.10 <http://www.pri.org/stories/22-03-2012/fault-line-haiti2011->

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Fig 2.14 <http://www.huffingtonpost.in/08/05/2015/nepal-earthquake-relief-survivors-battle-for-helicopters-near-v/>

Fig 2.15 <https://www.pinterest.com/pin/430375308112698844/>

TEMPORARY HOUSING

Untitled Image <http://www.japantimes.co.jp/news/12/05/2015/national/social-issues/dog-savior-tsunami-survivor-now-dying-friend/>

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PRECEDENTS

Untitled Image <http://www.archdaly.com/-15/489211things-you-didnt-know-about-shigeru-ban/5330334cc07a800de15-5000086things-you-didnt-know-about-shigeru-ban-photo>

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Middle Left <http://www.archdaly.com/-15/489211things-you-didnt-know-about-shigeru-ban/5330334cc07a800de15-5000086things-you-didnt-know-about-shigeru-ban-photo>

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Fig 4.7 <http://wgno.com/28/08/2016/the-katrina-survival-story-you-never-heard/>

Fig 4.8 <https://www.pinterest.com/pin/469922542338707264/>

Fig 4.9 <http://www.greenprophet.com/03/2015/first-earth-architecture-festival-in-iran-would-make-nader-khalili-proud/>

Fig 4.10 <http://www.archdaily.com/-15/489211things-you-didnt-know-about-shigeru-ban/5330334cc07a800de15-5000086things-you-didnt-know-about-shigeru-ban-photo>

Fig 4.11 Left <https://www.pinterest.com/pin/154389093450536844/>

Right <http://www.archdaily.com/489255/the-humanitarian-works-of-shigeru-ban/532b2346c07a80b50b-000029the-humanitarian-works-of-shigeru-ban-image>

DESIGN PHASE

Fig 5.01 From left to right :

<http://inhabitat.com/boxhome-small-living-inside-a-stylish-norwegian-box/>

<https://divisare.com/projects/-303224recetas-urbanas-casa-pollo>

<http://2s4oaa1fdmv1w8m4b3zhbsadcu.wpengine.netdna-cdn.com/wp-content/uploads/06/2014/exoshelter.jpg>

<http://www.archdaily.com/776931/muji-unveils-tiny-prefabricated-huts-at-tokyo-design-week/564bac25e58ece8c-42000118muji-unveils-tiny-prefabricated-huts-at-tokyo-design-week-image>

<http://qz.com/448959/japanese-prefab-tiny-homes-could-change-the-way-we-think-about-disaster-housing/>

<http://artasiapacific.com/Blog/ArtCrush2014AndTheOpeningOfTheShigeruBanDesignedAspenArtMuseum>

<http://www.microcompacthome.com/company/?con=ltid>

<http://www.iflscience.com/technology/harness-power-wind-and-sunlight-live-eco-friendly-egg-house/>

<http://www.iflscience.com/technology/harness-power-wind-and-sunlight-live-eco-friendly-egg-house/>

<http://www.iflscience.com/technology/harness-power-wind-and-sunlight-live-eco-friendly-egg-house/>

<http://www.iflscience.com/technology/harness-power-wind-and-sunlight-live-eco-friendly-egg-house/>

<http://www.iflscience.com/technology/harness-power-wind-and-sunlight-live-eco-friendly-egg-house/>

Fig 5.02 From left to right :

<https://sourceable.net/self-sustained-modules-offer-maximum-adaptability/>

<http://www.zerogroup.org/index.php?/projects/floating-pier/>

<https://www.designer.com/news/8300>

http://n55.dk/MANUALS/MICRO_DWELLINGS/micro_dwelling.html

<http://inhabitat.com/tag/micro-house/>

<http://interiorator.com/omg-30-night-tokyos-nakagin-capsule-tower/>

<https://marnoldmarchthesis.wordpress.com/09/2012/page/2/>

<http://www.architectsmith.com.au/>

Fig 5.03 From left to right :

<http://www.greggfleishman.com/structures.html>

<http://inhabitat.com/jean-prouves-maison-8-x-8-pioneered-affordable-prefab-design-way-back-in-1948/>

<http://news.hkpeanut.com/archives/2880>

<https://referenciasdearquitectura.wordpress.com/22/10/2012/system-3oskar-leo-kaufmann2/>

http://90.146.8.18/en/archives/picture_ausgabe_02_new.asp?iArealID=425&showArealID=455

<https://www.pinterest.com/pin/544935623633517663/>

<https://ifitshipitshere.blogspot.ca/09/2013/the-urban-campsites-coolest-caravan.html>

<http://www.shedworking.co.uk/-252/07/2009living-area-mobile-mini-house.html>

<http://www.shedworking.co.uk/-252/07/2009living-area-mobile-mini-house.html>

<http://www.shedworking.co.uk/-252/07/2009living-area-mobile-mini-house.html>

<http://www.shedworking.co.uk/-252/07/2009living-area-mobile-mini-house.html>

PRECEDENT ANALYSIS

Fig 6.01 <http://www.jebiga.com/hong-kong-micro-apartment-gary-chang/>

Fig 6.02 <http://www.jebiga.com/hong-kong-micro-apartment-gary-chang/>

Fig 6.03 By Author

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Fig 7.16 <http://dornob.com/expandable-furniture-pulls-out-all-the-stops-for-your-space/>
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Untitled Image By Author
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<http://www.bettershelter.org/insecurities-tracing-displacement-and-shelter/>
<https://www.pinterest.com/pin/469922542338707264/>

<http://www.reactioninc.com/exo>

<http://www.archdaily.com/489255/the-humanitarian-works-of-shigeru-ban>

http://www.wikiwand.com/en/FEMA_trailer <http://www.japantimes.co.jp/news/12/05/2015/national/social-issues/dog-savior-tsunami-survivor-now-dying-friend/>

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Fig 10.01 By Author

Fig 10.02 By Author

Fig 10.03 Photos By Michel Caron

Fig 10.04 <http://www.saturviit.ca/wp-content/uploads/2015/08/Chapter-1-Housing-Shortage-and-Homelessness.pdf>.

Fig 10.05 By Author

Fig 10.06 By Author

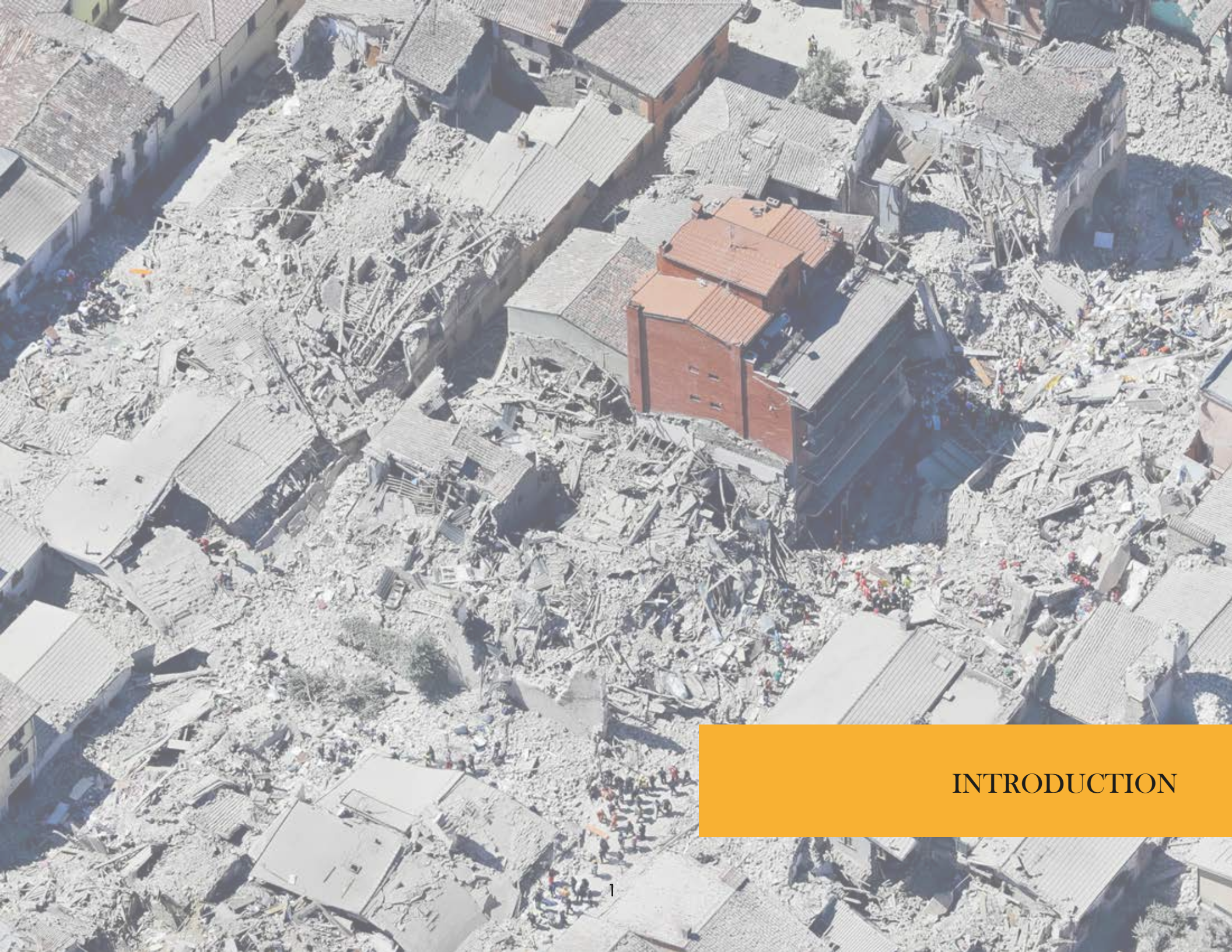
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INTRODUCTION

INTRODUCTION

For most of us, human catastrophes that emerge after natural disasters are distant stories until an earthquake, a hurricane, a flood or some other kind of disaster strikes a region and the media brings images of suffering and helplessness into our cozy living rooms. Curled up on our comfy sofas and enjoying a warm cup of tea, we are moved by the heart wrenching photographs of the destroyed houses, the grieving survivors, and the innocent victims. To ease our mind a bit, we reach for our checkbooks and return to our comfortable lives until nature strikes back again. We barely think this could happen to us one day. We are shown pictures of the poor people living in tents after losing everything they had, forgetting that many of them were like us who were pushed into poverty. However, nature does not discriminate. The world is already five times more disaster-prone as it was in the 1970s because of climate change. 3,496 natural disasters were reported in the first decade of 21st century as opposed to 743 catastrophes in 1970s.¹ We are in fall 2016 and the North Pole is already about 20C [36 degrees Fahrenheit] warmer than normal. As glaciers, ice sheets, and icebergs melt in the Arctic and Antarctic, the water volumes expand and ocean water levels rise, and coastal cities and low-lying areas will be flooded in the near future. Millions of people will be affected in some of the world's most populous metropolitan areas such as New York (USA), New Orleans (USA), Boston (USA), Mumbai (India), Nagoya (Japan), Osaka (Japan), and Shenzhen (China).² It is undeniable that the world is facing a rapid increase in the level of human suffering more than ever before. The number of displaced people caused by natural disasters has reached staggering levels.



Fig 1.01 Tsunami 2004 newspaper headline



Fig 1.02 Central Italy Earthquake 2016.

According to statistics, since 2008, an average of 26.4 million people have been displaced per year because of natural disasters. In other words, one person loses his/her home every second.³ Besides the increasing number of people who have been displaced and need humanitarian aids following recent disasters, there are also those who have lost their homes and are living in terrible conditions since many years ago. Sooner or later, politicians, decision makers, and architects should come into grips with the fact that anyone can be a victim of a natural catastrophe. We have turned disasters into crisis by designing and implementing solutions that focus on social status and class rather than humanity. Many of us have been convinced that when we are building a post-disaster shelter, four walls and a roof will be sufficient enough for people who have lost everything. "They should be grateful for not sleeping in the open," and "these are poor people who are used to living in difficult situations," are two things I heard so often when disaster relief shelters were being discussed. I firmly believe, there is only one remedy to the way we perceive victims and design for them: design for "you". When the "helpless victim" is changed to "you", a clean private space for cooking, a bathroom for washing up and cleaning up, and a secure comfortable space for sleeping and living in peace becomes your "basic human right" rather than "luxury". Walking long distances to bring unclean water for your family, spending nights with a candle, or sleeping on cold floor would not be considered acceptable anymore when the designer thinks of himself/herself as the ultimate user. Deciding about what kind of living environment the disaster survivors must live in is so easy when we are sitting on our comfortable sofa by the fireplace with the lights on and fresh drinking water is a couple of meters away from us. It is not

surprising that designers and politicians argue that temporary dwellings are a waste of money and that organizations should invest in building permanent houses rather than long-term transitional shelters. Architects spend a lot of time arguing about whether the newly constructed houses should be vernacular or not, or whether the people should be involved in the design and construction process, or what recycled materials can be used that would showcase their creativity better. These may be valid subjects to be discussed however only after making sure the survivors live in safe and standard temporary dwellings until permanent reconstruction begins. Rebuilding houses is a very lengthy, complicated process and involves thoughtful planning, dealing with land rights, and obtaining building permits which can take up to several years. (Refer to Fig. 1.10) Expecting the affected people to live in tents or other types of inadequate temporary shelters for such a long time in order to save up more money for permanent rebuilding would just lead to other humanitarian disasters such as sharp increases in crimes, severe depression, mental break downs, dangerous infectious diseases that would be even more costly to resolve if not already irreversible.

It is very critical to be aware of the fact that when a person goes through a catastrophe of this kind, they don't only lose their home and belongings. They also lose their beloved family members, best friends, neighbors, and so many other important people in their lives. The victims also deviate from their everyday life routine by losing their jobs, going through a deep depression and desperate phase, or feel helpless and confused about what they should do. All of these conditions are even worsened when the victims are living in an unsuitable environment. Their comfortable house has now been replaced by a thin tensile fabric stretched

over their head and is called their new home. Aside from all their losses, the disaster has also deprived them of the very basic standards of living for a human being. Now, instead of healthily going through the grieving period and coping with the loss of some of the most important things in their life, they have to face new emerging problems. The very basic facilities that we take for granted every day, such as going to the bathroom, taking a shower, washing clothes, cleaning the dishes, cooking food, and sleeping have now become incredibly difficult to do. There is absolutely no time left for grieving as the victims must worry about surviving the next challenges such as standing in long queues to use unsanitary public toilets shared by perhaps hundreds of people, finding some clean water and a suitable outdoor area to bathe, using the small communal kitchen to cook some food, sleeping uncomfortably on hard cold floor and feeling unsafe all night long because they have been sheltered by a thin piece of fabric which can be torn apart by any invader, or worrying about going to the public bathroom at midnight.

According to studies, the survivors of natural disasters experience some serious psychological disorders such as PTSD or posttraumatic stress disorder, severe depression, panic disorder, and complicated grief.⁴ One of the most critical steps that should be taken by any disaster management organization would be to avoid more complications and issues caused by poor living conditions. Unfortunately, the majority of the humanitarian groups tend to implement the easiest and cheapest emergency relief strategies in order to save as many people's lives as possible and provide them with basic needs such as water, food, and shelter. Distributing tents as primary shelters for the survivors might make sense since it is a very cost-efficient

solution and allows the organizations to shelter as many people as soon as possible. However, this strategy which is really meant to be implemented as an emergency relief solution becomes a catastrophe and new problems start emerging when the decision makers assume such short-term temporary shelters can be used as long-term transitional dwellings and completely ignore the complicated side-effects of poor living conditions on the whole recovery process.



Fig 1.03 Handwritten signs convey desperation in Sandy's aftermath.

The Gospel Truth
WWW.FACEBOOK.COM/THEGOSPELTRUTHNEWSPAPER HYDERABAD, INDIA
 NEWSPAPER

APRIL 28, 2015 (TUESDAY) PUBLISHER: NISHAN SAMPREETH CHILUKURI VOLUME 2: EDITION 108

The earthquake in Nepal has forced Pastor Krishna and his family to sleep out in the open

“Please pray for our nation. Please pray for us”




Life isn't easy in Nepal. The devastating earthquake has left thousands dead and rendered many homeless. Pastor Krishna of Lalitpur Christian Church and his family have also been affected by the earthquake. The 52-year-old pastor with a commitment to serve the Lord leads not only his church in living according to the Bible but also goes around visiting other churches encouraging Christians to stay strong in Christ. Pastor Krishna is also involved in taking the gospel to other countries. The committed pastor is not disheartened because

of the earthquake. The high intensity quake has affected him so much that he has to sleep outside – out in the open. The aftershocks and repeated quakes in Nepal are claiming more lives

We need to pray for Pastor Krishna, his family, his congregation for their safety. “I’m safe. Thanks. We are still sleeping outside,” Pastor Krishna said when contacted by The Gospel Truth

Newspaper. He said the wall of his house collapsed in the earthquake. Pastor Krishna said after the earthquake occurred after the church service on Saturday (April 25). “Please pray and help us. Our church building has also got damaged. We need help for repairs,” he said. He said his church is located just 9 km from Kathmandu. Is he getting enough help? “We don’t get support from the government. We pray to the Lord,” he said.



Fig 1.04 Handwritten signs convey desperation in Sandy's aftermath.

Fig 1.05 TOP TEN Sudden Onset Disasters Causing Most Displacement In 2010

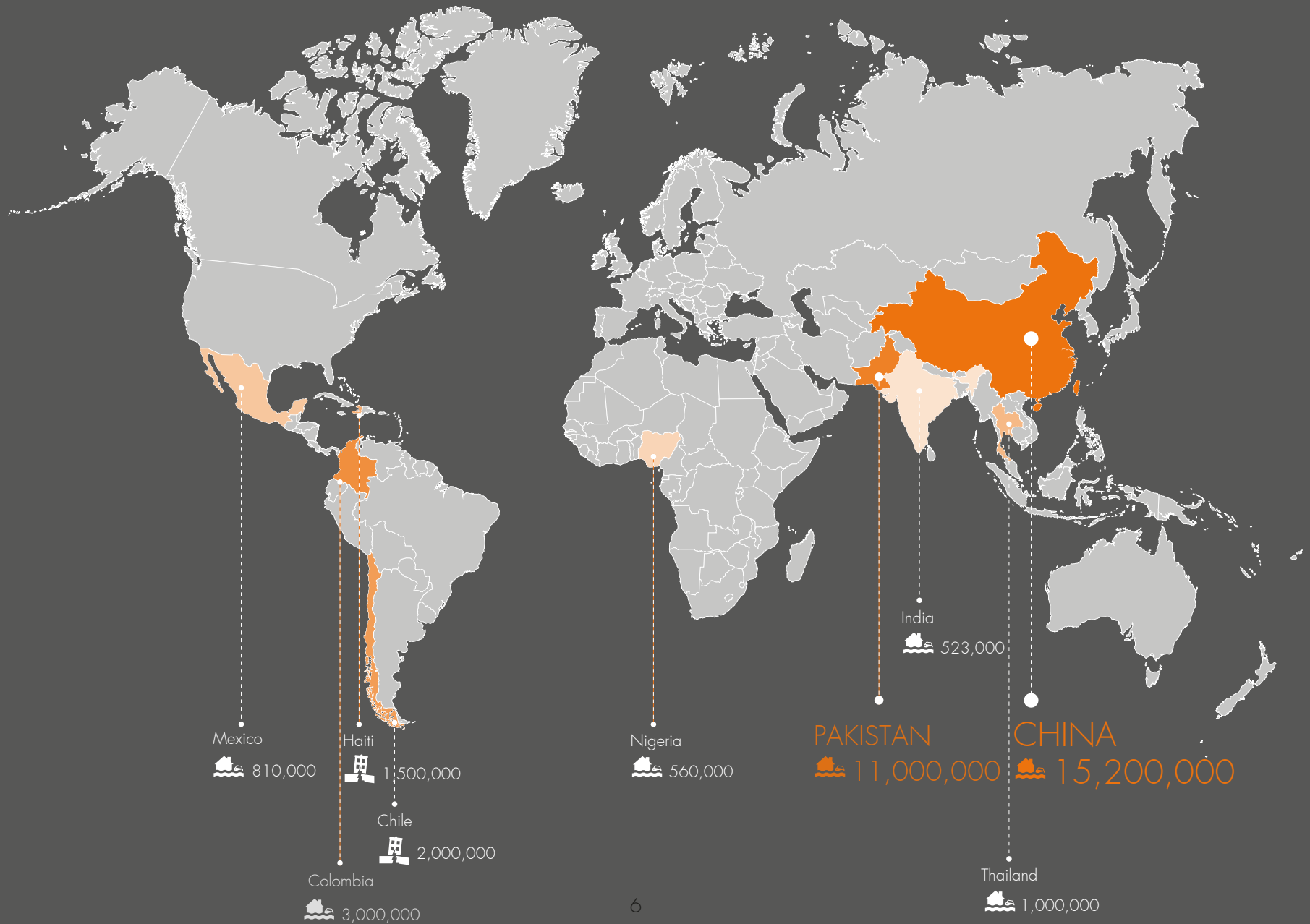


Fig 1.06 TOP TEN Sudden Onset Disasters Causing Most Displacement In 2011

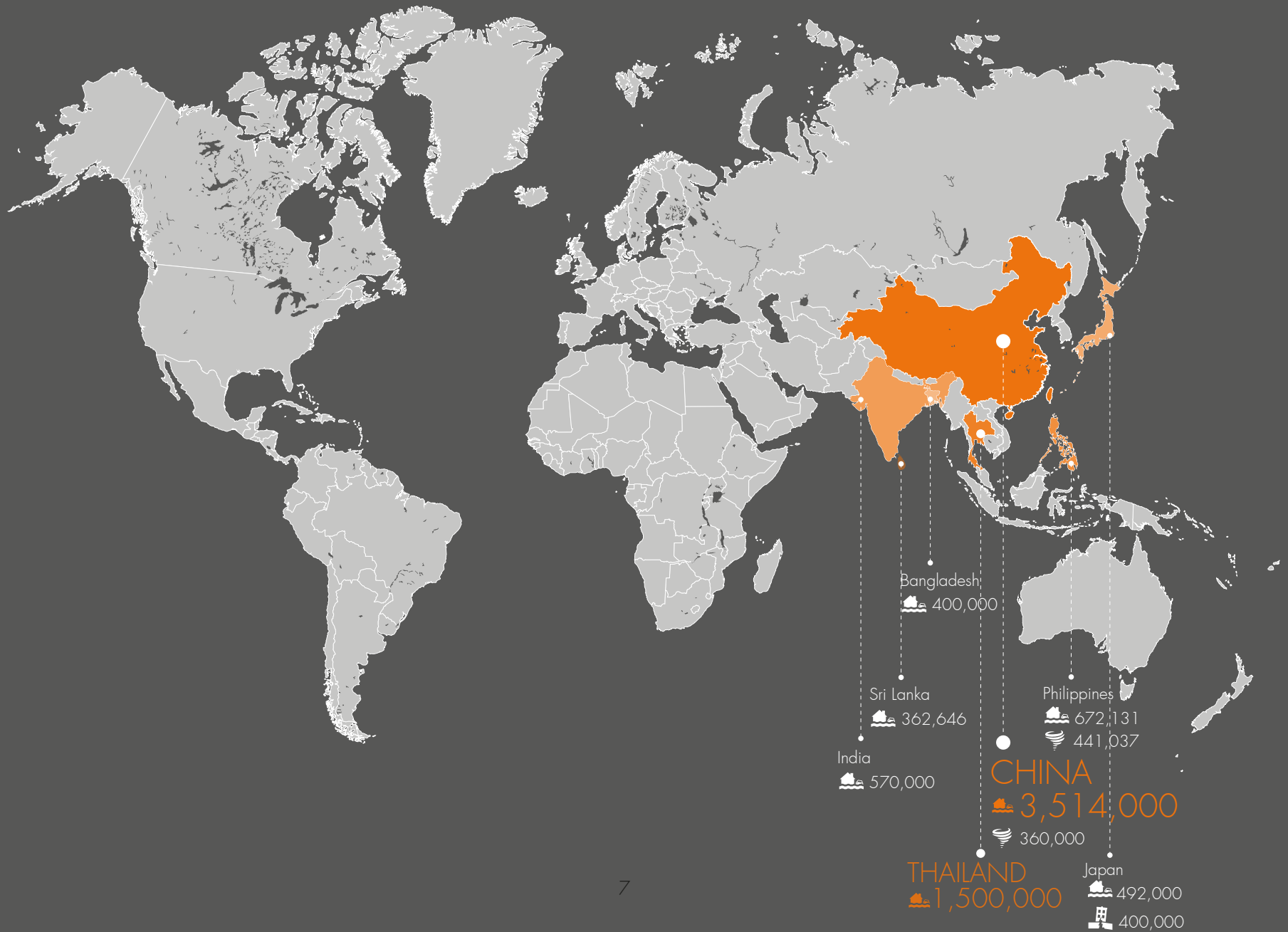


Fig 1.07 TOP TEN Sudden Onset Disasters Causing Most Displacement In 2012

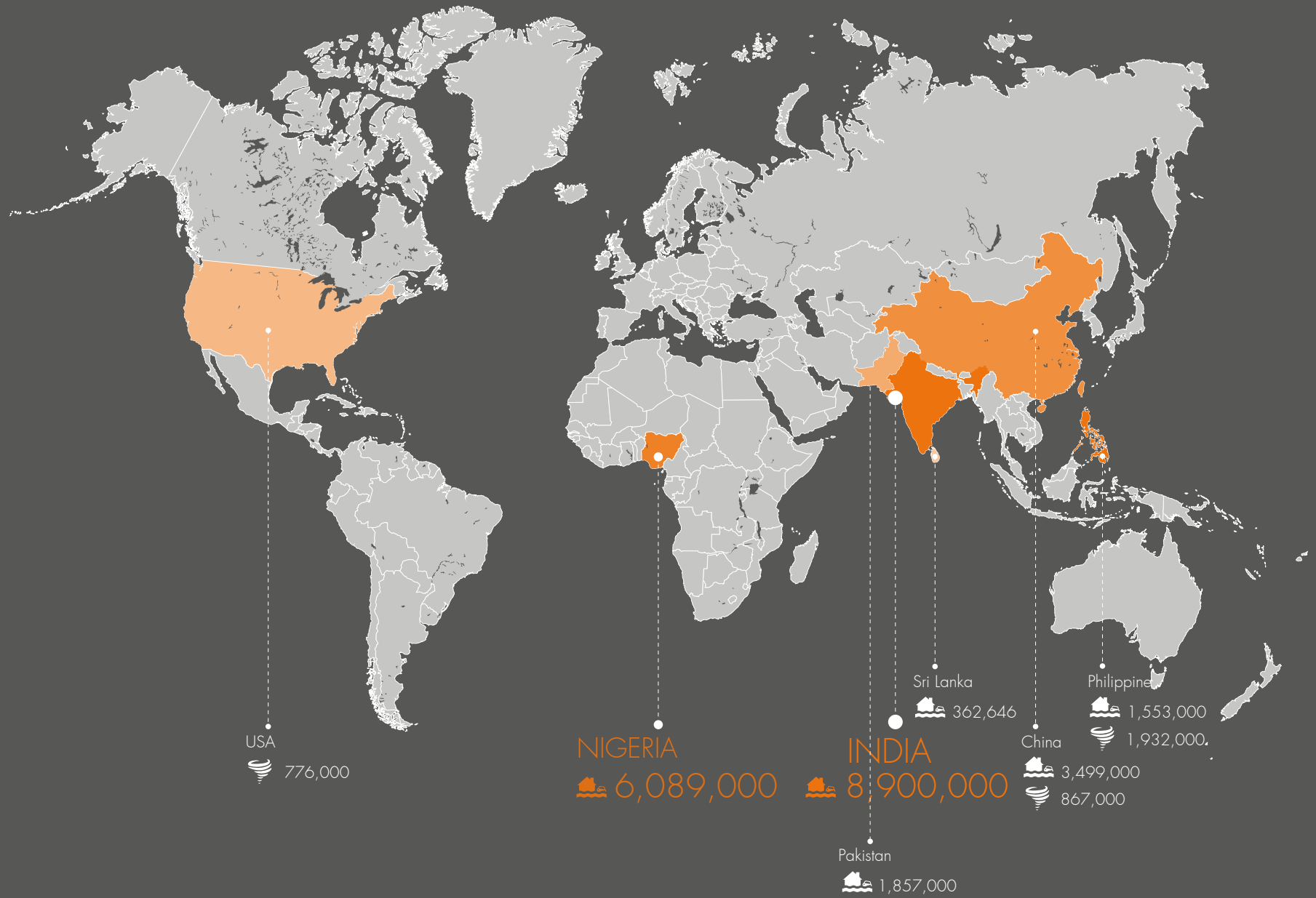


Fig 1.08 TOP TEN Sudden Onset Disasters Causing Most Displacement In 2013

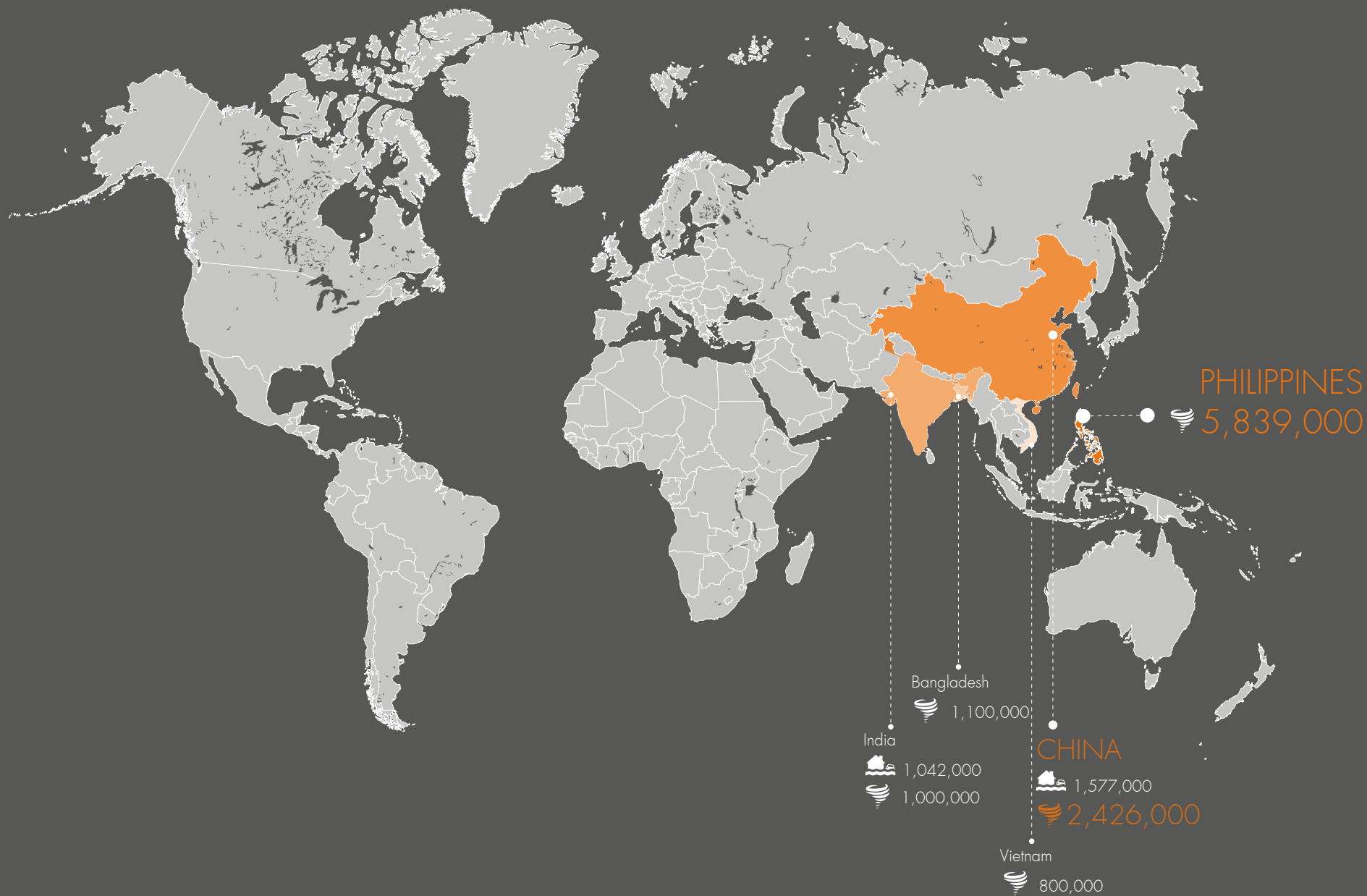
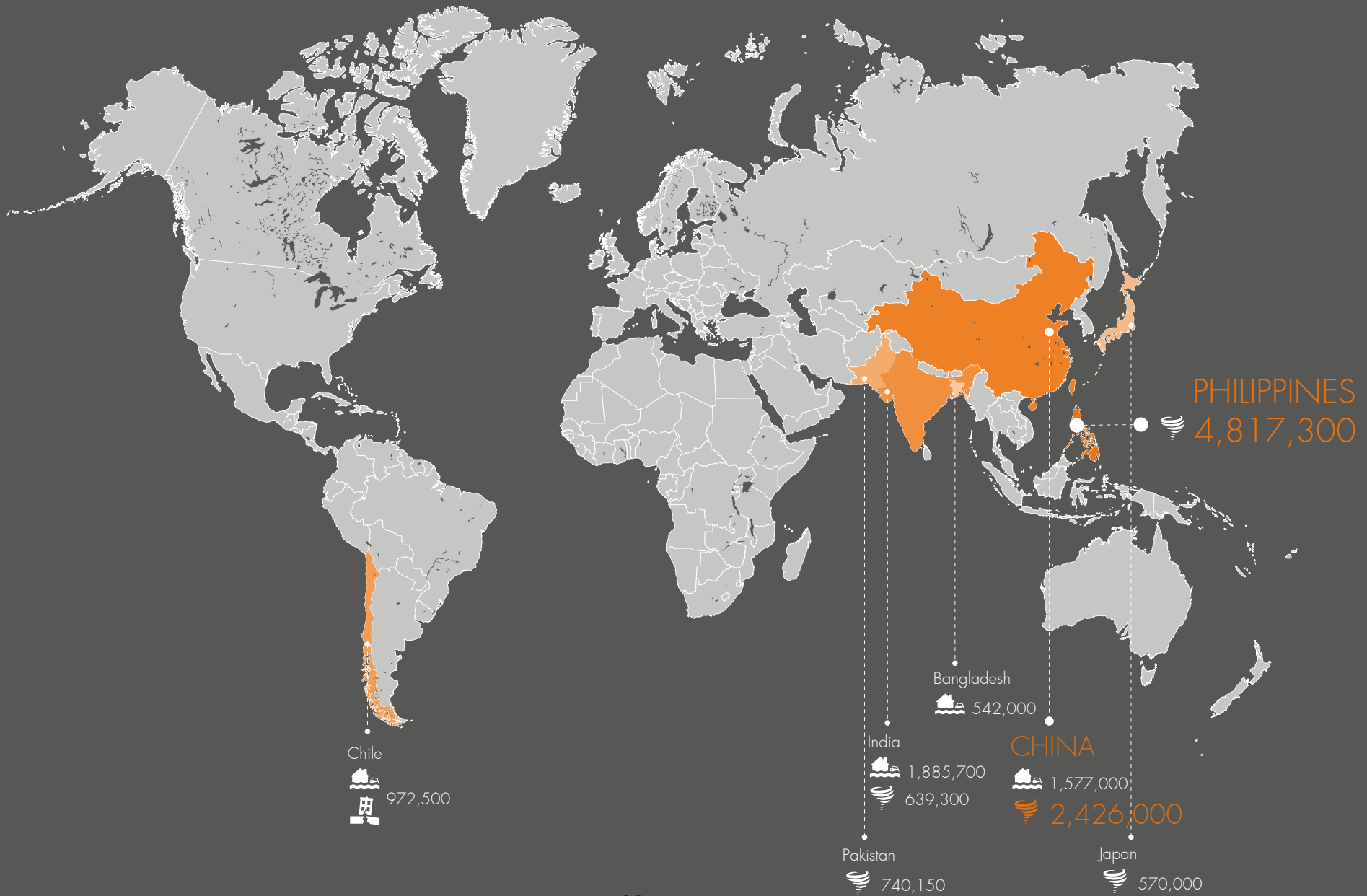


Fig 1.09 TOP TEN Sudden Onset Disasters Causing Most Displacement In 2014



STAGES OF DISASTER RELIEF

In general, disaster management is a complex process that involves national, local, and international organizations such as the United Nations and Red Cross who should be able to respond to situations in a coordinated effort. Each disaster is a unique event that affects communities in very different ways. Because relief and recovery take a long time, strategic planning is very critical in identifying the most severely affected people. In reality, the stages of recovery do not follow a precise agenda and timeline. However, there are certain steps that must be taken as the affected communities begin rebuilding their lives after disasters.

Phase 1: Initial assessment

International and national humanitarian organizations quickly assess the situation and gather information as soon as possible on an estimated number of victims, affected people who need urgent help or are displaced, and other critical statistics in order to determine the available resources and partners.

Phase 2: Search and rescue

The most important phase after a disaster strikes, is to save lives and rescue as many people as possible. The search and rescue phase can take hours or even several days depending on the situation and it usually involves local authorities and trained emergency-response teams and also public's help in many cases. Within a few days after this phase has passed, more organizations start focusing on the survivors.

Phase 3: Emergency Relief

Emergency relief starts in the immediate aftermath of a disastrous event while rescue operations are taking place. Disaster relief teams start providing people with basic needs such as food, water, shelter, and medicines to keep survivors alive. Emergency relief can take a short or very long time depending on the magnitude of the disaster, the number of affected population, the accessibility of the location, local resources, and most importantly the preparedness of the country. In countries such as Chile or Japan where communities and governments are more prepared and accustomed to earthquake activity, this phase may last a few months. However, in under-resourced countries such as Haiti, it can take years. After the 2010 earthquake in Haiti,

for example, the relief phase lasted two years and many people were struggling to find food, water, shelter, and medical care every day. In all cases, the relief phase of a disaster transitions into the recovery phase, when systems are in place and people are no longer worried about survival but can turn to rebuilding their lives.

Phase 4: Early Recovery

By this time, the affected population is in a more stable situation. They know where to get food and water from and a temporary or transitional shelter that can withstand rain and wind is provided to them. They start going back to their daily lives. Parents go to work or start looking for jobs and children go back to schools which may be held in temporary accommodations. People are learning to adapt to a “new normal” and get back on their feet. Early recovery can last from a number of weeks to years based on disaster-relief management and available resources.

Phase 5: Medium to Long-Term Recovery

The final step involves permanent reconstructions of social structures and residential houses to replace tents, trailers, or plywood houses. During medium to long-term recovery, the work of building permanent physical structures to replace tents, trailers, or plywood houses begins, as does restoration of social structures. During this phase, families become stronger. Children go back to their school buildings and adults will have more opportunities to improve their livelihoods and their family economies. Finally, life is stable once more.⁵

THEORY VS REALITY OF DISASTR-RELEIF



Fig 1.10 Real life case studies show that many natural disaster survivors around the world continue living in emergency shelters such as tents for more than 5 years.

COMMON POST-DISASTER HOUSING SOLUTIONS

This thesis is based on empirical research and is not built upon theoretical discussions and how things must be done in an ideal world such as how governments should react, how professionals should perform, or how people should participate. Understanding how things are actually done in post-disaster situations and how doing them can be improved within the real constraints and challenges should be the first and foremost step before proposing any solutions. However, unfortunately we as designers mostly tend to ignore the existing realities; instead of focusing on the possibilities of mitigation within the current broken systems, some propose ideal solutions that require serious changes in how disaster-relief strategies are implemented. We all know that such proposals are doomed to fail because they need the help of top decision-makers and politicians, something that is incredibly complicated to manage in today's world. Other designers find the post-disasters' challenges as an opportunity to showcase their creativity in design contests and gain fame without paying close attention to the survivors' problems and needs.

As I mentioned before, there are also so many controversies around the types of approaches that must be taken after a natural disaster. There are those who advocate mass construction of affordable permanent houses as opposed to those who believe in designing vernacular dwellings that are based on the users' preferences. Temporary and mobile houses are also other solutions that always spark controversy among the designers.

In general, three main approaches are taken by the humanitarian organizations and governments in any post-disaster situation:

- Emergency shelter
- Temporary housing
- Permanent housing



**EMERGENCY SHELTER
LIFESAVER OR A CRISIS?**

Emergency shelters such as tents or tarpaulins are usually the very first things distributed among the victims of natural disasters. Furthermore, to save as many lives as possible and facilitate the delivery of humanitarian assistance such as food, water, equipment, and medicines, humanitarian workers relocate the affected populations to camps. An emergency shelter, as its name suggests, is designed to provide a short-term temporary shelter for those who have lost their houses. If used as a short-term solution, a tent can be a lifesaver and relieve the displaced people from having to deal with potential existing threats in such situations. It is also very cost-efficient and light-weight and can be easily transported to and installed at the desired locations. However, it becomes problematic when such emergency shelters are used as long-term temporary housing solutions by the governments. What could be a great efficient way of managing a disaster, now becomes a crisis with so many negative consequences that would require a lot of investment and planning to deal with. Some of the disadvantages of a tent used as a long-term temporary shelter are as follows:

- Insecurity and Vulnerability
- Lack of Durability and Strength
- Lack of Privacy
- No Access Sanitary Facilities and Clean Water
- Lack of Thermal Insulation and Water Barrier
- Inadequate Ventilation

INSECURITY & VULNARABILITY

The materials used to make tents are usually either thin layers of fabric or plastic, both of which can be easily ripped apart by any sharp objects. This along with the fact that there is usually no electricity and security in disaster relief camps, exposes the families especially women and young girls to many potential dangers such as thieves and sexual offenders. This makes living in tents so much harder for females who have lost their parents, have been widowed, or have been separated from male family members due to the chaos of the situation. (Refer to case # 4 & 7)

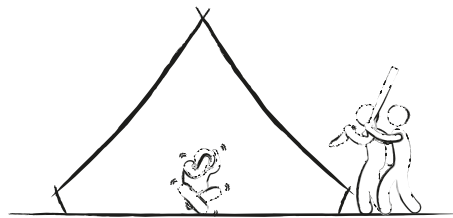
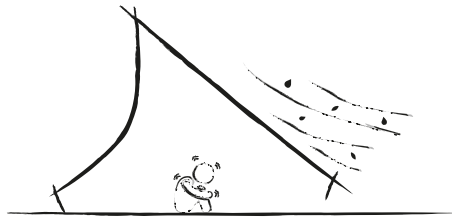


Fig 2.01 Tents can be easily sliced open by sharp objects.

LACK OF DURABILITY & STRENGTH

Tents are not durable and start deteriorating after six months. They can be easily blown away by strong winds or storms due to their flimsy structures. (Refer to case # 9)



LACK OF PRIVACY

Disaster-relief tents are not sound-proof, which makes them uncomfortable for those living in overcrowded camps. Changing clothes is difficult especially for females as one common space is sometimes shared by many people sometimes including strangers. (Refer to case # 8) Many women in disaster relief camps have also expressed their concern that shadows are cast on tents at night and that they are embarrassed to change their clothes even if they live by themselves.

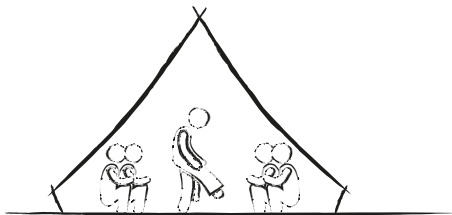


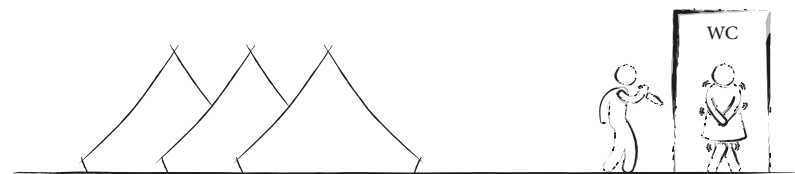
Fig 2.02 Shadows are cast on tents at night making them uncomfortable to live in.



Fig 2.03 A boy takes a shower inside a Tibetan monastery, a month after the April 25 earthquake in Kathmandu, Nepal.

NO ACCESS TO SANITARY FACILITIES & CLEAN WATER

Whether tents are located in camps or independently on streets, they do not usually come with showers or toilets. Having to walk a long distance to use the public bathrooms or taking a shower in the open exposes women to risks of getting attacked and sexually assaulted. (Refer to case # 5) Furthermore, unsanitary public bathrooms shared by hundreds of people and lack of access to clean drinking water leads to an increased risk of several diseases including diarrhoea, Hepatitis A, Cholera, Typhoid and Shigella Dysentery, Intestinal helminths, Malaria and Trachoma which kill infected people especially children every year.⁶



LACK OF THERMAL INSULATION & WATER BARRIER

Tents are not thermally insulated. They can get very hot during the day and very cold at nights. Such shelters are not water proof either and they easily get wet during the rainy seasons of the year.

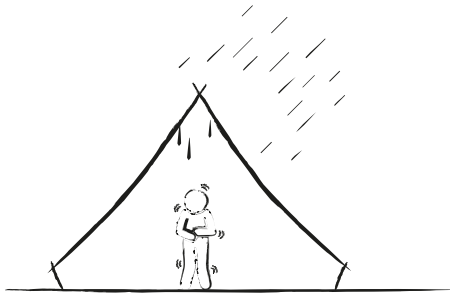


Fig 2.04 Tents are not properly ventilated and insulated.

INADEQUATE VENTILATION

Inadequate ventilation, poor air circulation, humidity, and insufficient outdoor air intake in disaster relief shelters often lead to serious health issues and respiratory problems. Mold growth could be another issue in such conditions.⁷

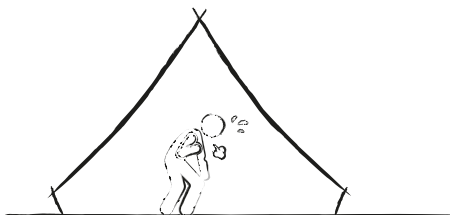


Fig 2.05 People abandon disaster-relief tents because of rain water leakage into their living area.

Fig 2.06 Disadvantages of using tents as long term temporary shelters after natural disasters.



WHAT DO THE SURVIVORS SAY?

One of the critical tasks of anyone who is involved in post-disaster management would be to listen to what the survivors of previous natural disasters say about the difficulties they faced or are still facing during the recovery process. By listening to their complaints and suggestions, one can easily understand what the survivors need in their temporary transitional dwellings to be able to call a place home and go back to their daily life routine until more permanent solutions are provided. Currently, what makes disasters more unbearable for the victims is that not only they have to deal with losing their closest family members and friends, their house, their belongings, and their job, but also they have to constantly worry about losing the most basic living rights of any human being in this world. Therefore, furious survivors who have lost everything they had in seconds are even more irritated when they are expected by the decision makers to live in unhealthy overcrowded tents with absolutely no sanitary facilities, privacy, and safety sometimes for years. Unsuitable temporary shelters such as tents, if used as a long-term solution are definitely a crisis within a crisis and unfold complications that will be very difficult to solve. Also a very critical fact that is often ignored by disaster relief agents and politicians is that the survivors come from very different classes of society and therefore there is a wide range of tolerance levels within the victims. For example, a family who used to live in the slums before the earthquake may be able to handle living in an emergency tent for a long period of time since this style of living is not that far from how they lived before. However, it would be tremendously difficult for a middle class family who used to live in a three bedroom apartment with access to all

facilities to live in a small tent for years. Shifting to this style of living in a few days would place a lot of physical and psychological pressure on such families and as case studies suggest, it pushes them into poverty over time. Now, this is not suggesting that we should place the poor families in terrible conditions just because they are used to it. This is just a reminder that such decisions should be made more carefully as they can easily push the middle class into poverty and make the matters far worse.



Fig 2.07 Middle class suburbs in Haiti. People went back to their old neighborhood because they found camps intolerable.

CASE # 1: RONIDE BADUEL A NURSE IN HAITI

Unlike her Haitian compatriots, Ronide Baduel had everything, an education, a decent job as a nurse, a three-bedroom home with her teenage son, who was in school. But after the massive earthquake, her house collapsed and she had nothing for the first time. A natural disaster had plunged her to the depth of poverty. When the reporters met Baduel about two weeks after the earthquake, she was living under a few sheets of plastic and sleeping on dirt. She had bought a handbag where she kept her few personal items, a shampoo, a soap, a few clothes, and two photos of herself and her son that she rescued from the rubbles. Baduel did not know how to live in squalor. She was not from Cite Soleil, Port-au-Prince's biggest slum, where many people, even before the earthquake slept under tarps or on the streets. "It was harder for middle-class people like me," she said. "It's more difficult for those who had something before. I spent my money on my house, and the rest I saved for the future."⁵ Finally, after two months in the tent city, she moved to her sister's flat where she felt safe and began to feel halfway back to having a proper existence. She now had access to a private kitchen and bathroom. When asked if she would go back to the camp to live independently, she said she will never return to a tent and tarp encampment. "Not me," she says with defiance. "Never."⁸

CASE # 2: CLAUVY ROBAS AN ATTORNEY IN HAITI

Another Haiti earthquake survivor is attorney Clauvy Robas. After he lost everything, he was given a tent to sleep in but he prefers to sleep in a friends' car. "I am not supposed to be sleeping in the streets," said Robas, 29, a middle-class man that has been forgotten in urgency to save lives and provide relief to thousands of people displaced by the strong quake. According to Kesner Pharel, a local economist, "The worst place to be right now in this country is the middle class. They've invested everything they had in their house and they've lost it all. You have a lower class that didn't have a house, and today they have a tent and say 'better for me.' The top already had money to get back on their feet." About six months after the quake, Haiti's middle-class including the doctors, lawyers, receptionists, and thousands of employees have become the new poor. Now they are homeless and unemployed. Almost never seen in the homeless camps, they have set up their tents in the front yards of their damaged homes or in neighborhood streets.⁹

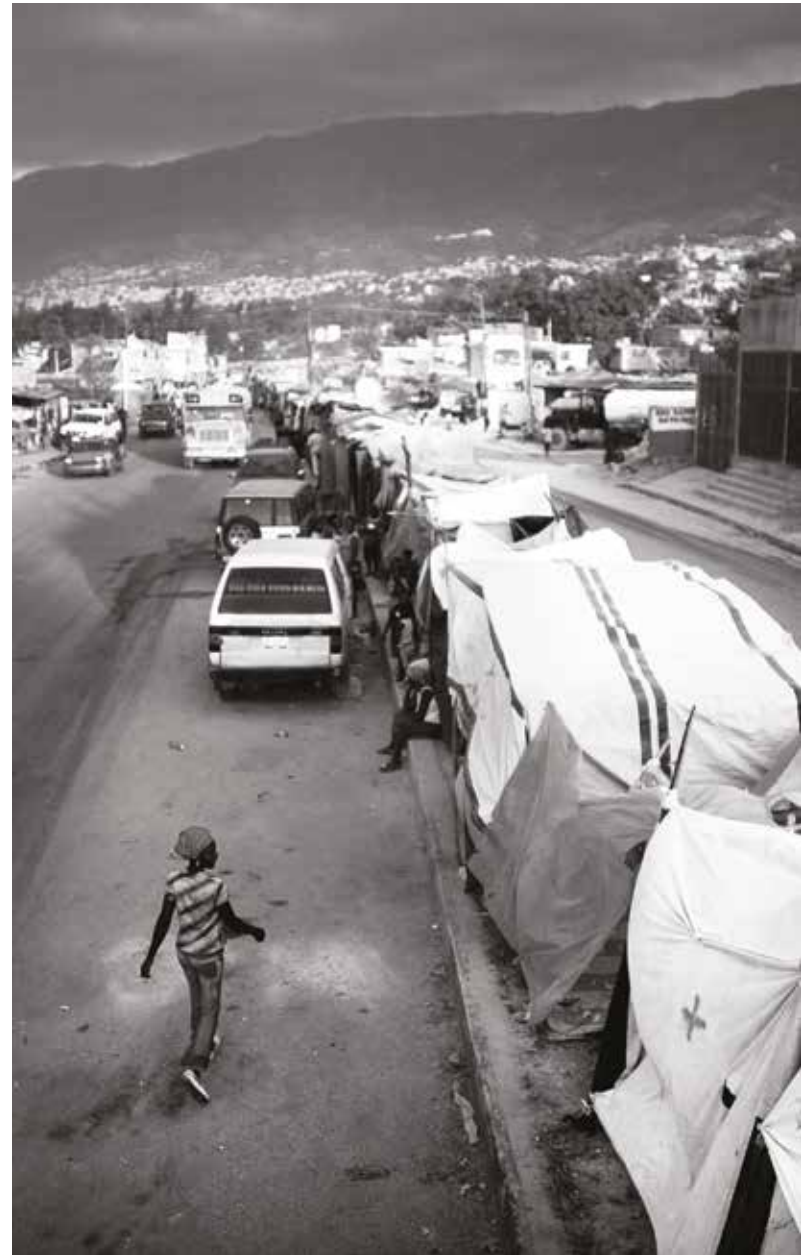


Fig 2.08 Tents on Haiti streets after the quake.

CASE # 3: BATA MAYA TAMANG A VILLAGER IN NEPAL

Batu Maya Tamang, a mother of 5 and 7 years old daughters lost her house and she is sharing a tent with some neighbors. She is a patient of Gynoecea and suffers from excessive bleeding. "Sharing the same space with other families including men is very awkward and difficult in times of heavy bleeding but I have no other option than this," she said.¹⁰



Fig 2.09 Batu Maya Tamang, an earthquake survivor

CASE # 4: SHIRLY A TEENAGE GIRL IN HAITI

Shirley is a 19 year old Haitian girl who lost both of her parents in the earthquake. She is one of thousands of women and girls in Port-au-Prince that get sexually violated in disaster relief shelters. After she lost everything and all her family, she had no choice but to live in a tent by herself in the overcrowded camp, Champ De Mars. One night after moving there, she was violently raped. "In the night it was raining. I was in my tent and one man slit open the tent and came in. He kicked me in the belly then raped me. I screamed but nobody could hear me because of the rain," she said.¹¹ Terror has not stopped since the ground stopped shaking in Haiti. Reports show that sexual violence is on the rise as the camps' lack of lighting, security, and flimsy tent structures make everything so much easier for criminals. Rapists rip the tents open with blades and knives like a piece of cake and there is absolutely nothing women can do to protect themselves.¹² Moreover, long distances to public bathrooms make matters even worse. Most of the time, women should be accompanied by their male relatives to use the bathroom at night. Those who live on their own face a scary challenge every time they have to walk to the toilets in the dark.

**CASE # 5: CARINE EXANTUS
A COLLEGE STUDENT IN HAITI**

Reporting from the camp in Champs-de-Mars across the National Palace, Carine Exantus, a college student says, " In my camp, there are 12 toilets in the front, 12 toilets in the back for 4,200 people. In the camp, the shower is... Everyone at their tent has a little plastic basin, where they throw water over themselves, or they just shower in public. They put water in their basin and they bathe like that, there are many young men and women who do it that way. In my journal I wrote about this; young women suffer sexual aggression because they have to take showers in public."¹³



Fig 2.10 People living in the Champs de Mars camp across from the Presidential palace.

WHAT DO CHILDREN SAY ABOUT THEIR TEMPORARY SHELTERS?

A report was written by Lucia Withers and Nir Dahal on behalf of Save the Children, World Vision International, Plan International and UNICEF. The report reflects the voices of 1838 children, including both boys and girls, who survived the earthquakes in Nepal. Some of the issues of concern identified by these children were as follows:

LACK OF COMFORT CASE # 6:

Children in 76 group discussions reported their temporary shelters to be very uncomfortable. They explained that their tents were very hot during the day and cold during the night. Children complained about sleeping on hard ground and the fact that they were afraid of catching diseases from mosquitoes and other insects in the tents.¹⁴

“We are living in a tent but it gets cold and hot, and it’s infested with flies and mosquitoes.”¹⁵
girl aged 8-12, Kavre



Fig 2.11 A child's bicycle is parked inside a family's tent.



Fig 2.12 A boy looks out from a makeshift shelter, Nepal.

INSECURITY

CASE # 7:

A common theme among children was the feeling of insecurity in the temporary shelters. Young children were very concerned about wild animals such as leopards, tigers, and snakes. Children also expressed their fear of thieves and some older children reported they felt responsible to protect their family.¹⁶

“At night also I don’t sleep well because my mother and sister and I sleep in the same tent as others and I have to be vigilant as I have to protect my sister and mom.”¹⁷
boy aged 16, Dolakha

“The earthquake destroyed my house and we are living in a tent. We are scared and cannot sleep at night.”¹⁸
boy aged 11, Kavre

“Living under the tarpaulin is scary, I am afraid that a snake will bite me.”¹⁹
boy aged 8-12, Sindhupalchowk

OVERCROWDING & LACK OF PRIVACY

CASE # 8:

Overcrowding and lack of privacy was a prominent concern among many older children. Girls found it very difficult to live in a tight space with people outside of their family. They also mentioned there was not enough space for them and their belongings.²⁰

“Our tent is not comfortable to live in. We have seven people in our family and living in the single tent is suffocating. Living here for a long time will be challenging.”²¹
girl aged 13-18, Ramechhap

Adolescent girls find it so challenging to change their clothes since they had nowhere private to do so. Maintaining a menstrual hygiene in a cramped, shared space is also nearly impossible for them.²²

“The entire family is sleeping together under the same tarpaulin. Being a girl, it becomes really uncomfortable for us while changing clothes. Particularly during the menstrual cycle, changing pads inside the tarps and washing it openly is really embarrassing.”²³
girl aged 13-18, Makwanpur



Fig 2.13 Overcrowded tents, Nepal earthquake 2015

DURABILITY AND WEATHER CONDITIONS

CASE # 9:

In the immediate aftermath of the earthquakes, tents and tarpaulins were distributed among the homeless to provide a minimal level of shelter as quickly as possible. However, these shelters are insufficient to protect the children and others from the elements of changing weather such as heavy rains and storms. Heavy rains and storms in the weeks after the earthquakes created further challenges for children living in temporary shelters. Children from mountainous areas where weather conditions are more extreme reported that their shelters are not waterproof and that their belongings got wet every time it rained. The durability of shelters is considered a source of considerable anxiety among children as they have to stay awake all night to hold onto tarpaulins to prevent them from blowing away. Others also expressed their fear of landslides or falling trees.²⁴

“My house has not collapsed but there are cracks everywhere. I am afraid to live inside my cracked house but I am also afraid to sleep outside. When it rains or when a storm blows, it carries away the tent and leaves us in a mess and it pains me to see all this.”²⁵
girl aged 17, Sindhupalchowk

“I get furious when it rains heavily because our tent starts to leak and if there is a storm along with the rain, the situation gets worse.”²⁶
girl aged 13-18, Ramechhap



Fig 2.14 Harsh weather makes post-disaster life even more challenging, Nepal

SUMMARY

The findings powerfully demonstrate that many of the children's immediate concerns relate to their current living conditions. Not only they have to cope with the loss of their parents, siblings, or friends, they are also expected to adjust to new and extremely challenging circumstances. To summarize, the issues that the children were mostly concerned about were:

- The inadequacy and insecurity of temporary shelters
- The lack of access to safe and clean water, sanitation, and medical care which results in fear for their health and that of family members
- Vulnerability, especially among girls, to exploitation and abuse
- Deep feelings of sadness and grief at loss of family and friends, homes, belongings, school, communities, and ways of life

Such expressed concerns show the necessity of prioritizing the more tangible requirements such as shelter along with the psychological needs of children and their families.²⁷



Fig 2.15 Children struggle against cold weather conditions and diseases in tent cities.



TEMPORARY HOUSING

In the aftermath of a disaster, temporary housing provides a place affected families can call “home”, a place where the survivors can recover from the tragedy and go back to their normal daily routine until more permanent solutions are provided. Temporary housing can take on many different forms such as a prefabricated house, a mobile trailer, a shipping container, a rented apartment, or a self-built shack; they vary greatly in terms of cost, level of comfort, and accompanying services. In general, the most important criteria is that they have to be comfortable enough with an adequate level of services to enable people to continue their life with dignity until permanent rebuilding takes place.²⁸

Temporary housing projects are often criticized for their social, economical, and environmental unsustainability, but it can be argued that they play a very essential role in helping the disaster affected families recover their lives and face the tragedy as the reconstruction of permanent houses takes several months to even start and probably many years to complete.²⁹

WHY IS TEMPORARY HOUSING NECESSARY?

Many experts believe that the temporary housing phase should be avoided in post-disaster situations because the cost of temporary housing and then permanent housing amounts to rebuilding twice over. However, the reality on the ground contradicts the experts opinions by showing that some kind of temporary housing has been used after every major disaster in the last century; examples include housing programs in US after hurricane Katrina (2005), Pakistan after the Kashmir earthquake (2005), Thailand after the south Asian tsunami (2004), and Iran after the Bam earthquake (2003). Unfortunately, many experts including the designers, humanitarian representatives, and decision makers tend to ignore the most critical realities of large scale disasters. After witnessing so many catastrophes and their huge consequences, we should all agree on one fact: permanent reconstruction is a lengthy process and takes a very long time. Factors that prolong this process include:

- Large numbers of the affected population
- Amount of damage to the infrastructure
- Overwhelming demand for building materials
- High demand for building contractors
- High demand for building permits
- Disputes over land rights
- Urban planning issues
- Obtaining adequate financing

According to case studies and statistics, even if NGOs or the governments refuse to provide temporary housing in favor of accelerating the reconstruction of permanent houses, disaster survivors often go on and build their own temporary structures because they do not want to live in tents or mass shelters for several months or even years until their houses are rebuilt. For example, after the 1999 earthquakes in Armenia, the government decided to leave the affected families in emergency shelters instead of providing them with temporary houses in order to invest the time and money on rebuilding permanent houses. However, within months, the hillsides were filled with temporary wooden shacks built by the families themselves.³⁰

Ian Davis, in his book "Shelter After Disaster", argues that although temporary housing may consume large amounts of the financial resources and limit the resources for permanent housing, in reality, accelerated reconstruction is often not possible because of the existing complications. As an example, he refers to the south Asian tsunami, after which it took months for the officials to agree on the setbacks from the shore. After many years of research on temporary housing programs, Davis states that there are two models of reconstruction strategy:

- **SMALL INVESTMENTS** in temporary housing: Basic structures with minimum services are provided and the majority of financing and organizational capacity goes to permanent housing. This model is suitable for cases where there are few complications in regards to land rights and urban planning and permanent houses can be built within a few months.
- **LARGE INVESTMENTS** in temporary housing: Fully serviced and higher quality housing will be provided to be inhabited for more than three years. This model is suitable for cases where the extent of destroyed houses is very severe, long delays with reconstruction are anticipated, and temporary houses are needed for longer occupancy.³¹

WHY ARE SOME TEMPORARY HOUSES ABANDONED BY DISASTER SURVIVORS?

According to experts, temporary housing projects can fail due to reasons such as inappropriate design layouts, lack of basic services, and site selection. Although, design layouts that do not conform to the living style and culture of the affected families, or lack of services such as private kitchens and sanitary facilities affect the satisfaction levels of the occupants or could potentially lead to their refusal to live under such circumstances; research suggests that the most prominent reason disaster survivors abandon the donated temporary dwelling is relocation. As case studies show, many affected families prefer living in their own shacks or inadequate tents over well-built high quality dwelling units, only to avoid relocation and stay close to their damaged property. Having mentioned that, many planners and developers of post-disaster projects have the tendency to relocate and resettle disaster affected communities because land is more readily available and more houses can be erected at once. There is often little consideration given to the significance of “place” in the formation of community identity and socio-cultural and economical relations. This is while studies show that temporary housing should be located in the city, near the families’ damaged homes, if possible. This allows people to benefit from the supportive atmosphere of their established social networks, which is an important factor in recovery. It also allows them to remain close to their jobs or income generating activities. Furthermore, the overall costs of the program would be significantly reduced because the residents can draw on the existing services in the city such as schools, clinics, bus routes, and garbage collection routes instead of waiting for new ones to be

provided from scratch. According to case studies and reports, temporary houses which are not in close proximity to where the affected families used to live, could get abandoned by the people regardless of their high quality or comfort levels; that is because disaster survivors prefer to live near their own property even if they have to endure unsuitable living conditions.³² Living in their old neighborhood would allow them to:

- Protect their remaining belongings and avoid looters
- Protect their property
- Be close to their sources of income
- Take care of their livestock and cattle.
- Be close to their family and friends
- Use the existing services such as schools, clinics, public transportation and etc...
- And oversee the reconstruction process of their houses

CASE STUDY: Sri Lankan Fishermen and vendors abandoned their new houses after relocation.

The case study on the 2004 Indian Ocean tsunami in Sri Lanka reveals how livelihoods can be affected when vendors relocate further away from markets. After the tsunami, the government of Sri Lanka decided to relocate thousands of households as no more reconstruction was allowed long the water. Research conducted in 2008 using a random sample of 211 households found that relocation had a major negative impact on the affected people's livelihoods and that many families abandoned their houses and went back to their old neighborhood to build their own shacks. This is while 96% of the interviewed people considered their new houses to be similar or superior in quality to their pre-tsunami houses. Factors that caused dissatisfaction among the disaster survivors were as follows:

- Families had goats, cattle, and poultry before the tsunami but after relocation they were not able to keep the same number of animals. The number of animals owned by the sample households decreased from around 6400 only 107 after relocation.
- Families enjoyed access to free fish by living close to the ocean. Many of the affected population were in fact fishermen and earned their living by fishing. Relocation took the jobs of many people, making it impossible for them to earn a living.
- Families who used to sell their products in the local markets lost their earning opportunities as they had to pay for transportation and travel long distances to the market after relocation.³³



Fig 4.01 This Dec. 2004 ,26, photograph shows a trail of destruction in the southern Sri Lankan town of Lunawa after tidal waves lashed more than half of Sri Lanka's coastline.



PRECEDENTS

Existing Post-Disaster Temporary Dwellings

EXISTING POST-DISASTER TEMPORARY DWELLINGS

Post-disaster temporary housings typically fall under one of the following categories:

1. Modular
2. Kit of Parts
3. Mobile
4. Vernacular
5. Recycled Materials
6. Others

In this chapter, five projects have been selected from each category to further examine their pros and cons and evaluate their success in providing the disaster survivors with an adequate living environment.

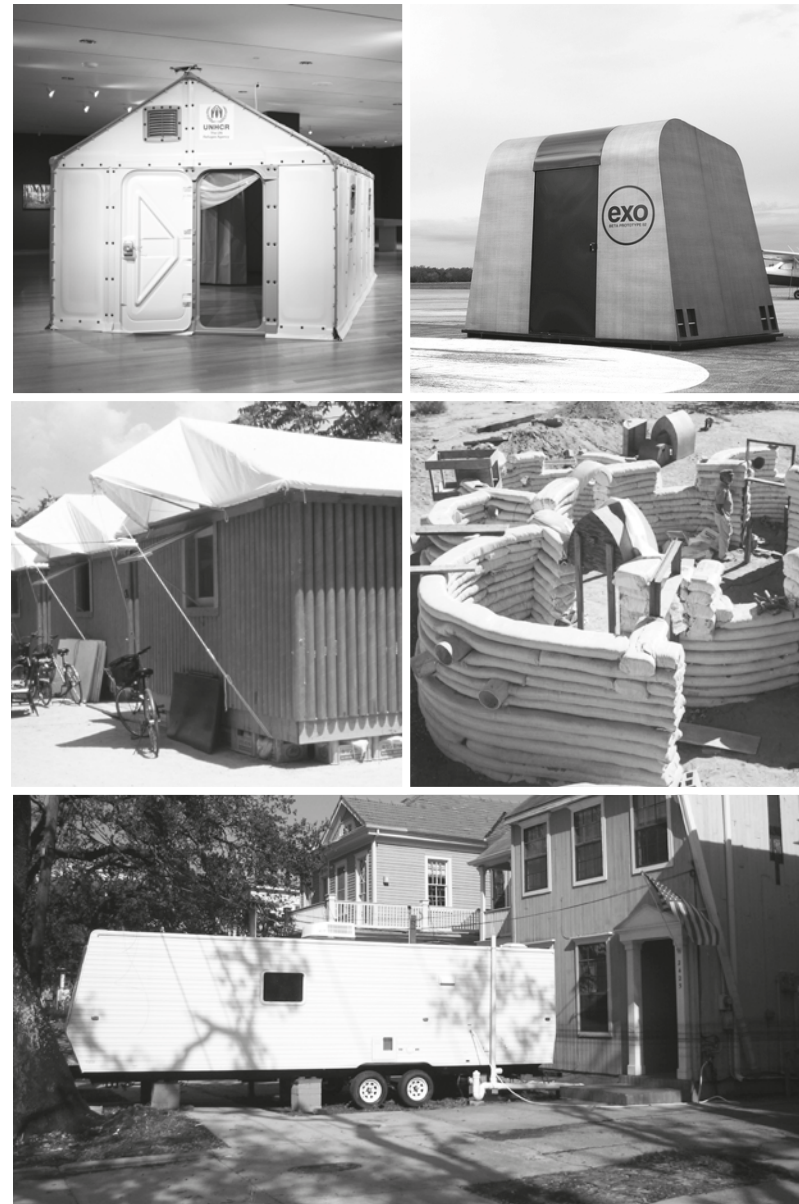


Fig 3.01 Some of the existing post-disaster dwellings.

EXO SHELTER [Modular]














	2.9m W x 2.6m D x 2.7m H	According to shelter and settlement standards, a minimum covered floor area of 3.5 m ² is required per person. Although this project is intended to be used by 4 people, the total area of 7.5 m ² is really more appropriate for 2 people only.
	\$5000	\$5000 is too expensive for a very basic living space without sanitary facilities, kitchen, solar panels, and water filtration systems.
	It takes 4 persons 4-8 hours to build a Better Shelter.	-
	<input checked="" type="checkbox"/> On Grid : Needs City Power	This shelter can only operate on grid. Therefore, if the infrastructure is destroyed as the result of natural disasters, the affected families will not have electricity.
	<input checked="" type="checkbox"/> 1 Window	A small non operable window is placed on the roof. There is no view of the outdoors and the window cannot be opened for ventilation purposes.
	<input checked="" type="checkbox"/> On Grid : Needs City Water	This shelter can only operate on grid. Therefore, if the infrastructure is destroyed as the result of natural disasters, the affected families will not have access to clean water.
	<input checked="" type="checkbox"/> No Gas Pipes	Only portable mini stoves can be used in this shelter.
	<input checked="" type="checkbox"/> No kitchen	Having a designated area for cooking and washing is a basic requirement for temporary dwelling units. Cabinets, stoves, sinks, and plumbing must be later added by the families themselves.
	<input checked="" type="checkbox"/> No Sanitary Facilities	Easy access to private sanitary facilities (toilets and showers) is a basic requirement for temporary dwelling units. Toilets and showers must be either added by the families themselves or public facilities must be used.
	<input checked="" type="checkbox"/> Ceiling Fans & Floor Mounted Vents	This shelter is well ventilated. Proper ventilation prevents breathing problems and other issues such as mold growth.
	<input checked="" type="checkbox"/> Water Proof	This shelter is water proof. This would prevent rain water from getting into the living area making it a more comfortable dwelling unit during rainy seasons.
	<input checked="" type="checkbox"/> Not Insulated	No insulation is provided for this shelter which makes it a very uncomfortable living space especially in hot summers or cold winters.
	<input checked="" type="checkbox"/> Combustible	Combustibility is a serious issue in the case of post disaster shelters as neither the disaster survivors (occupants) nor the humanitarian agencies cannot afford another disaster.



Fig 3.02 Exo is a stackable housing unit that provides private living and sleeping quarters for up to four people, within a climate-controlled, secure environment. Units can also be placed together to expand the living space. Exo designers claim that their design is more secure and durable than tents and more affordable than trailers or containers.³⁴



Fig 3.03 Exo shelter specifications

IKEA'S BETTER SHELTER [Kit Of Parts]

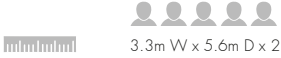












	3.3m W x 5.6m D x 2.8m H	This shelter offers a minimum covered floor area of 3.5 m ² /person for a family of five. More units can be added to increase the living area.
	\$ 10000 reduced to \$ 1000 after mass production	\$ 1000 is a very low price for a temporary shelter. However, this unit is really an emergency shelter more than a temporary dwelling unit given the fact that it does not include insulation, proper electricity, sanitary facilities, or kitchen.
	It takes 4 persons 4-8 hours to build a Better Shelter.	-
	✓ Off Grid : Solar powered	The solar panels installed on the roof can only charge a mobile phone and an LED lamp, which can only be used for 4 hours.
	✗ 4 Small Windows	4 small windows are placed on the sides of this shelter. The windows are too small to let in sufficient amounts of natural light.
	✗ No Water Inlets	There are no water inlets and outlets which means water has to be stored in containers for daily use.
	✗ No Gas Pipes	Only portable mini stoves can be used in this shelter.
	✗ No kitchen	Having a designated area for cooking and washing is a basic requirement for temporary dwelling units. Cabinets, stoves, sinks, and plumbing must be later added by the families themselves.
	✗ No Sanitary Facilities	Easy access to private sanitary facilities (toilets and showers) is a basic requirement for temporary dwelling units. Toilets and showers must be either added by the families themselves or public facilities must be used.
	✓ 2 Ventilation Openings	There are two ventilation openings. However, it not clear yet if they can provide enough ventilation and air circulation.
	✓ Water Proof	This shelter is water proof. This would prevent rain water from getting into the living area making it a more comfortable dwelling unit during rainy seasons.
	✗ Not Insulated	No insulation is provided for this shelter which makes it a very uncomfortable living space especially in hot summers or cold winters.
	✗ Easily Combustible	IKEA claims that this shelter is designed in compliance with UNHCR safety standards, however the Swiss city of Zurich has just announced it will not use the 62 Ikea refugee shelters it has purchased to house asylum-seekers after a test showed they constituted a fire hazard. ³⁵



Fig 3.04 Better shelter designed by IKEA is a temporary light-weight modular shelter. This shelter can be dismantled and reassembled by 4 people. Each shelter is delivered in 2 flat pack boxes with the total weight of 160 Kg.³⁶



Fig 3.05 Interior shot of IKEA shelter

FEMA TRAILER [Mobile]

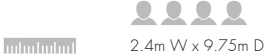












	2.4m W x 9.75m D	This shelter offers a minimum covered floor area of 3.5 m ² /person for a family of five. More units can be added to increase the living area.
	\$ 14000 to produce \$ 10000 to set up on site	\$ 24000 is very expensive compared to other designs available in the market. However, it can be argued that such trailers can be retrofitted and used again later.
	It takes 6-10 people several days to install it on site.	Several private contractors are hired to install FEMA. A subcontractor installs the trailer. Another contractor installs the stairs and ramps, furniture, appliances, and water. Then the power company installs a power line and meter.
	✓ On Grid : Needs City Power	FEMA will not install trailers in neighborhoods that have no access to electricity.
	✓ 4-6 Windows	4-6 small windows are placed on the sides of this trailer to let in daylight. The windows can also be opened for cross ventilation.
	✓ On Grid : Needs City Water	FEMA will not install trailers in neighborhoods that have no access to running water.
	✗ No Gas Pipes	The trailer has two propane tanks on the front of the trailer, which provide the hot water, indoor heating, and gas for the stove and oven.
	✓ Small Kitchen	A few cabinets, a sink, a propane-operated stove and oven, a small microwave oven, and a large refrigerator are included.
	✓ Bathroom With Shower	A small bathroom with shower is provided. Occupants have access to both cold and hot water.
	✗ Poor Ventilation	Units are ventilated however, a federally funded analysis shows toxic levels of formaldehyde were found in 42% of the trailers tested. This is due to poor ventilation and use of cheap building materials.
	✓ Water Proof	This trailer is water proof. This would prevent rain water from getting into the living area making it a more comfortable dwelling unit during rainy seasons.
	✗ Poor Insulation	FEMA trailers are known for having very poor insulation so they are already very inefficient at holding temperatures at a steady level.
	✗ Easily Combustible	-



Fig 3.06 FEMA trailers are temporary manufactured houses used by the victims of natural disasters. They include sanitary facilities, kitchen, and furniture. FEMA is designed to operate on grid and can only be installed on properties with running water and electricity. The most critical advantage of these trailers is their mobility which enables them to be installed next to the affected families' property and relocated after permanent houses are reconstructed.³⁷



Fig 3.07 FEMA trailers can be parked on the survivors' property.

SUPER ADOBE ECO-DOME [Vernacular]











	37 sq meters	-
	\$150 - \$300 per m2 or more depending on the proportions of the ingredients (cement, gravel, ...)	-
	It takes 1 skilled or 4 unskilled workers to build one in 5 days.	Several private contractors are hired to install FEMA. A subcontractor installs the trailer. Another contractor installs the stairs and ramos, furniture, appliances, and water. Then the power company installs a power line and meter.
	 No Electricity	If city power is not provided by the government, solar panels have to be added or the users will have not have access to electricity.
	 8 Windows	8 windows are used for daylighting and cross ventilation.
	 No Water Connection	This would be an issue if infrastructure is damaged due to disaster or no water lines exist at all.
	 No Gas Pipes	Either city gas or propane tanks can be used.
	 Space provided only	Although an area is designated for cooking, the affected families will not have cabinets and appliances if they cannot afford buying them.
	 Bathroom With Shower	An area is designated for bathrooms but basins, toilets, or water heaters are not included.
	 Cross Ventilation & Roof Vent	-
	 Water Proof	Although initially designed for hot arid climates, this structure can also be made waterproof for cold wet climates.
	 Insulated	Building mass, which is earth in this case, is used as insulation.
	 Not Combustible	-



Fig 3.08 SuperAdobe is an earth bag architecture developed by the Iranian architect Nader Khalili. This building system needs long sandbags, barbed wire, on-site earth, and a few tools. One of the biggest advantages of this system is that it has passed severe earthquake code tests in California.³⁸ However, it should be noted that this structure is more permanent than temporary and building it would require dealing with land rights, construction permissions and etc. Moreover, the dimensions and the permanency of this design proposal is a major drawback in post disaster cases where the affected families would like to have their temporary houses next to their damaged property.



Fig 3.09 Baninajar refugee camp

PAPER LOG HOUSES [Recycled Materials]














	16 sq meters	-
	\$ 2000	-
	It takes 10-20 people to build this house in 6 hours.	Building this shelter needs both skilled and unskilled workers. Skilled workers need to be trained in advance in order to teach the unskilled workers how to construct this unit properly. Therefore, managing workshops and workers of different skills on site could be time consuming and delay the process.
	<input checked="" type="checkbox"/> No Electricity	Connection to city power should be managed by the residents themselves.
	<input checked="" type="checkbox"/> 3 Windows	3 windows are used for daylighting and cross ventilation.
	<input checked="" type="checkbox"/> No Water Connection	This would be an issue if infrastructure is damaged due to disaster or no water lines exist at all.
	<input checked="" type="checkbox"/> No Gas Pipes	Either city gas or propane tanks can be used.
	<input checked="" type="checkbox"/> No Kitchen	There is no designated kitchen area in this temporary shelter which means the affected families must share a communal kitchen if in camps or they will have no access to cooking or washing facilities at all.
	<input checked="" type="checkbox"/> No Sanitary Facilities	There are no sanitary facilities in this temporary shelter which means the affected families must either use public bathrooms or they will have no access to private bathrooms at all.
	<input checked="" type="checkbox"/> Cross Ventilation	-
	<input checked="" type="checkbox"/> Water Proof	Although initially designed for hot arid climates, this structure can also be made waterproof for cold wet climates.
	<input checked="" type="checkbox"/> Poor Insulation	Although it is claimed that the operable roof and sponge tapes in between the tubes keep the shelter warm in winter and cool in summer, reports show that this shelter was actually too cold in winter and too hot in summer.
	<input checked="" type="checkbox"/> Not Combustible	-



Fig 3.10 Paper log houses are temporary structures designed by Shigeru Ban after the 1995 earthquake in Japan. This shelter is built with recyclable paper tubes, donated beer crates loaded with sandbags, and tenting material for the roof. The units are dismantable and the materials can be recycled.³⁹ Although this project is designed for long term temporary use by disaster victims or refugees, it only meets the requirements of a short term temporary shelter by not being properly insulated, and lacking the most basic living conditions such as sanitary facilities and kitchen. Furthermore, since paper log houses are not mobile, they still involve dealing with land rights and official permissions which complicates the construction process.



Fig 3.11 Paper log house interiors

Fig 3.12 Precedents' Comparison Chart [Major Disadvantages]

															Major Disadvantages
EXO SHELTER 	4	7.5 m ²	\$ 5000	4 People	✓ On Grid	✓ On Grid	✗	✓	✓	✓	✗	✗	✗	✗	<ul style="list-style-type: none"> • Basic shelter rather than long term temporary dwelling unit • No sanitary facilities • No kitchen • No temperature comfort • Needs infrastructure to operate • Needs flat sites • No storage space • Industrial cold look for "home"
IKEA BETTER SHELTER 	5	18.5 m ²	\$ 10000	4 People	✓ Off Grid	✗	✗	✗	✓	✓	✗	✗	✗	✗	<ul style="list-style-type: none"> • Basic shelter rather than long term temporary dwelling unit • No sanitary facilities • No kitchen • No temperature comfort • No daylighting or outdoor views • Needs flat sites • No storage space • Industrial cold look for "home"
FEMA TRAILER 	4	23 m ²	\$ 14000	1-4 People	✓ On Grid	✓ On Grid	✗	✓	✗	✓	✗	✗	✓	✓	<ul style="list-style-type: none"> • Very tight living area • Breathing problems because of toxic materials • No temperature comfort • Needs infrastructure to operate • Very expensive to build & install • No storage space • Industrial cold look for "home"
SUPER ADOBE 	4-5	37 m ²	\$150 to \$300	1-4 People	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	<ul style="list-style-type: none"> • More permanent than temporary • Land right issues • Needs building permission • Too big to be located on the disaster survivors' property • No sanitary facilities • No kitchen • Needs infrastructure to operate • Needs flat sites
PAPER LOG HOUSES 	4-5	16 m ²	\$2000	10-20 People	✗	✗	✗	✓	✓	✓	✗	✓	✗	✗	<ul style="list-style-type: none"> • Basic shelter rather than long term temporary dwelling unit • Land right issues • Needs building permission • No temperature comfort • No sanitary facilities • No kitchen • Needs infrastructure to operate • Needs flat sites

ENDNOTES

INTRODUCTION

1. "Climate Change," Guardian, accessed Oct 19, 2016, <https://www.theguardian.com/environment/blog/2014/-jul/14/8-charts-climate-change-world-more-dangerous>.
2. "Rising Tides: Cities Of The World That May Be Flooded By Climate Change," World Atlas, accessed Oct 23, 2016, <http://www.worldatlas.com/articles/high-tides-cities-of-the-world-that-may-be-sunk-by-climate-change.html>
3. Unknown author, "Global Estimates 2015: People displaced by disasters." IDMC. July 2015. <http://www.internal-displacement.org/publications/2015/global-estimates-2015-people-displaced-by-disasters/>
4. Bryant, Richard, "The impact of natural disasters on mental health." APS. April 2009. https://www.psychology.org.au/inpsych/impact_disasters/
5. <http://reliefweb.int/report/world/phases-disaster-recovery-emergency-response-long-term>

EMERGENCY SHELTER

6. Sten Ziemons, Andreas, "Lack of toilets poses serious health risk." DW. May 2012. <http://www.dw.com/en/lack-of-toilets-poses-serious-health-risk/a-15965852>
7. Unkown author, "Indoor Air Quality." CCOHS. July 2016. http://www.ccohs.ca/oshanswers/chemicals/iaq_intro.html
8. Basu, Moni, "After quake, middle-class Haitians wrestle with fall into poverty." CNN NEWS. June 2010. <http://www.cnn.com/2010/WORLD/america/06/03/haiti.middle.class/>
9. Ibid.
10. Unkown Author, "Haiti, impoverished middle class, also despaired." The Colombian Post. Oct 2011. http://thecolombianpost.com:8081/index.php?option=com_cotent&view=article&id=6180%3Ahaiti-impoverished-middle-class-also-despaired&catid=94%3Aideas&Itemid=73
11. Pariyar, Binda, "Case Studies on Immediate Impact of Earthquake, Jaisithok, Kavre." Jagarn Nepal. April 2012. <http://www.jagarnnepal.org/-case-studies-on-immediate-impact-of-earthquake,-jaisithok,-kavre>
12. Kotecha, Sima, "Rape at 'crisis' level in Haiti earthquake camps." BBC NEWS. January 2011. <http://www.bbc.co.uk/newsbeat/article/12171443/rape-at-crisis-level-in-haiti-earthquake-camps>
13. Kotecha, Sima, "Rape at 'crisis' level in Haiti earthquake camps." BBC NEWS. January 2011. <http://www.bbc.co.uk/newsbeat/article/12171443/rape-at-crisis-level-in-haiti-earthquake-camps>
14. Schuller, Mark, "Haiti's Disaster after the Disaster: The IDP Camps and Cholera." The Journal of Humanitarian Assistance. December 2010. <https://sites.tufts.edu/jha/archives/869>
15. Lucia Withers and Nir Dahal, "After the Earthquake: Nepal's Children Speak Out: Nepal Children's Earthquake Recovery Consultation." Save the Children, World Vision International, Plan International and UNICEF, (2015):12, <http://www.wvi.org/nepal-earthquake/publication/after-earthquake-nepals-children-speak-out>.

16. Ibid.
17. Ibid.
18. Ibid.
19. Ibid.
20. Ibid.
21. Ibid, 13.
22. Ibid.
23. Ibid.
24. Ibid.
25. Ibid, 14.
26. Ibid.
27. Ibid.

TEMPORARY HOUSING

28. Ibid, 4,5.
29. Gonzalo Lizarralde, Cassidy Johnson, and Colin Davidson, *Rebuilding After Disasters: From Emergency To Sustainability*, (New York: Spon Press, 2010), 71.
30. Ibid., 70.
31. Ibid., 74.
32. Ibid., 83.
33. Abhas K. Jhas, *Safer Homes, Stronger Communities: A Handbook for Reconstructing after Natural Disasters*, (Washington DC: The World Bank, 2010), 84.

PRECEDENTS

34. "Meet the Exo – a home away from home.," Reaction, accessed Oct 19, 2016, <http://www.reactioninc.com/exo>.
35. "Swiss city buys Ikea shelters to house refugees, then ditches them over fire risk .," Guardian, accessed Oct 26, 2016, <https://www.theguardian.com/world/2015/dec/19/swiss-city-buys-ikea-shelters-to-house-refugees-then-ditches-them-over-fire-risk>.
36. "A better shelter," The Better Shelter, accessed Oct 30, 2016, <http://www.bettershelter.org/product/>
37. "People are still living in FEMA's toxic Katrina trailers and they likely have no idea," Grist, accessed Nov 11, 2016, <http://grist.org/politics/people-are-still-living-in-femas-toxic-katrina-trailers-and-they-likely-have-no-idea/>.
38. "What Is Superadobe?," CalEarth, accessed Sep 22, 2016, <http://www.calearth.org/intro-superadobe>.
39. "The Humanitarian Works of Shigeru Ban," Archdaily, March 24, 2014, accessed January 18, 2017, <http://www.archdaily.com/489255/the-humanitarian-works-of-shigeru-ban>.



INTRODUCTION

According to statistics, since 2008, an average of 26.4 million people have been displaced per year because of natural disasters. In other words, one person loses his/her home every second. This is while these figures do not even include the number of people who have become homeless or are forced into living in terrible conditions in their own countries because of political conflicts, or other issues such as financial difficulties. Sadly, as statistics show these numbers are increasing every year; this is while so many critical issues such as lack or shortage of proper housing or shelter, food, water, sanitary facilities and many other problems have still been left unresolved for those who have been displaced years ago. Firstly as human beings and secondly as architects, we are all well aware of the fact that no matter who we are or what status we have in the society, a safe and clean shelter is one of our basic needs in life. Therefore, everyone in this world, regardless of who he/she is deserves to live in a comfortable shelter where one has access to the basic facilities such as toilet, shower, kitchen, electricity, water and where one is not constantly threatened by outside circumstances or forces. Going back to the UN statistics, it is critical to mention that children constitute the majority of the world's displaced population. According to studies, children who do not live in proper houses have up to 25 percent higher risk of severe ill-health and disability, increased risk of slow growth, and a greater chance of suffering from mental health and behavioral problems. Children are the future adults of this planet, and if not taken care of or left in abusive environments, they will become grown-ups that then transfer all their issues and shortcomings

to the future generations and the cycle will continue and many more people will be victimized. Therefore, if only one person, a child or an adult, is rescued from the current living conditions of a typical displaced person and is provided with a safe living environment, the impact of this simple act will be evident in the lives of the coming generations. If only one girl is not raped in the darkness of the night just because she has to use the toilet on the other side of the camp, or a mother does not worry every night that a stranger would rip open their tent and abuse her family, I have achieved my goal in rescuing not only one person but all the people who will be affected by these victims at some point in their lives. In short, because of the importance of the living environment on one's mental and physical health, this thesis is focused on designing and building a portable dwelling unit that would provide the occupants with the basic facilities needed for a comfortable life, the most important of which are private sanitary facilities for each family; something that is considered an absolute necessity for every human being on this planet but is disregarded and considered a luxury by many designers around the world. In other words, one of the main differences between this project and other existing emergency or temporary shelters would be the fact that it provides every family with their own private toilet, wash basins, shower, and a kitchen. In order to be able to do that, a basic portable unit will be designed which will contain all the sanitary facilities together with plumbing, sewage system, and electricity. The size of this basic unit would be minimized as much as possible firstly in order to make it easily portable by the distributors or the users and secondly,

in order to maximize the number of units that would fit into a shipping container. The main logic behind using a basic unit is using one compact space that contains the critical elements, which would otherwise have to be shipped to the site as separate packages. Regarding other spaces and functions that are required for a comfortable living environment, there are three main systems that can be used: modular system, kit of parts system, and expandable system. It is interesting to note that going through all the critical precedents that I could find through different resources, there were only a few of them that had used expandability as a design strategy. It appears to me that designing a flexible system that can be expanded on site would be challenging but it would be worth exploring since many designers use either the modular or the kit of parts systems for the design of their temporary or emergency dwelling units. Therefore, the design of my dwelling unit will be based on two main concepts, expandability and flexibility. For example, spaces such as the bedrooms, living room, and dining room will be designed such that they would be pulled out of the basic unit, which contains the bathroom and a mini kitchen, using different expansion strategies. It is important to note that the design intention would be to explore as many expandable techniques as possible, and such techniques can even be inspired by the existing collapsible/foldable furniture and objects. In other words, it would be interesting to see if a design strategy used for a compact, space saving furniture can be applied at a larger scale to a compact dwelling unit. The most challenging part of the project, of course, would be choosing the right materials and construction details that would make the final product as light-weight, strong, and

durable as possible. Additionally, collapsible, foldable, or expandable furniture would be designed to furnish the different spaces; they would either be built-in or movable depending on which option provides more flexibility and adaptability. The ultimate goal of this thesis is to design a dwelling unit that is suitable for most climates and is flexible enough for different types of users. Therefore, other issues that would be tackled as part of this thesis would be how to design a dwelling unit that would be usable on various sites with different climates, topography, and other site conditions. Furthermore, another critical issue would be how can this project be designed as self-sufficient as possible so that it could operate on sites where infrastructure is not provided? And would this be possible if the goal is to design a cost-efficient solution? In other words, are there cost effective solutions to, for example, generate electricity or filter water, and design a dwelling unit that would be able to function totally off the grid?

Fig 5.01 Precedents' Types Comparison Chart

This chart demonstrates that **EXPANDABLE/COLLAPSIBLE** projects are the **LEAST COMMON** among **COMPACT MOBILE** precedents.









								
Project Name	Boxhome	Casa Pollo	Exo	Aluminum Hut	New Temporary House	Paper Log House	Micro Compact Home	Eco Capsule
Designer	Rintala Eggertsson Architects	Santiago Cirugeda	Frog Design	Muji and Konstantin Grcic	Shigeru Ban & Muji	Shigeru Ban	Horden, Chery, Lee Architects	Igor Zacek
Location	Norway	-	Norway	Japan	Japan	Japan	Munich	Anywhere
Dimension	19 sq meters	30 sq meters	19 sq meters	10 sq meters	Varies ?	?	6.75 sq meters	44 sq meters
Materials	Pine Timber Frame & Aluminum Cladding	Steel, Wood, Sandwich Panels, Aluminum, PVC	Aluminum & Composite Materials	Aluminum	FRP structural panel	Paper Tubes & Sandbag	?	Used Cans, Hardwood, OSB Wooden Plate
Single Unit								
Modular								
Kit of Parts								
Flat Pack								
Expandable								

Fig 5.02 Precedents' Types Comparison Chart [Continued]



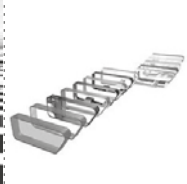
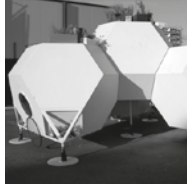

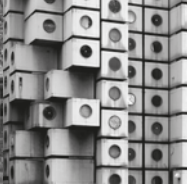
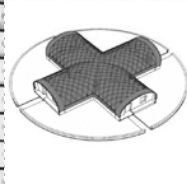

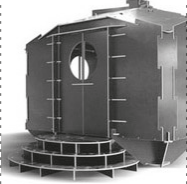





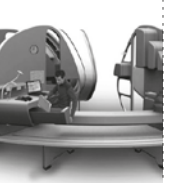
								
Project Name	Self Sustained Module	Floating Pier	The Living Box	Micro Dwellings	Micro House	Nagakin Capsule Tower	Red Housing Manifesto	Cardboard House
Designer	Cannatá & Fernandes'	Laurent Troost	Architecturburo	N55	Studio Liu	Kisho Kurokawa	Pablo Castro	Peter Stutchbury Architecture
Location	Portugal	New York	Anywhere	-	Beijing	Tokyo	Anywhere	-
Dimension	27 sq meters	-	Varies	Varies	5.7 sq meters	8.7 sq meters	40 Sq Meters	-
Materials	Wood Frame	Polyethylene Cell With UV Inhibitors and Carbon Black Pigment	Polyethylene & Polyurethane Foam	Steel Frame, Steel Panels, Polyethylene Foam	fibre-reinforced foam composite structure	Welded Lightweight Steel Truss Box & Galvanized Steel Panels	Bamboo Plywood	Cardboard
Single Unit								
Modular								
Kit of Parts								
Flat Pack								
Expandable								

Fig 5.03 Precedents' Types Comparison Chart [Continued]

								
Project Name	DHI Disaster House	Demountable House	WikiHouse	System 3	Cocobello	Fred	Marquis	Mobile Mini House
Designer	Gregg Fleishman	Jean Prouve	WikiHouse	Oskar Leo Kaufmann	Studio Fur Architektur	Oskar Leo Kaufmann	Andrew Maynard	Stephanie Bellanger
Location	Los Angeles	Anywhere	Anywhere	-	Rotterdam, Netherlands	Reuthe, Austria	Varies	-
Dimension	1.5 sq meters	36 or 68 Sq Meters	Varies	22 sq meters	42 sq meters	18 Sq Meters	Varies	-
Materials	Slotted Finland Birch Plywood	Steel and Wood	Plywood	Solid Wood Slabs	Steel Frame and Aluminum Cladding	Wood	Steel Clad Fire Retardant Styrene Paneling	-
Single Unit								
Modular								
Kit of Parts								
Flat Pack								
Expandable								



PRECEDENT ANALYSIS

PRECEDENT ANALYSIS

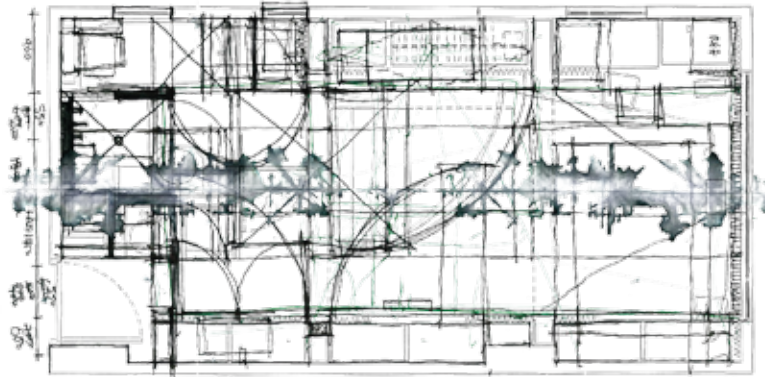


Fig 6.01 Apartment 24's flexible plan

APARTMENT 24 BY GARY CHANG

"Residential space is becoming an exceptionally expensive commodity and a growing problem in urbanized Asian environments. However, architect Gary Chang from Hong Kong need not worry. His ingenious solution called 'Micro Apartment' could be the key to creating more space with sliding wall units and fold-away furniture. Gary's apartment is only 344 square foot (or 32 square meters) but with a smart use of resources he has managed to transform it into 24 different designs. Virginia Gardiner described the apartment in the New York Times: "The wall units, which are suspended from steel tracks bolted into the ceiling, seem to float an inch above the reflective black granite floor. As they are shifted around, the apartment becomes all manner of spaces – kitchen, library, laundry room, dressing room, a lounge with a hammock, an enclosed dining area and a wet bar."⁴⁰



Fig 6.02 Space transformation by movable elements

SPACE TRANSFORMATION by FLEXIBLE ELEMENTS

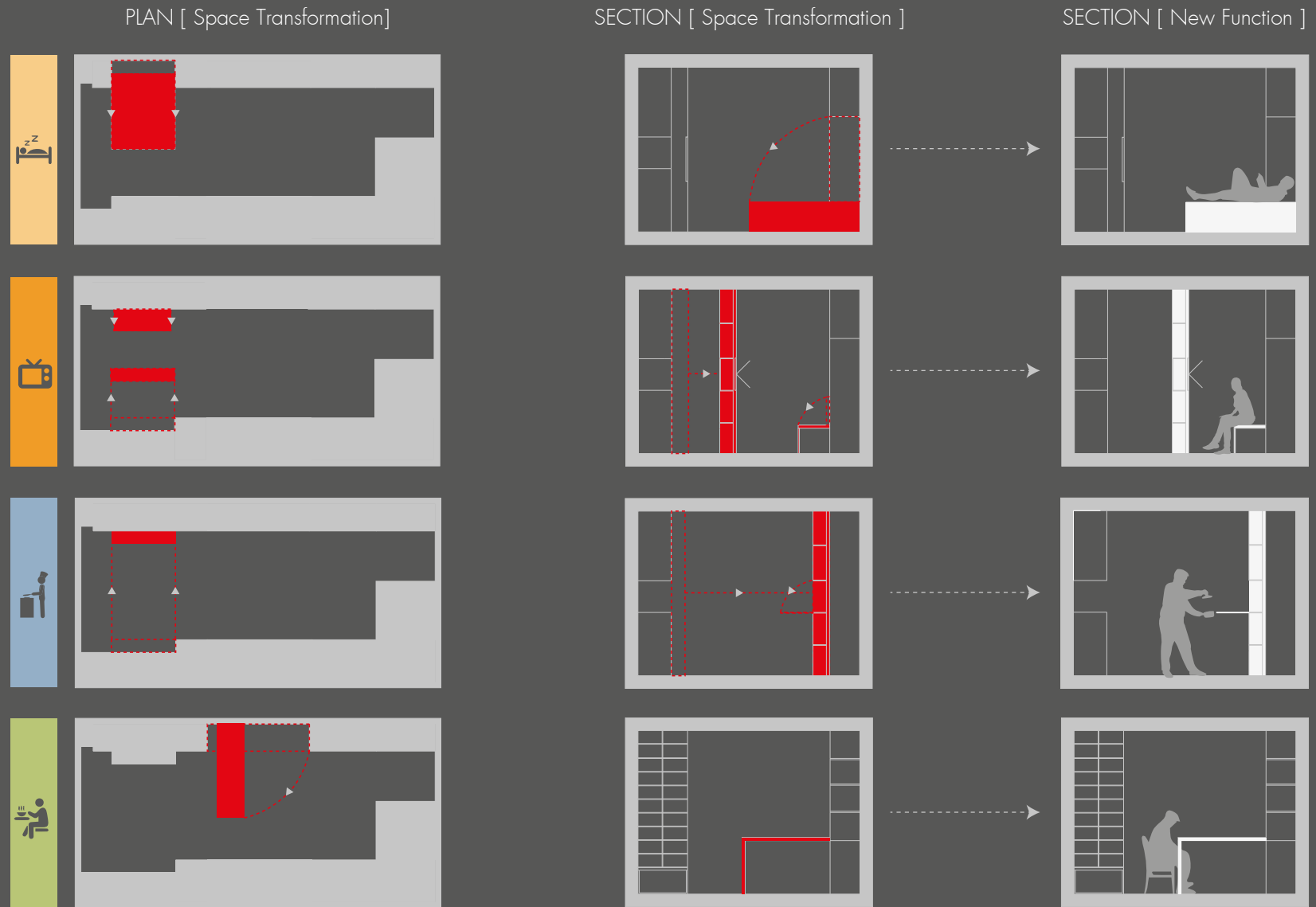


Fig 6.03 Space transformation diagrams

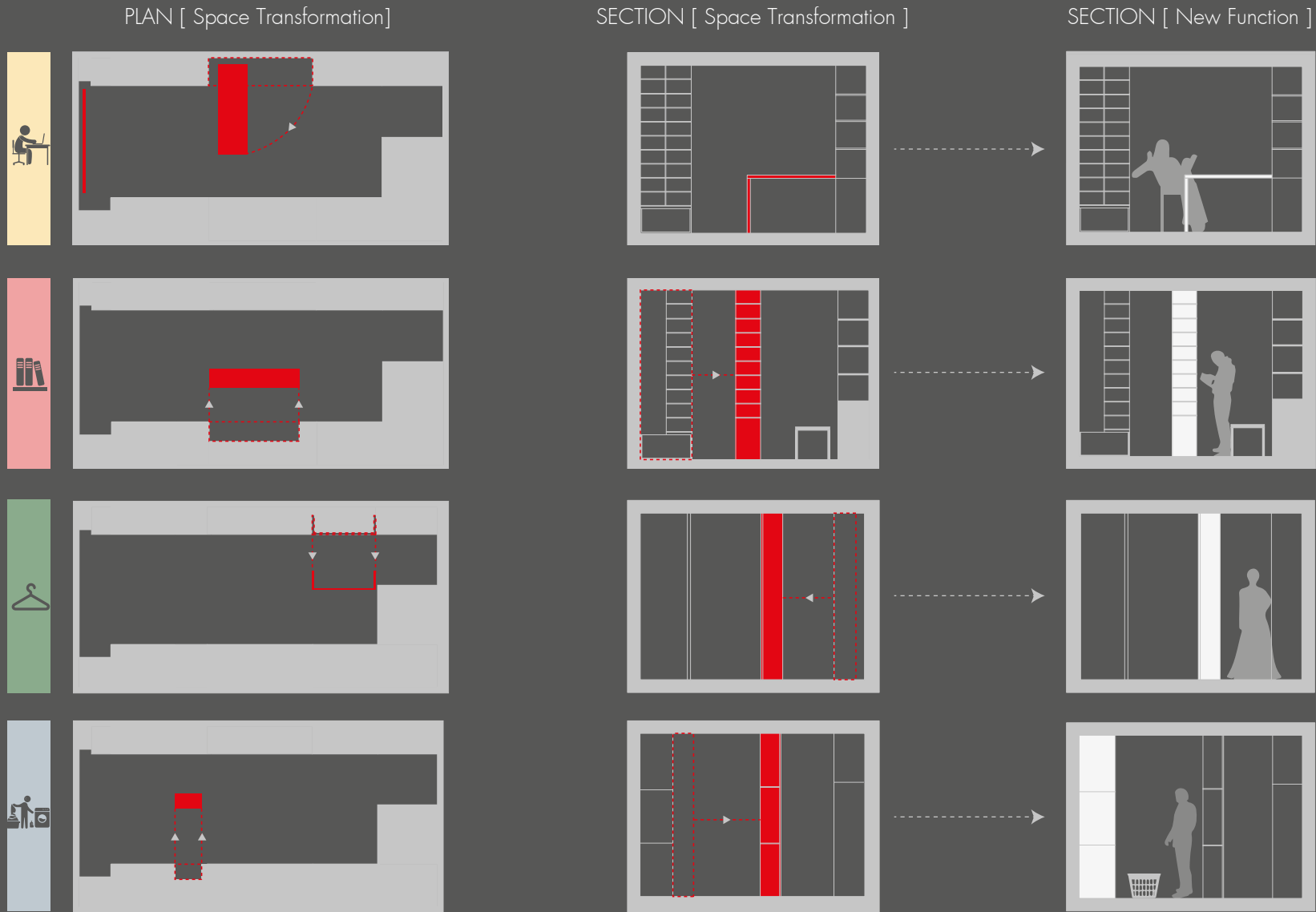


Fig 6.04 Space transformation diagrams [Continued]

FUNCTIONS & AREAS

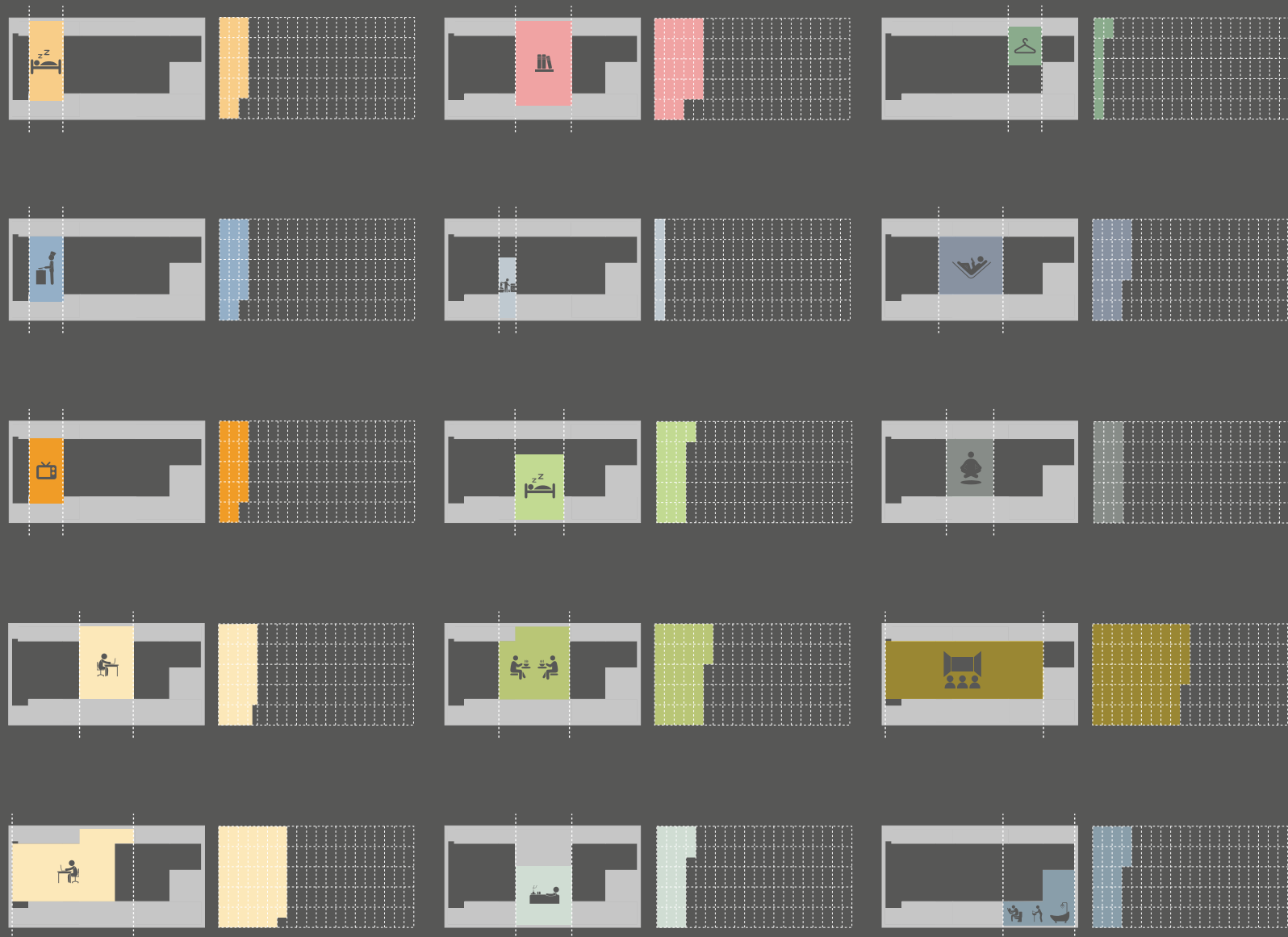


Fig 6.05 Ratio of each function to the whole area



TEST DRIVE

- Off Grid & On Grid

The unit will be able to operate on grid as well as off grid for situations where infrastructure is destroyed by natural disasters and access to electricity, clean water, and gas is not available.

- Thermal Insulation & Water Proofing:

The dwelling unit will be sufficiently insulated to create a comfortable living environment during cold winters and hot summers. Water proofing materials will also be used to prevent water leakage during the rainy seasons.

- Storage:

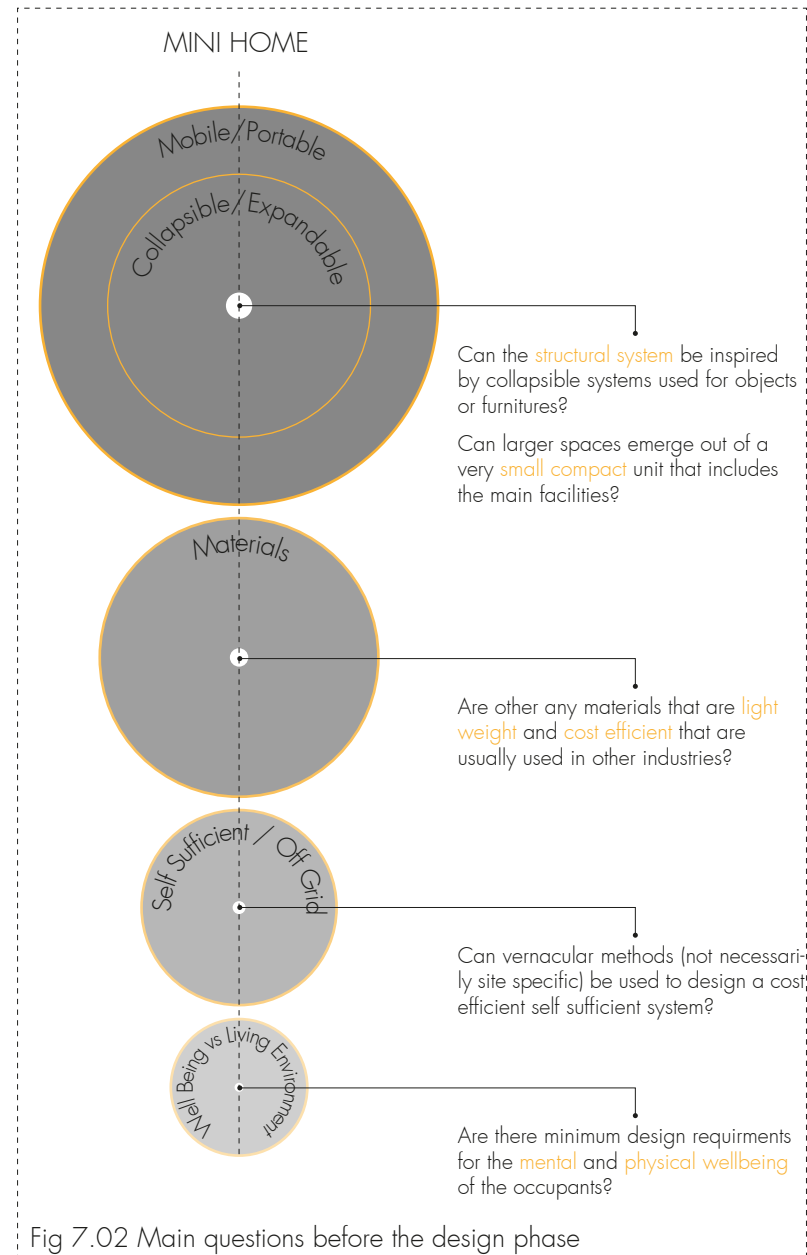
Storage space (shelves) will be provided so the occupants can organize and store their belongings and keep the main living area as tidy and clean as possible.

- Cost Effective & Affordable:

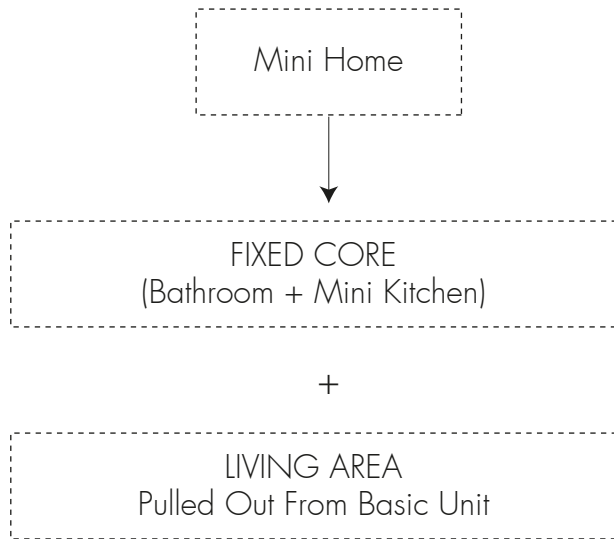
Using materials of good quality will be more beneficial to both the occupants and the owners (NGOs or governments). The main goal would be to use building materials that have good qualities, need less maintenance, and are affordable.

- Homey Design:

Both exterior and interior materials will be carefully selected to avoid an industrial look as many contemporary disaster relief projects, and create a warm homey environment.



MAIN CONCEPT



? How small can the "basic unit" be ?

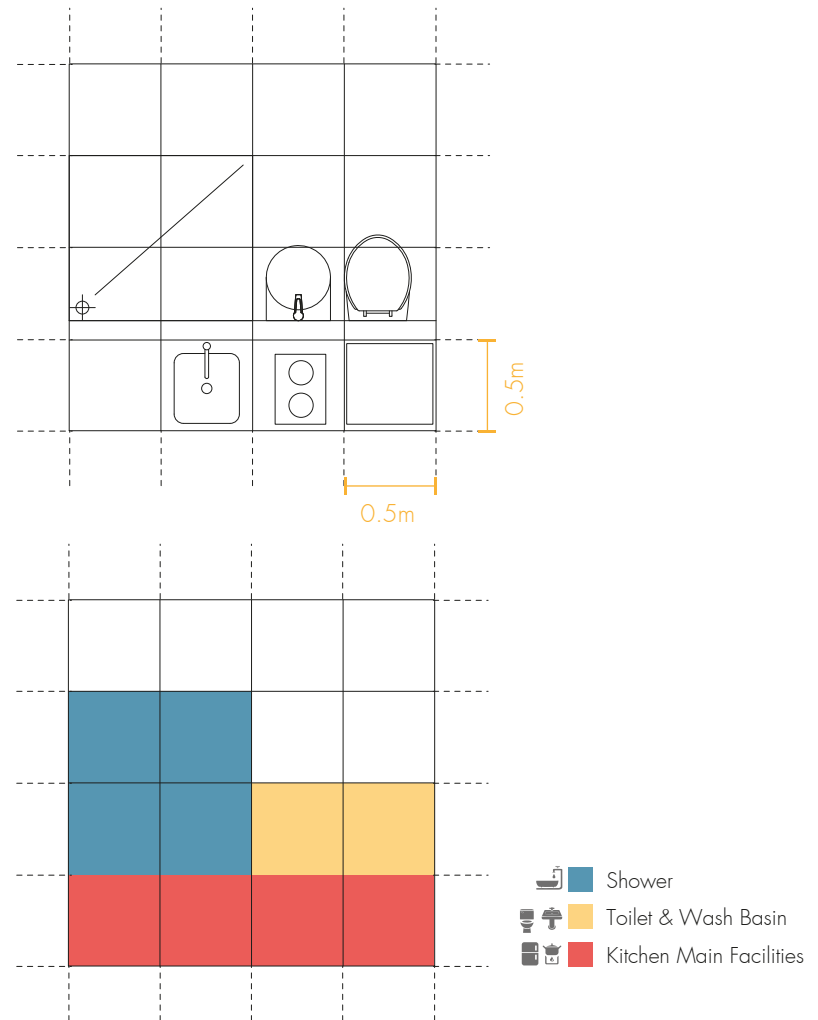


Fig 7.03 Basic unit dimensions

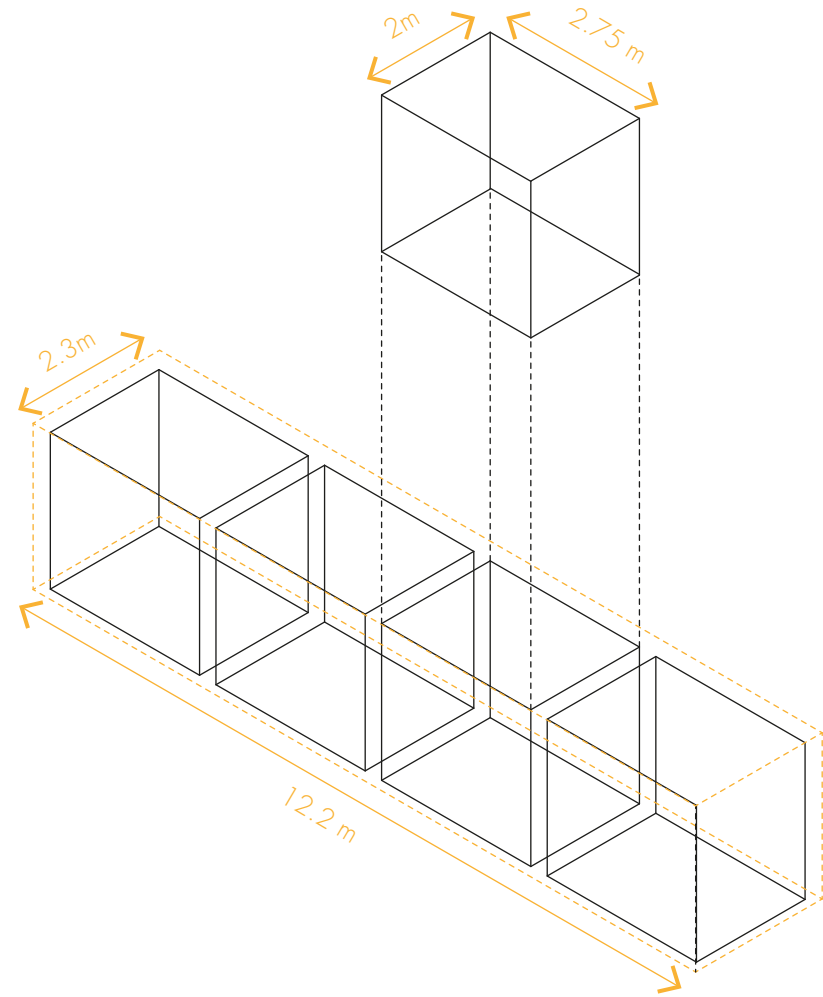
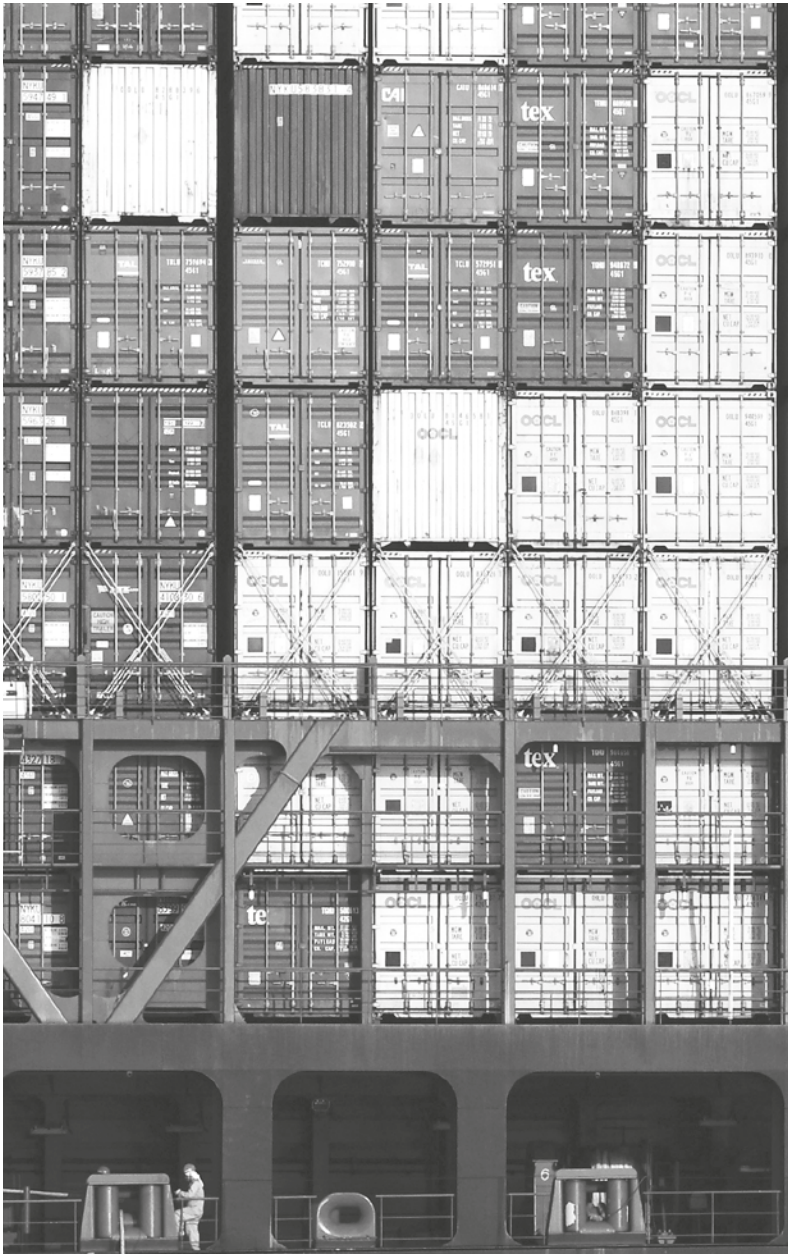


Fig 7.05 Four units can fit a 40 ft shipping container

FUNCTIONS



Kitchen [Sink + mini stove + mini fridge]



Shower



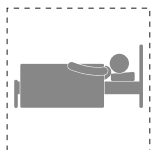
Bathroom [Toilet + Water Heater]



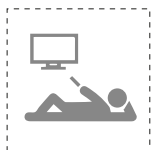
Washing Clothes Area



Dining Area



Sleeping Area



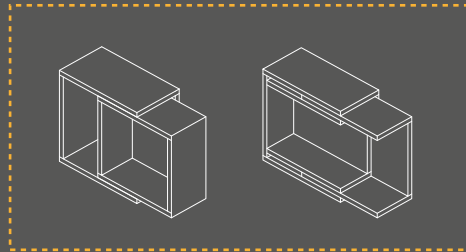
Living Area

30 IN 1 PACKAGE

Roof
Table
Walls
Floor
Pipes
Filter
Pump
Wires
Toilet
Stove
Doors
Trailer
Filters
Battery
Shelves
Fixtures
Cabinets
Windows
Insulation
Structure
Mini Fridge
Solar Panel
Wash Basin
Shower Tray
Water Heater
Grey Water Tank
Black Water Tank
Fresh Water Tank

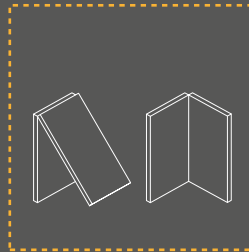
Fig 7.06 Everything can be transported to the site as one unit

POSSIBLE EXPANSION STRATEGIES - SELECTION PROCESS



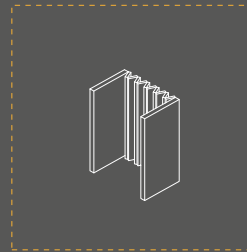
Telescopic (Selected)

Floor, ceiling, or walls will be stepped as one box is pulled out of the other one.



Foldable (Selected)

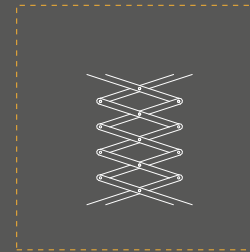
Every time an exterior plane is folded, weatherproofing is needed.



Accordion

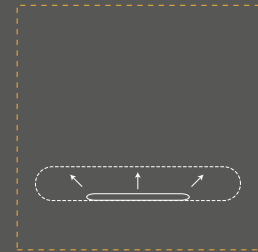
Extensive weatherproofing will be needed between all the folded planes.

If the accordion structure is made of flexible materials such as fabric or plastic, it would not be secure enough for a dwelling unit since it can be easily cut open with any sharp objects.



Scissors

If this method is used, facade, roof, or floor panels must be added after the structure is expanded. Combining a lattice structure with fixed panels is only possible if the panels are either foldable as well which would be very complex or be made of flexible materials with low insulation values and low security.

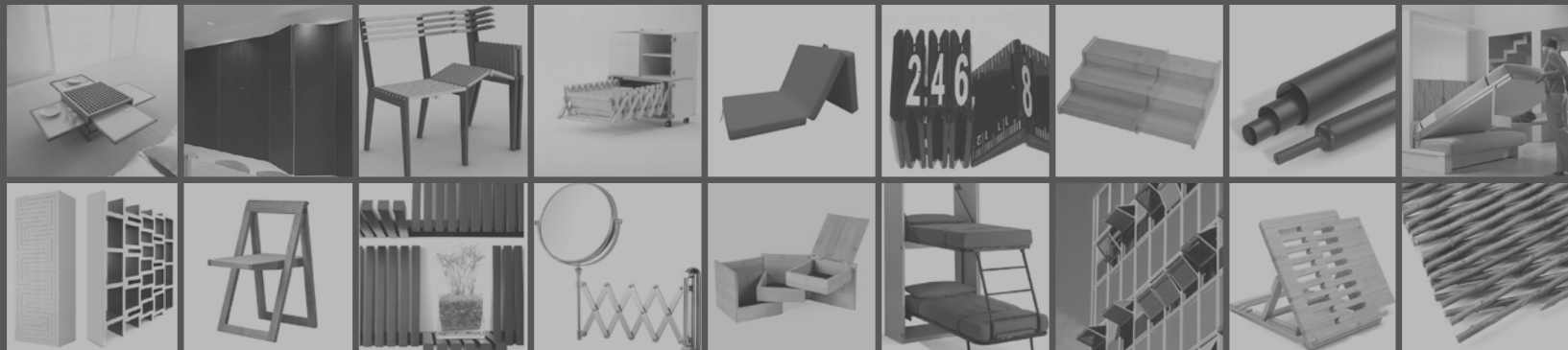


Inflatable

Inflatable structures need special equipments which would be a major disadvantage in post disaster situations. Moreover, inflatable dwellings can be cut open with sharp objects which means they are not secure enough and would need major costly repairs.

Major Disadvantages

Fig 7.07 Expandable Objects



TEST DRIVE 1

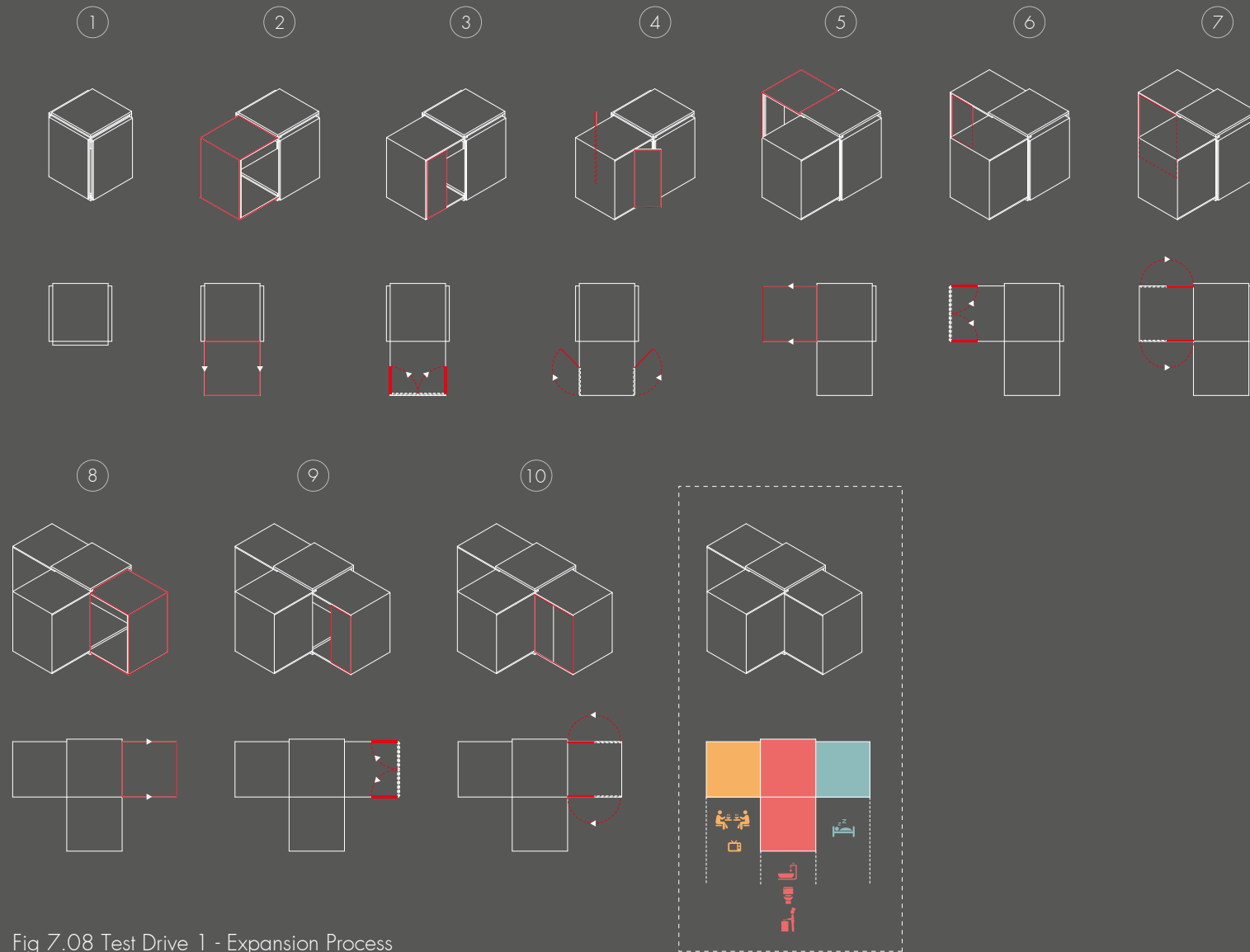


Fig 7.08 Test Drive 1 - Expansion Process

TEST DRIVE 2

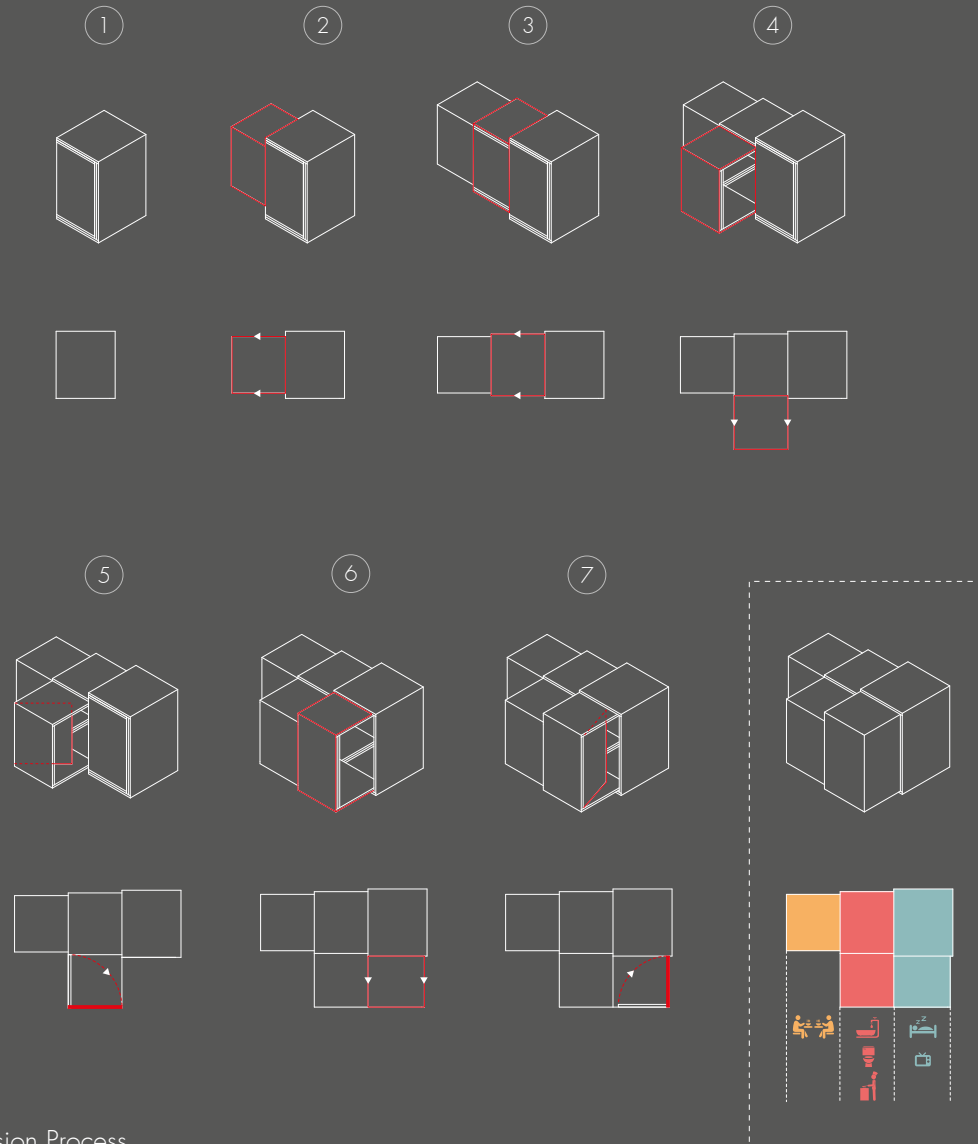


Fig 7.09 Test Drive 2 - Expansion Process

TEST DRIVE 3

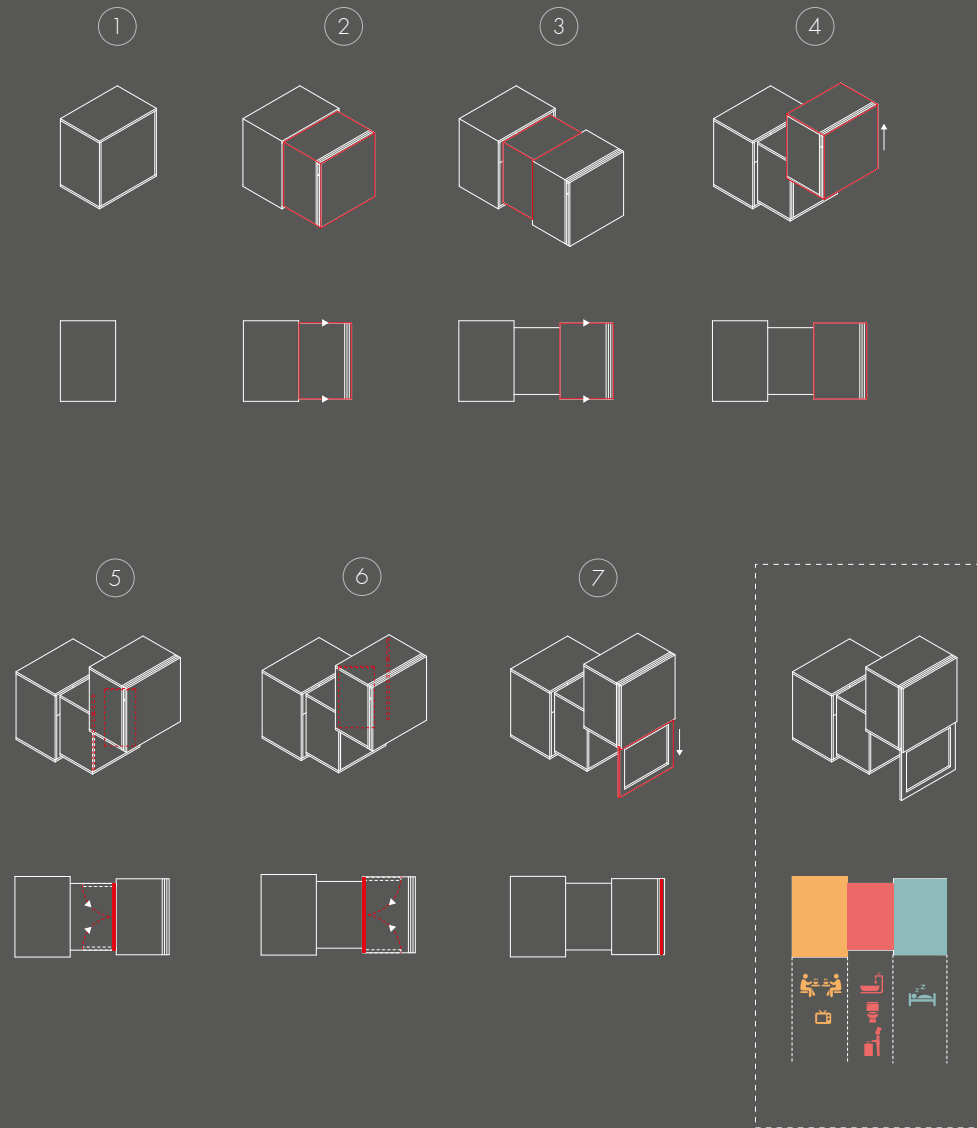


Fig 7.10 Test Drive 3 - Expansion Process

TEST DRIVE 4

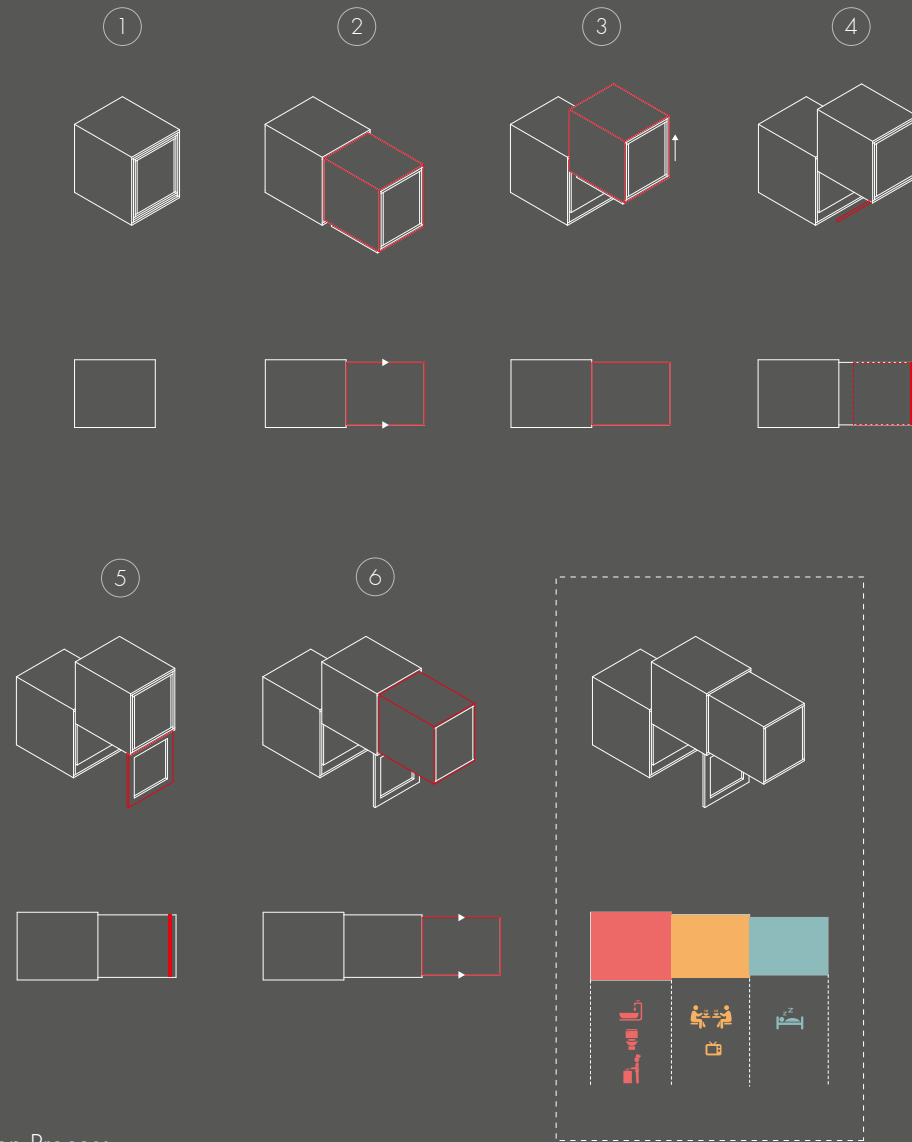


Fig 7.11 Test Drive 4 - Expansion Process

TEST DRIVE 5

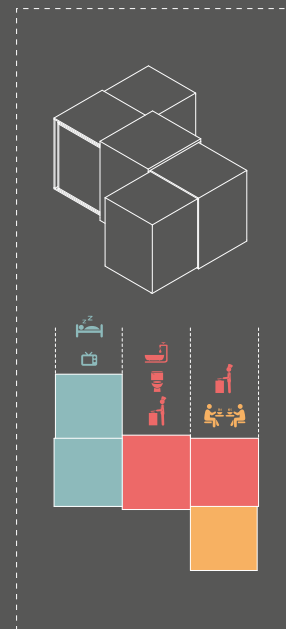
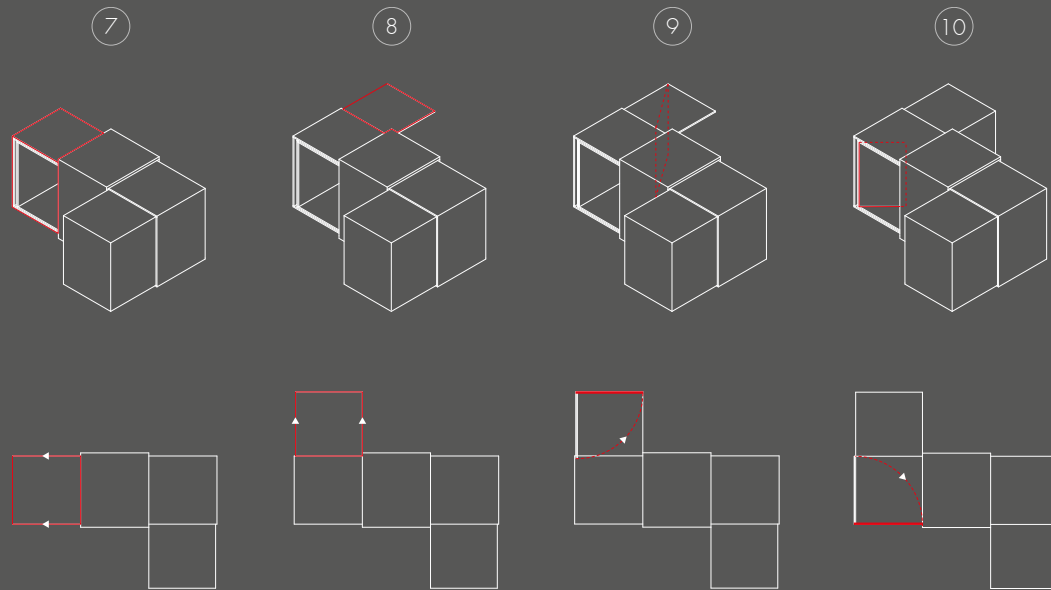
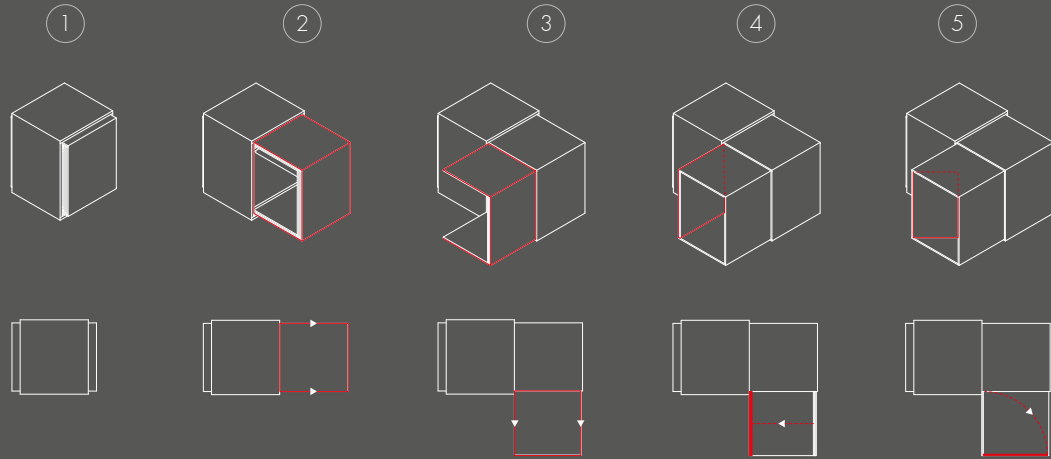


Fig 7.12 Test Drive 5 - Expansion Process

TEST DRIVE 6

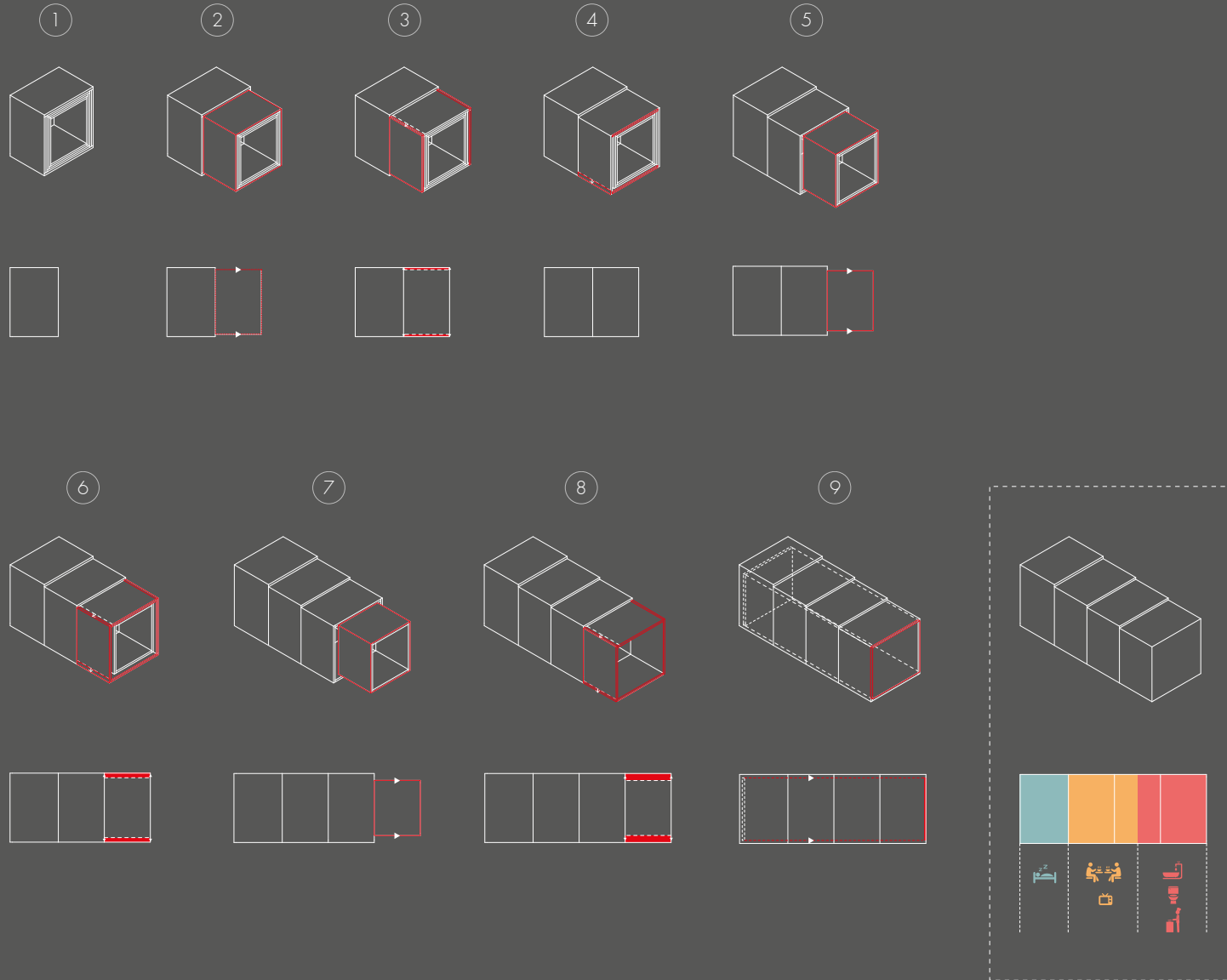


Fig 7.13 Test Drive 6 - Expansion Process

TEST DRIVE 7

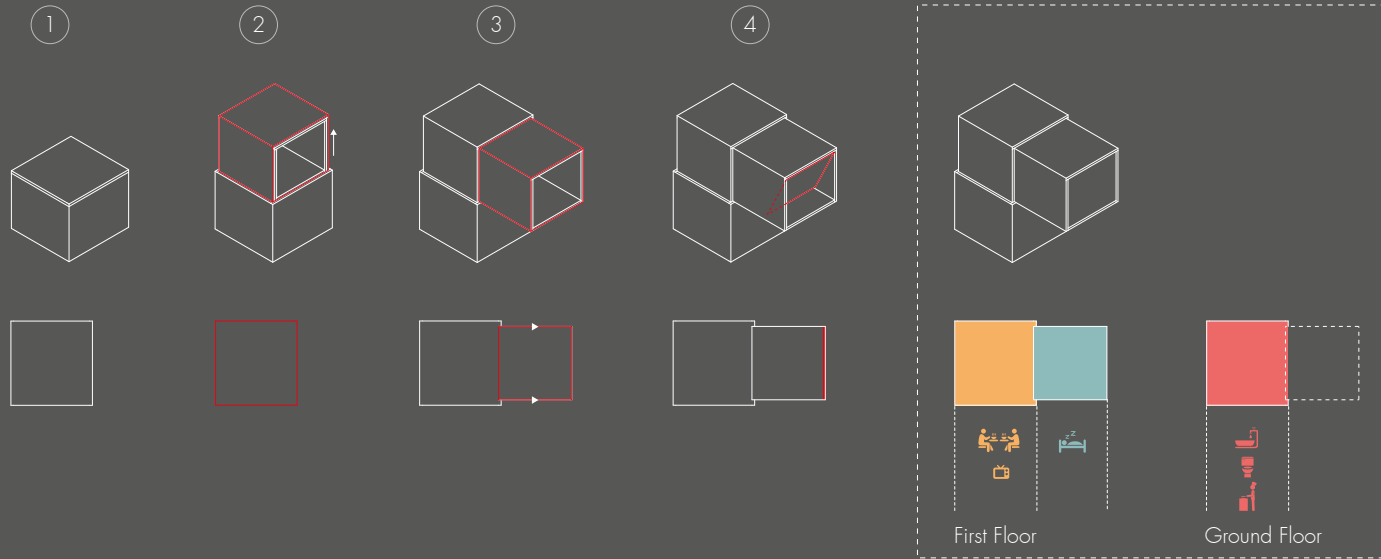


Fig 7.14 Test Drive 7 - Expansion Process

TEST DRIVE 8 [SELECTED CONCEPT]

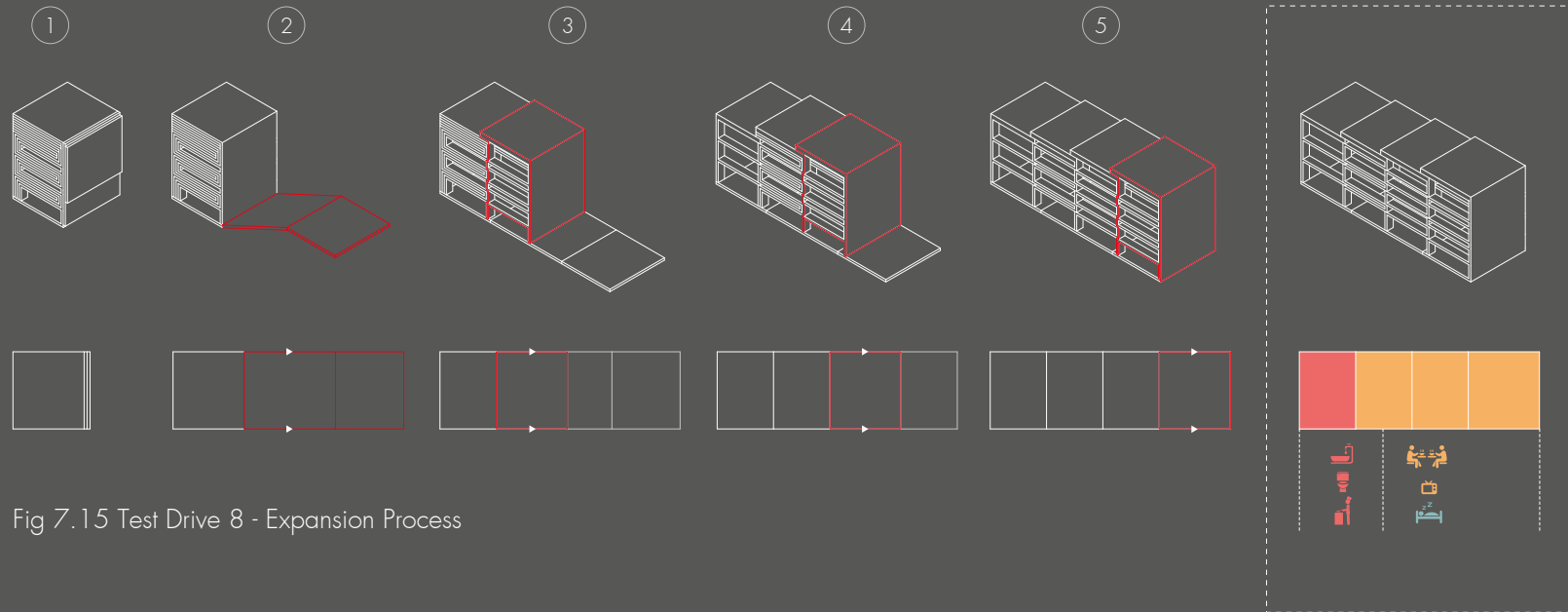


Fig 7.15 Test Drive 8 - Expansion Process

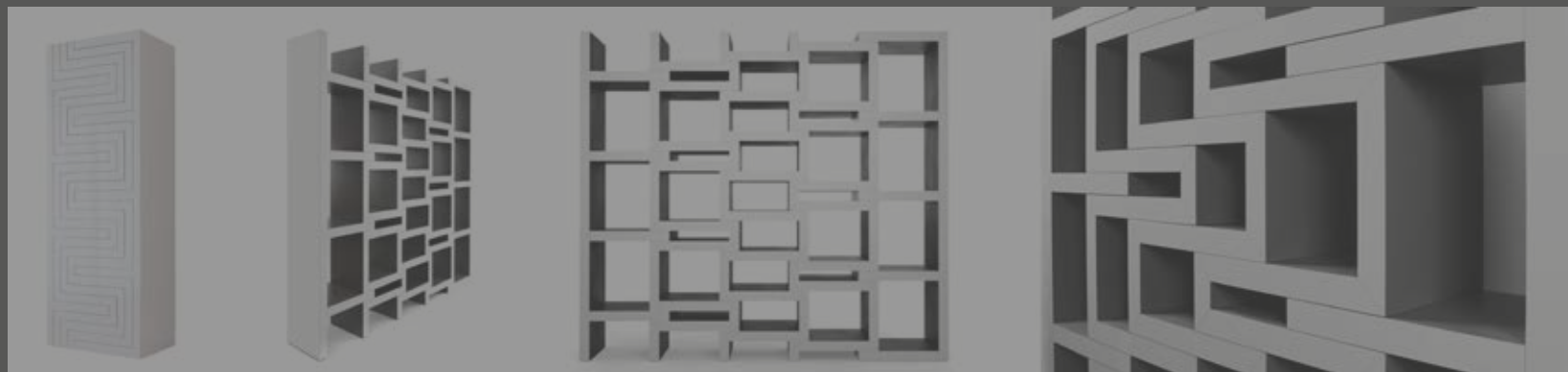
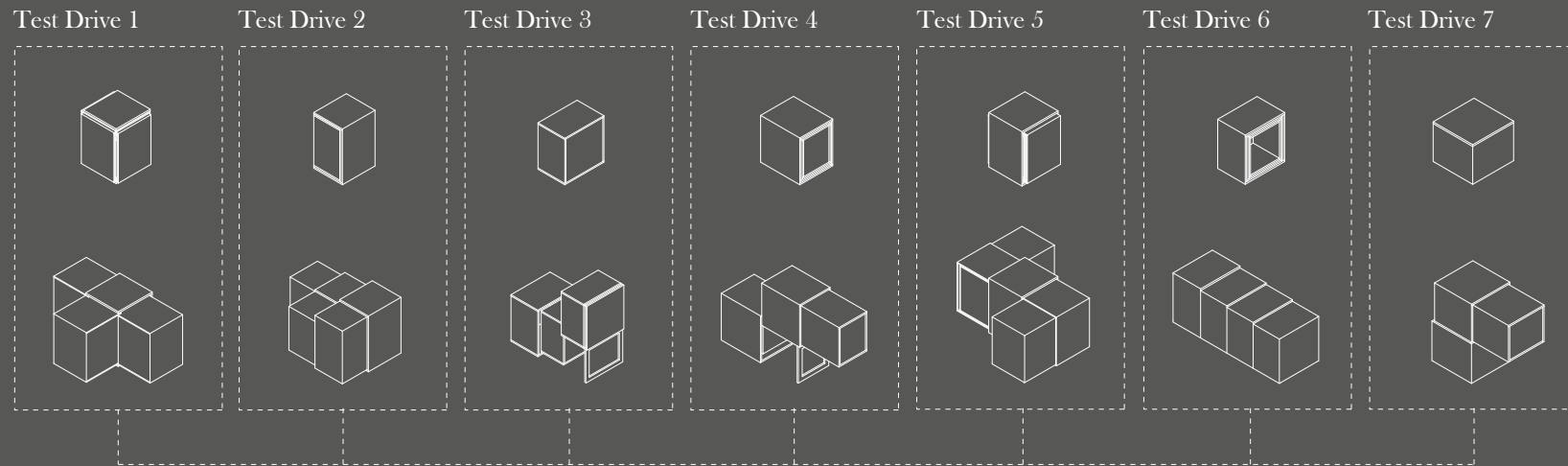


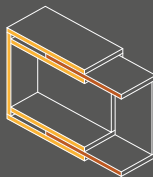
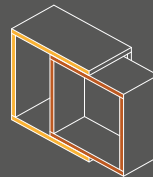
Fig 7.16 The selected design concept was inspired by the expandable REK bookcase.

ELIMINATED CONCEPTS COMPARISON

Fig 7.17 Test drives' comparison chart



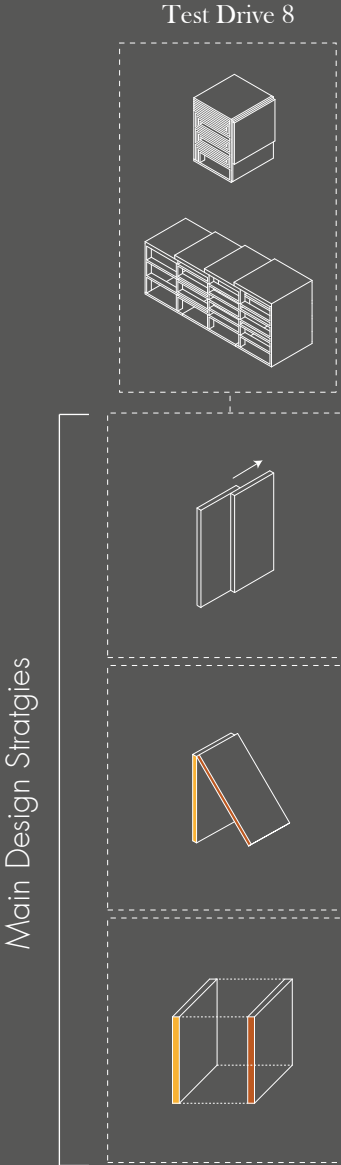
Main Design Strategies



Major Disadvantages :

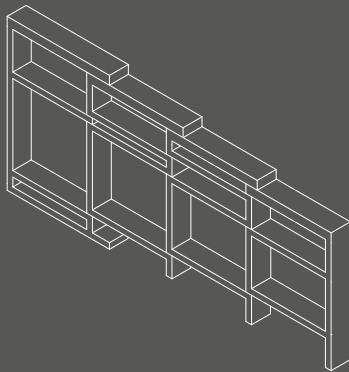
- Change in level everytime the space is expanded [It would be uncomfortable for occupants to walk around the house]
- The total living space is over compartmentalized and divided into very small areas.
- Storage space cannot be integrated into the walls as they are very thin and space is limited
- Exterior walls cannot be properly insulated as they are very thin.

SELECTED CONCEPT'S ADVANTAGES

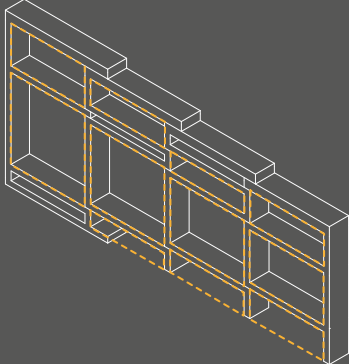


Major Advantages :

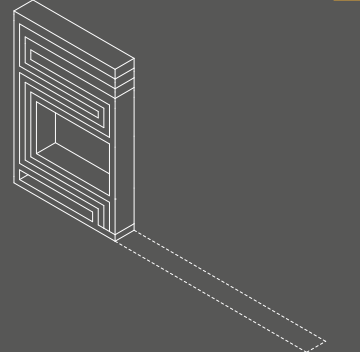
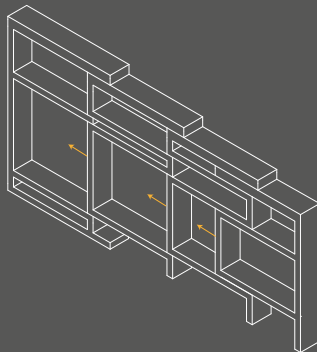
- Change in levels are avoided by sliding roof beams and folding the floor structure.
- Thick walls allow for both proper insulation.
- Adequate storage space can be integrated into the wall structure.



Thermal Insulation
in thick walls

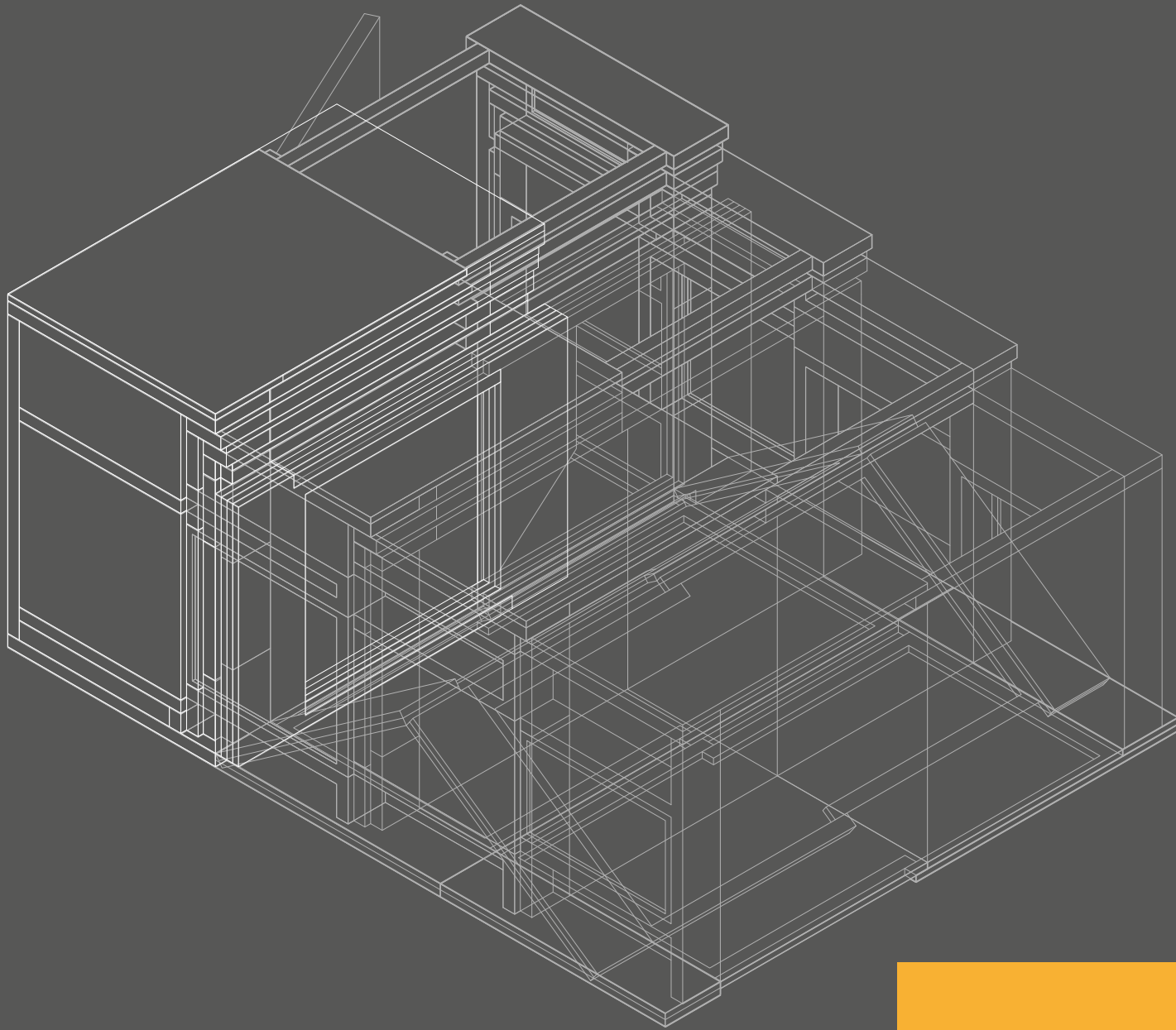


Storage Space
in thick walls



Expandable/Collapsible

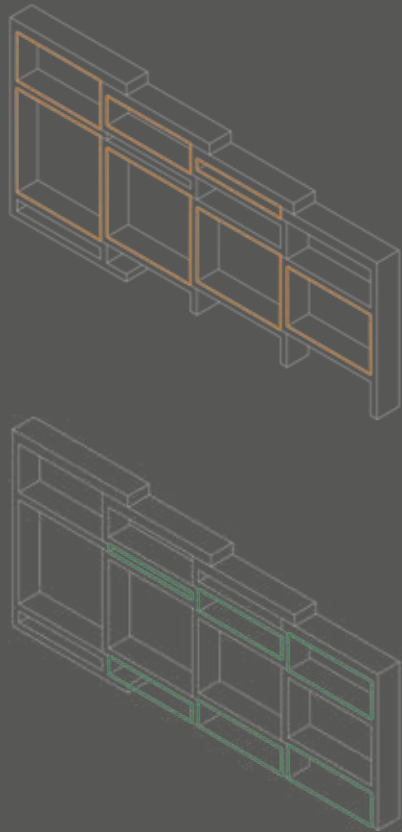
Fig 7.18 Selected concepts' advantages



PROTOTYPE A

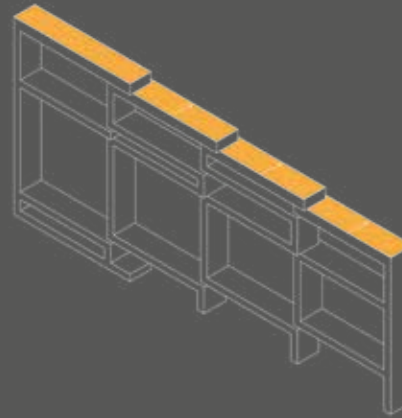
FACADE

If walls are aligned, facade panels would NOT allow expandability.



SOLUTION:

1. Shifting Walls



2. Placing facade panels on both sides of the wall

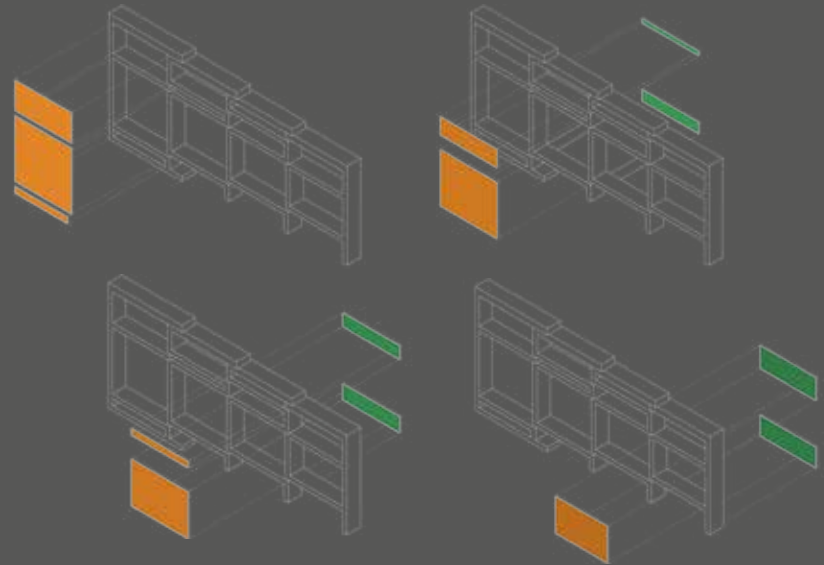
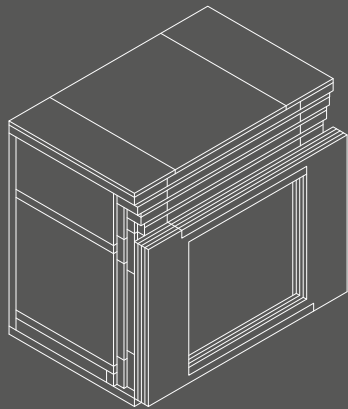


Fig 8.01 Aligned vs shifted walls

EXPANSION PROCESS

A. Closed Unit



B : Sliding the Front and Back Doors

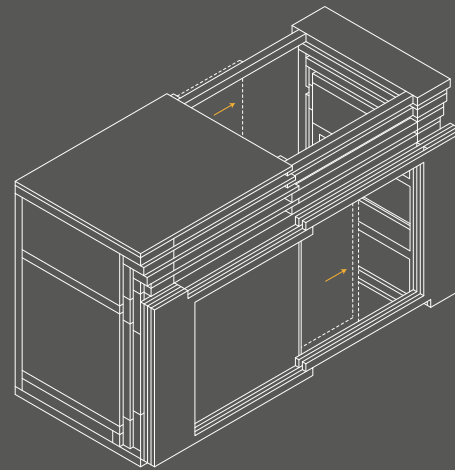
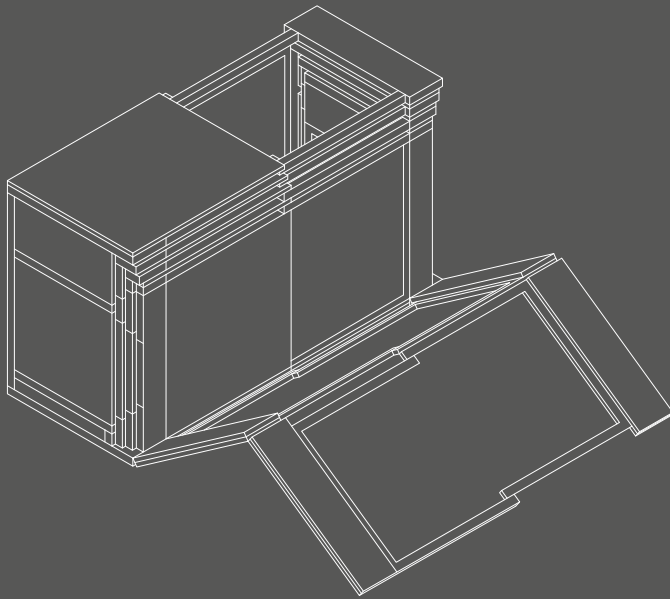


Fig 8.02 Expansion process (Steps 1-2)

C. Unfolding the Floor



D. Adding the Floor Panels

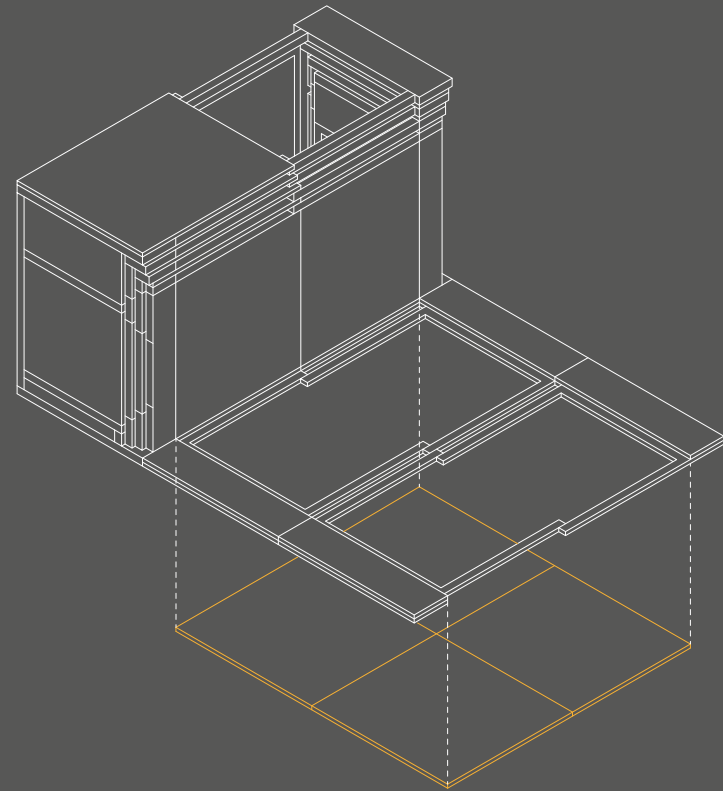
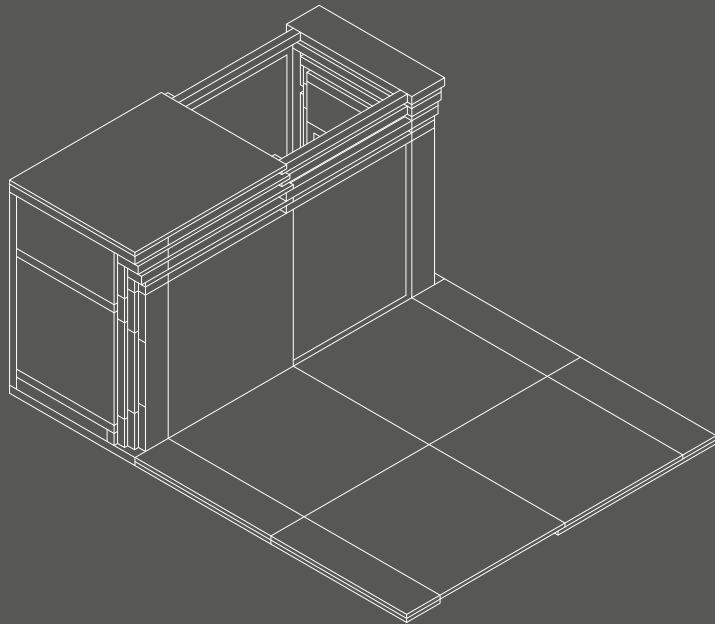


Fig 8.03 Expansion process (Steps 3-4)

E. Floor Panels in Place



F. Expanding the Living Space **2X**

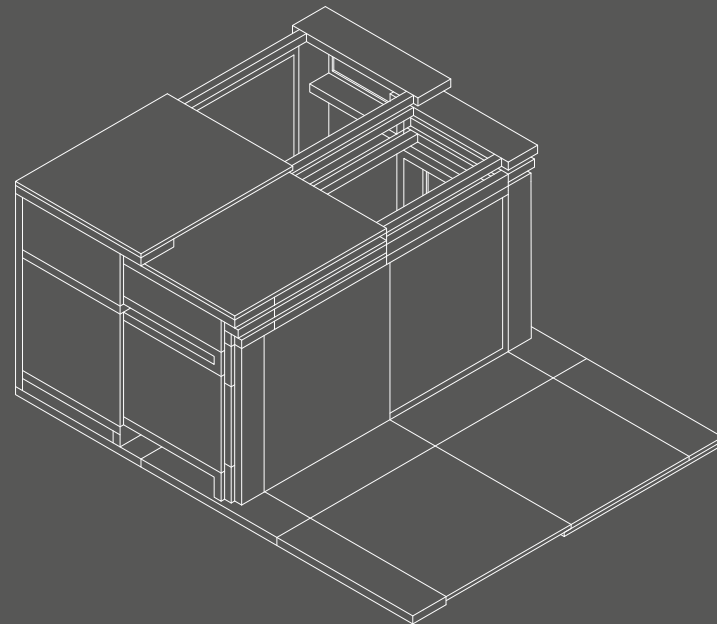
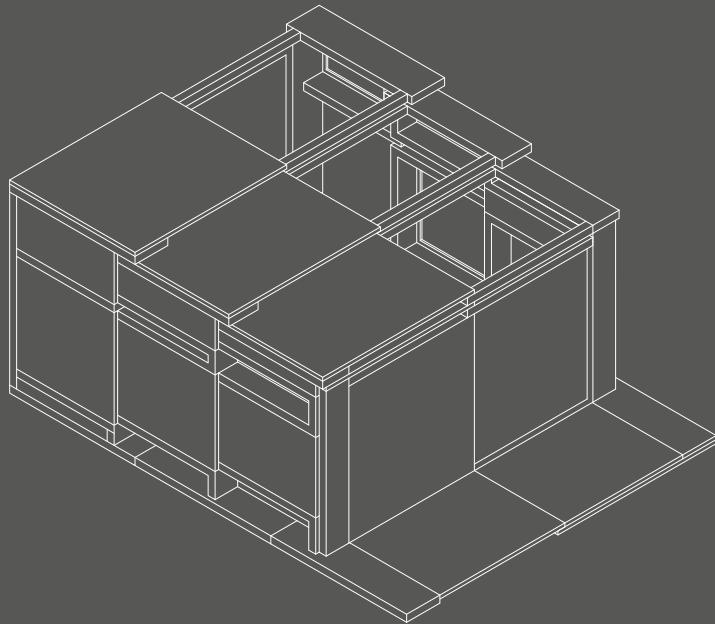


Fig 8.04 Expansion process (Steps 5-6)

G. Expanding the Living Space **3X**



H. Expanding the Living Space **4X**

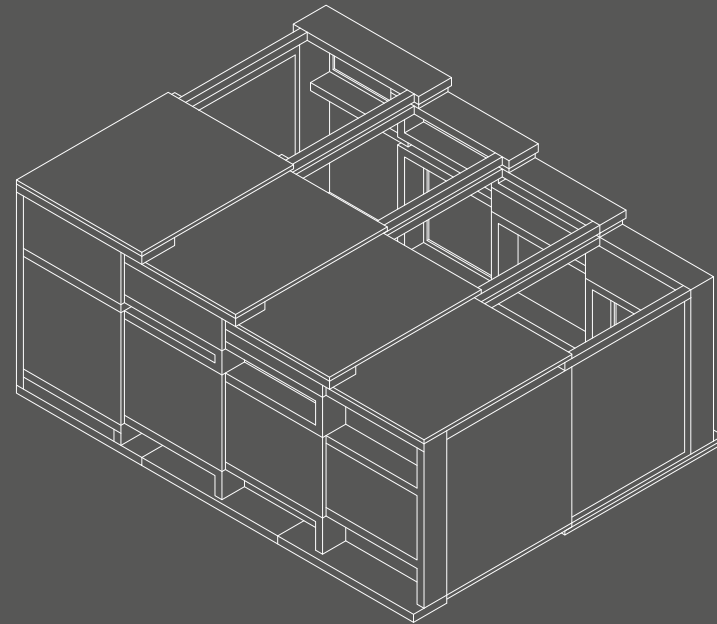
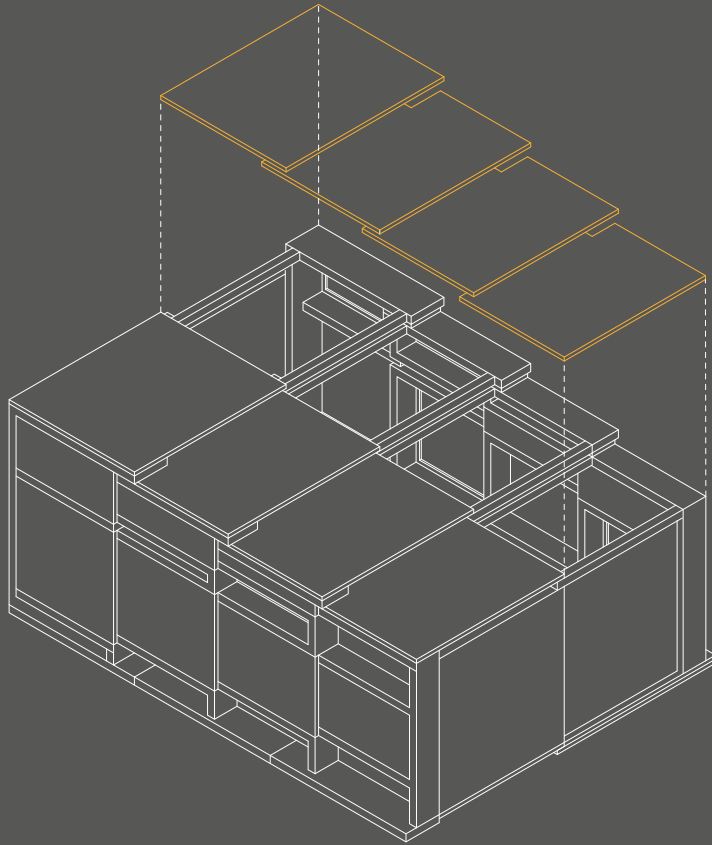


Fig 8.05 Expansion process (Steps 7-8)

I. Adding the Roof Panels



J. Final Outcome

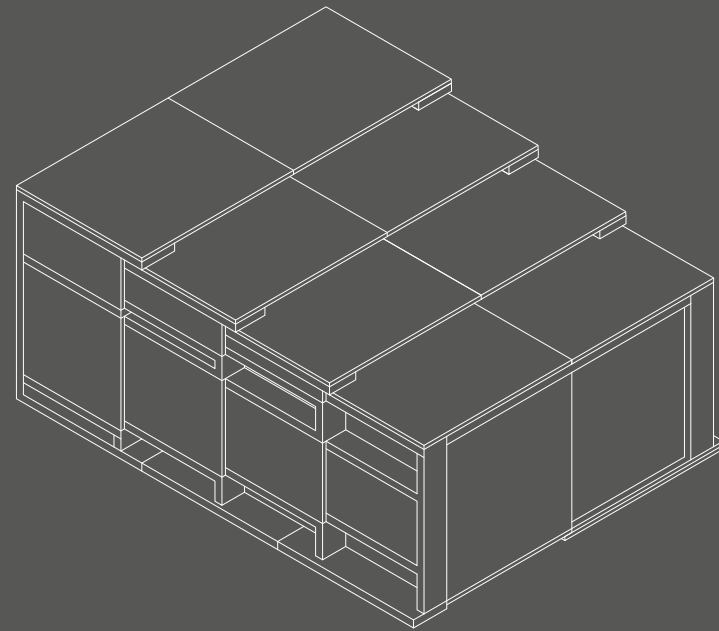


Fig 8.06 Expansion process (Steps 9-10)

CLOSED UNIT PLAN

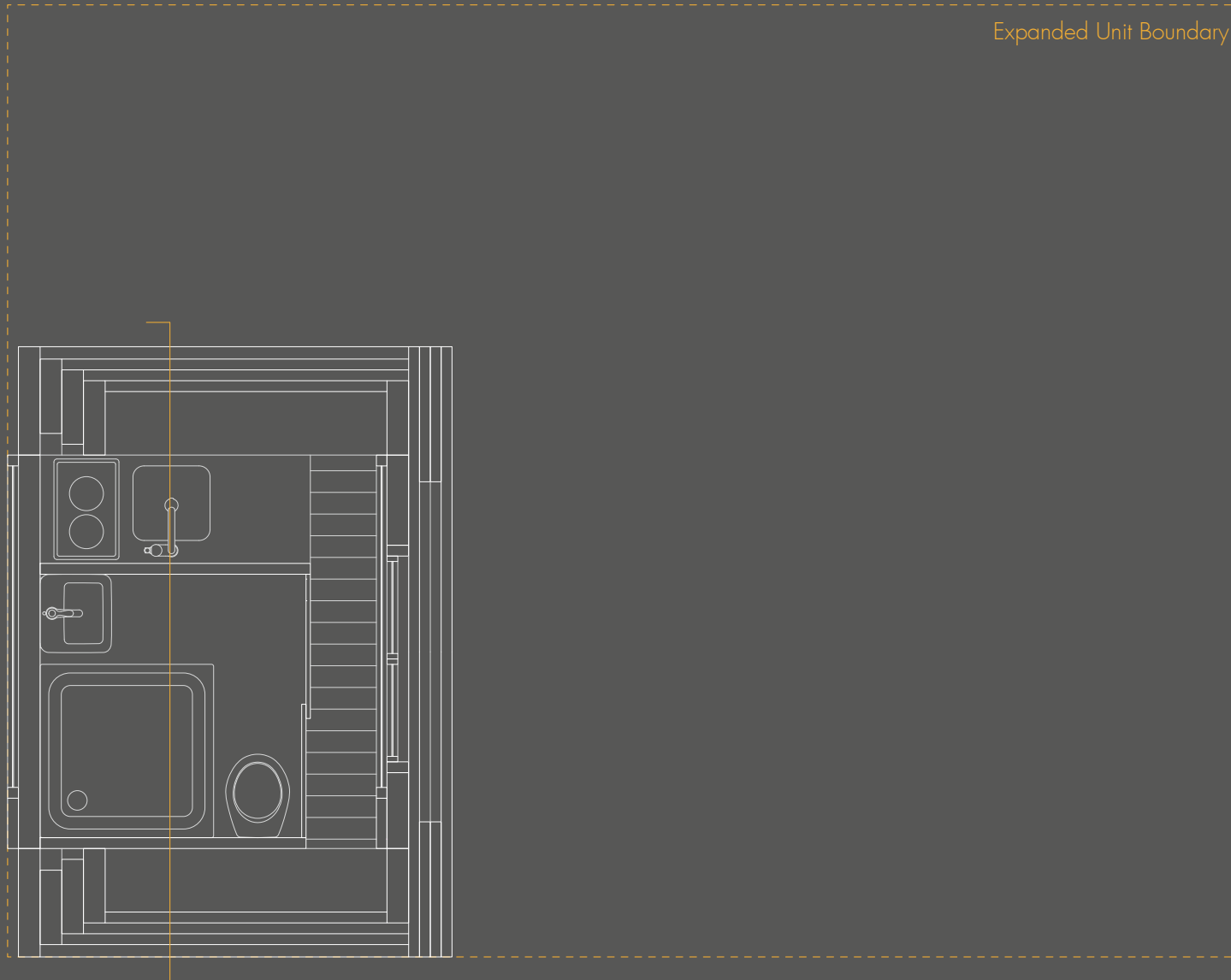


Fig 8.08 Closed Unit / Cross Section

CLOSED UNIT CROSS SECTION

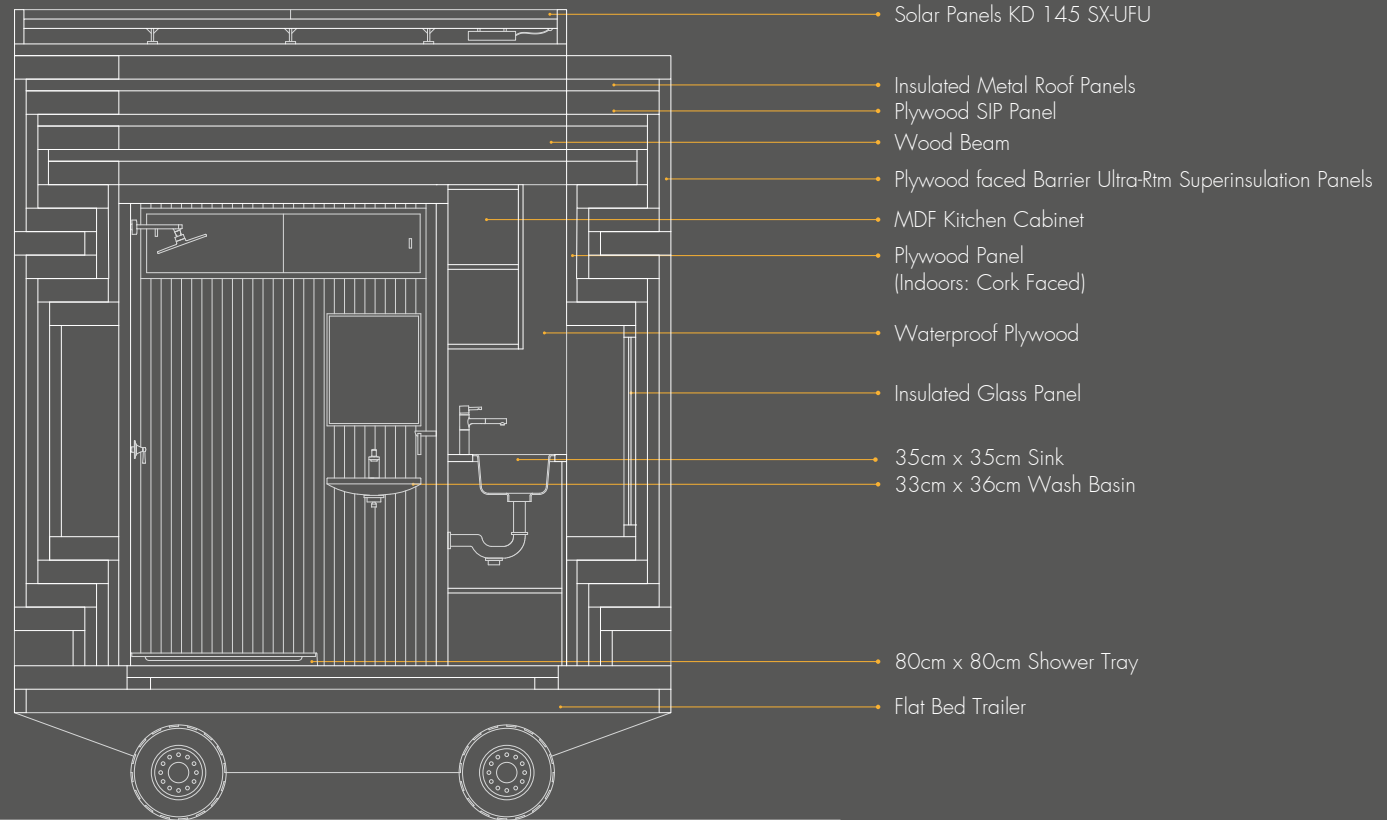


Fig 8.09 Closed Unit / Cross Section

EXPANDED UNIT PLAN

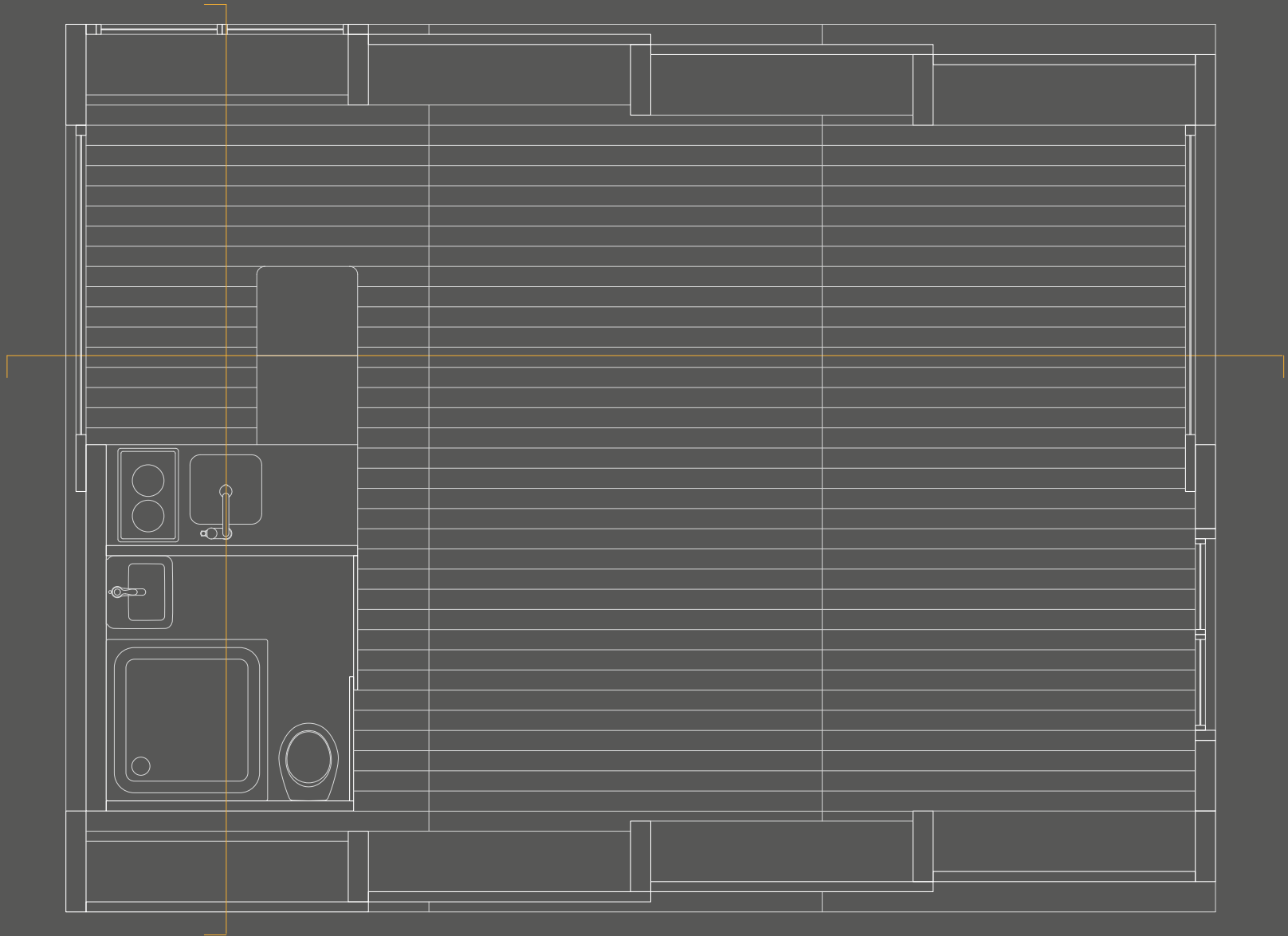
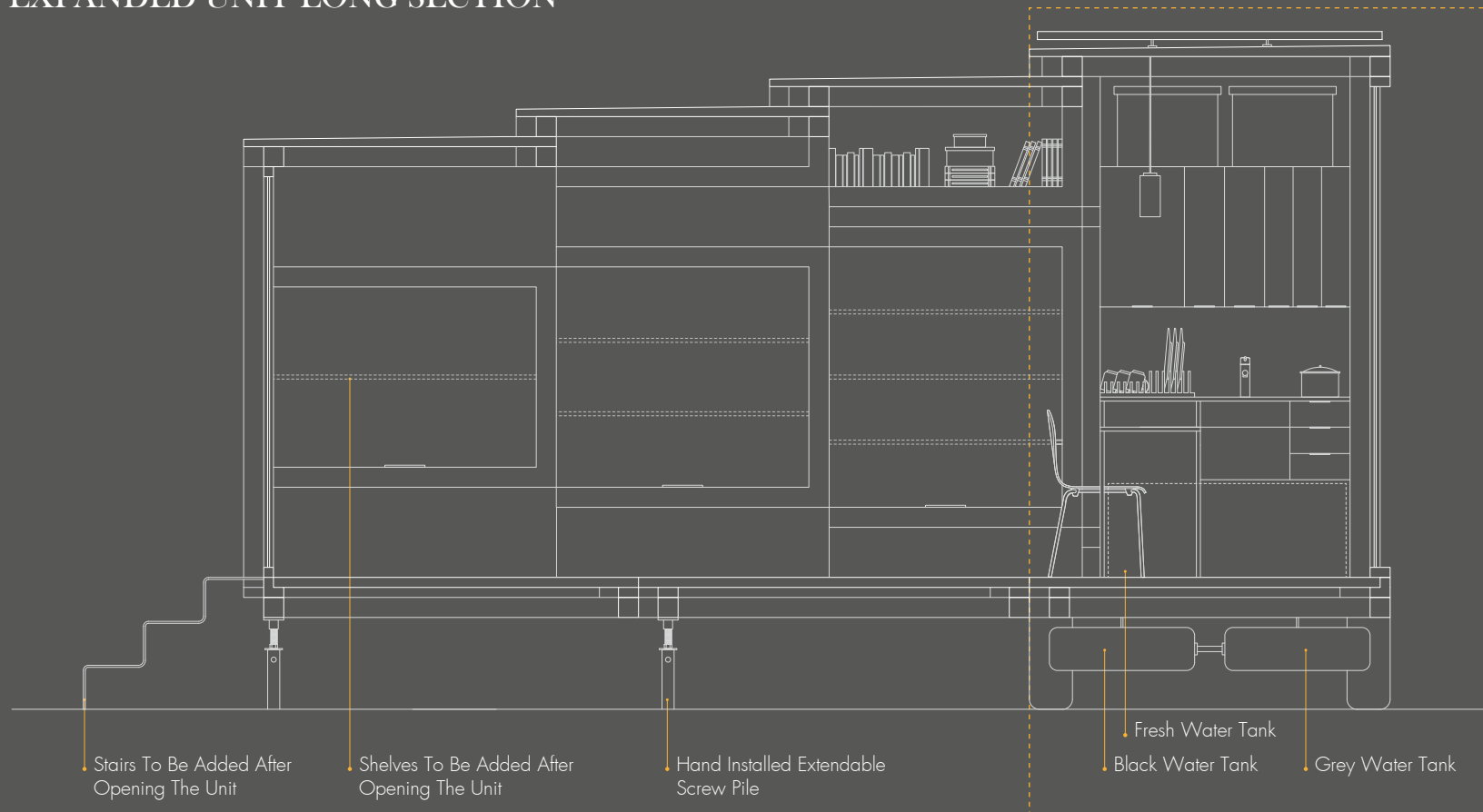


Fig 8.10 Closed Unit / Cross Section

EXPANDED UNIT LONG SECTION



Fixed Section:
Kitchen & Bathroom units are placed at the end of the dwelling unit along with the fresh water tank, grey water tank, black water tank, water filters, solar panels, water heaters, and electrical sockets to avoid the need for extendable cables, pipes, or lighting fixtures. Once on site, the living area which is much lighter than the fixed portion will have to be pulled out which would make the unit's set up so much easier and less complicated.

Fig 8.11 Expanded unit long section

EXPANDED UNIT CROSS SECTION

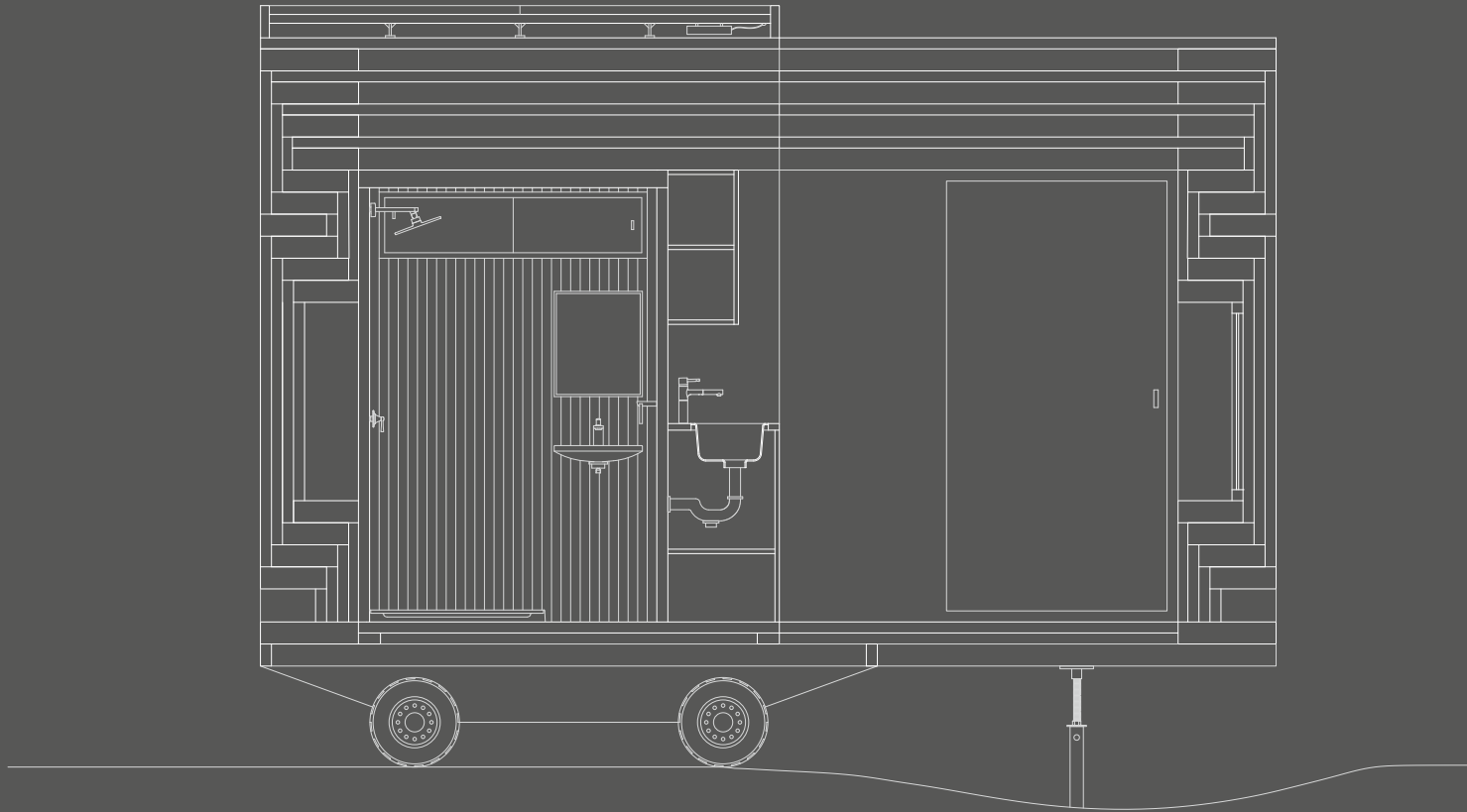


Fig 8.12 Expanded Unit / Cross Section

DETAILS [Side Walls' Sliding Track]

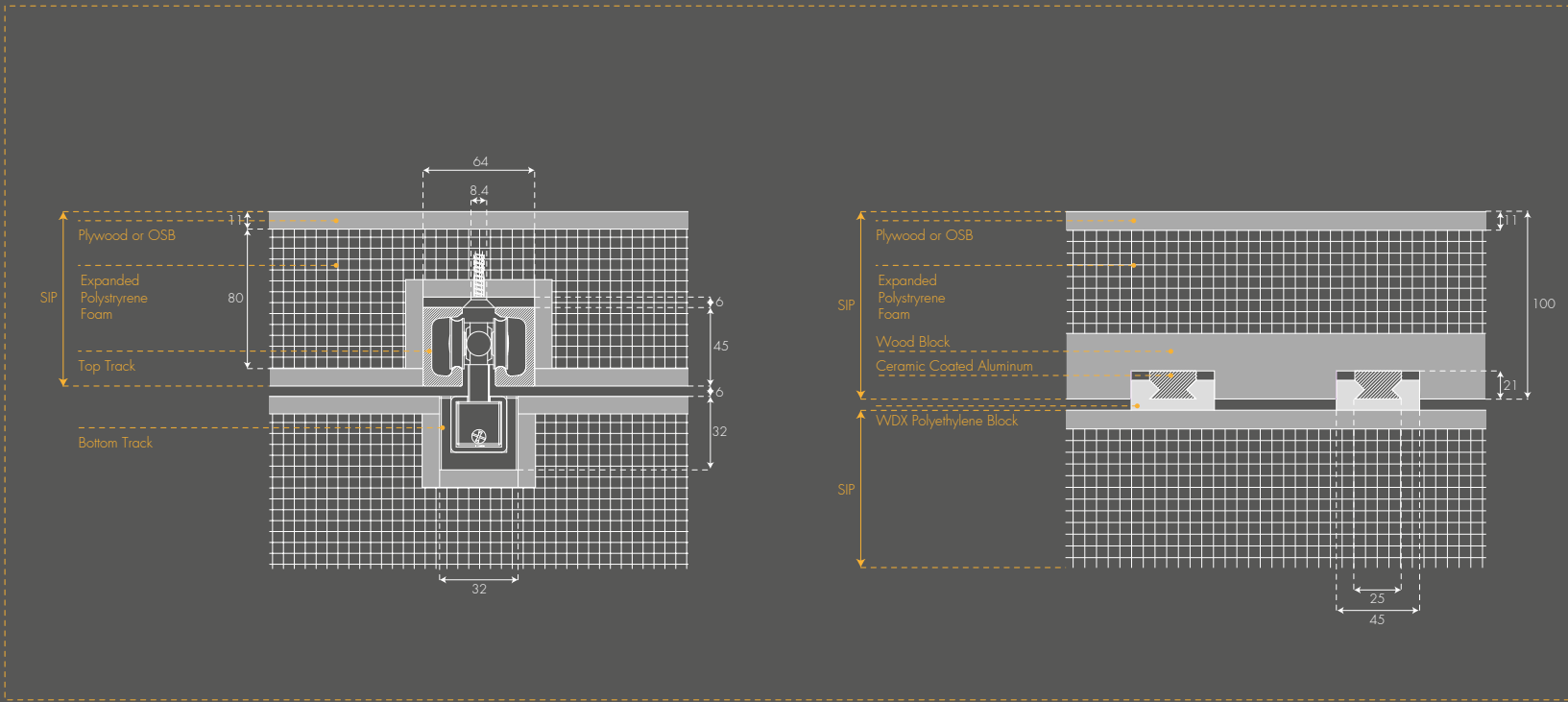
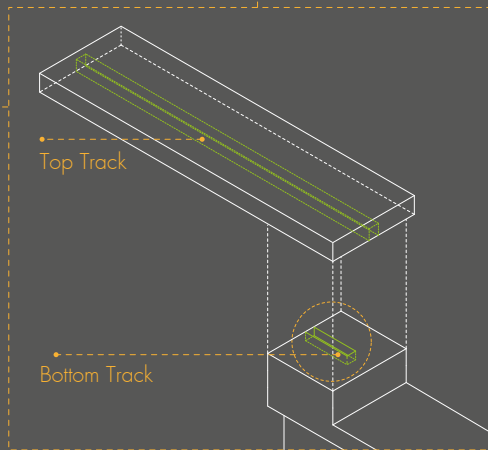
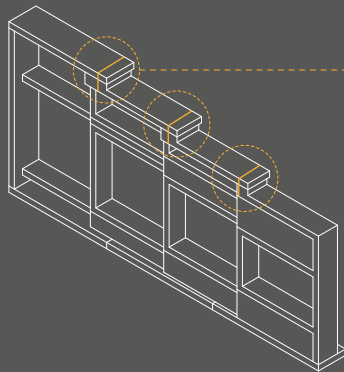


Fig 8.13 Side Walls' Sliding Track [Typical Detail]
Unit = mm



The side walls' sliding tracks are placed inside to avoid exposure to direct sunlight, rain, snow, dust, and extreme weather conditions. This would increase their lifespan and reduce the need for maintenance.

DETAILS [Floor Guides For Sliding Walls]

Option B

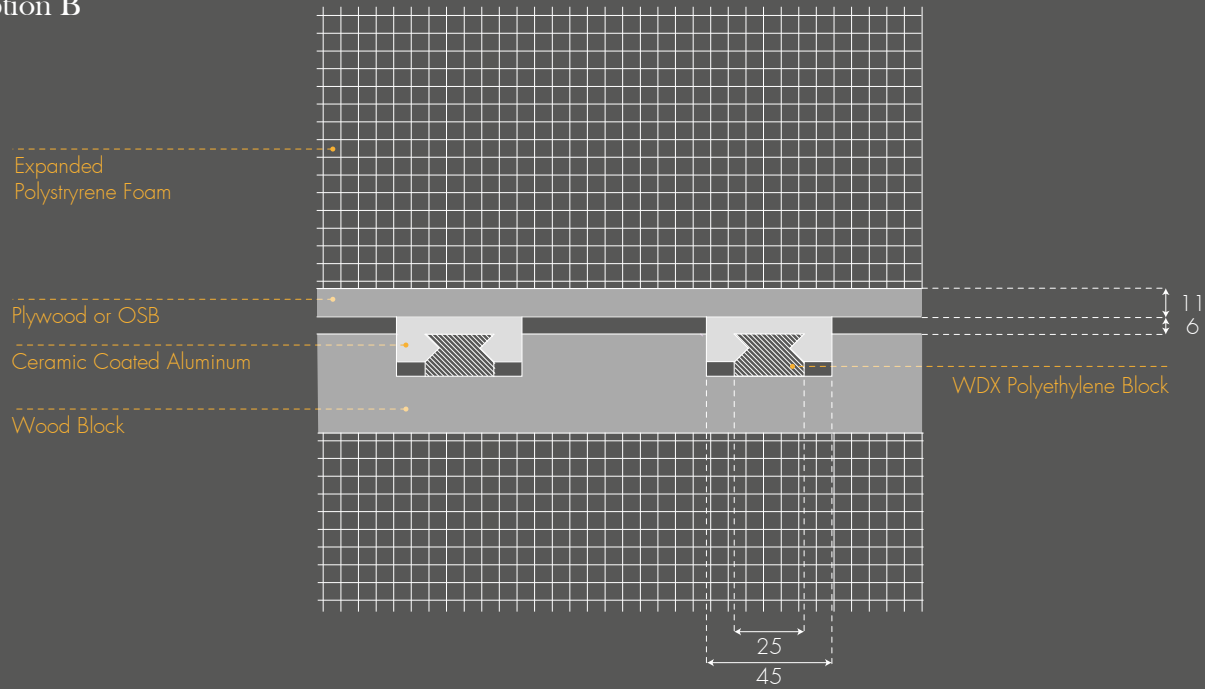
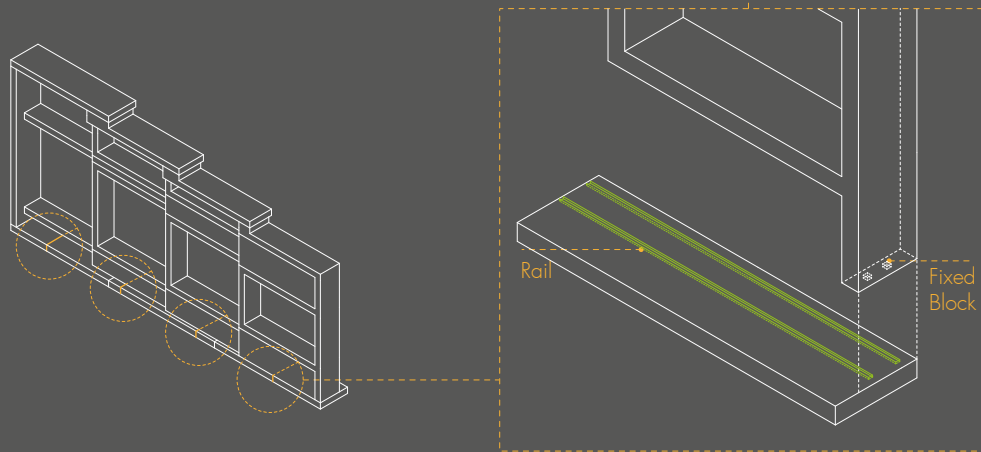


Fig 8.14 Floor Guide For Sliding Walls [Typical Detail]
Unit = mm



DETAILS [Sliding Walls Interlock]

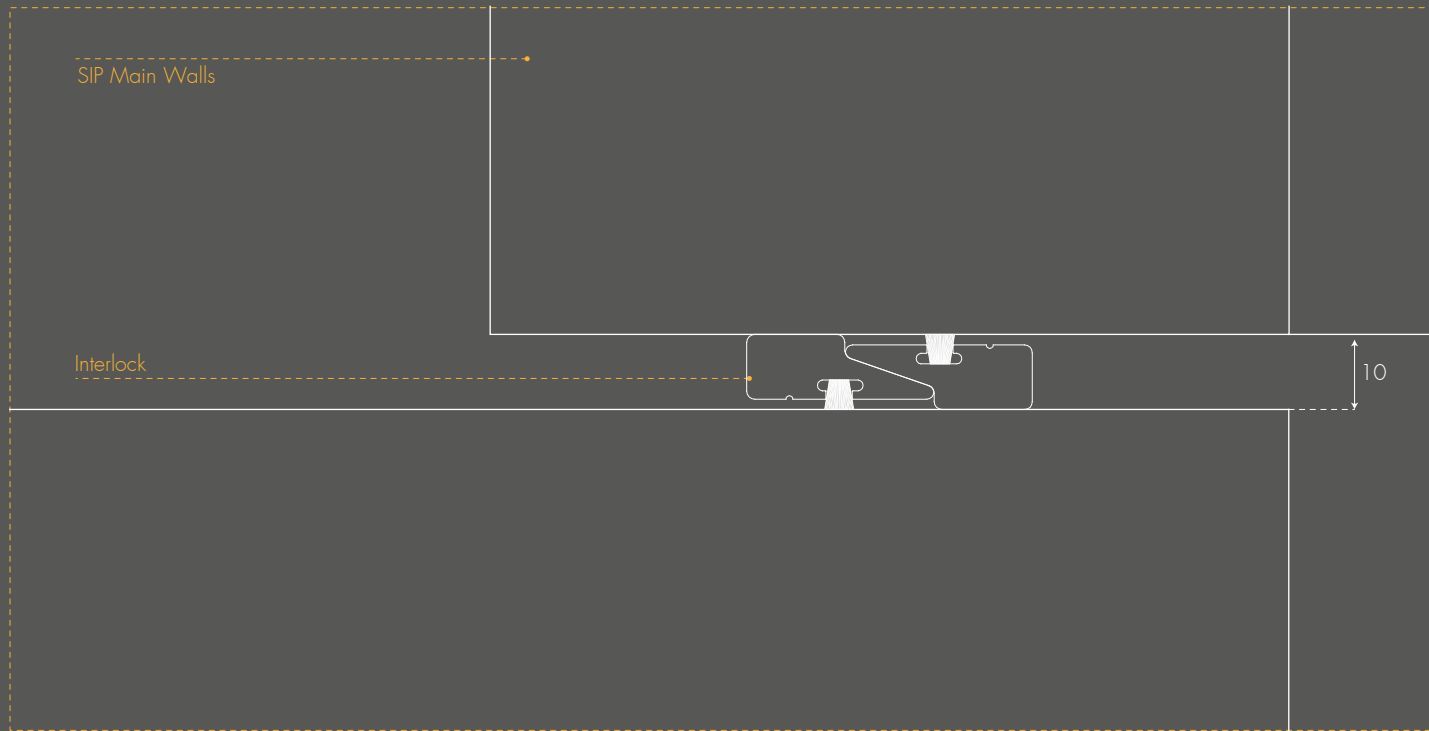
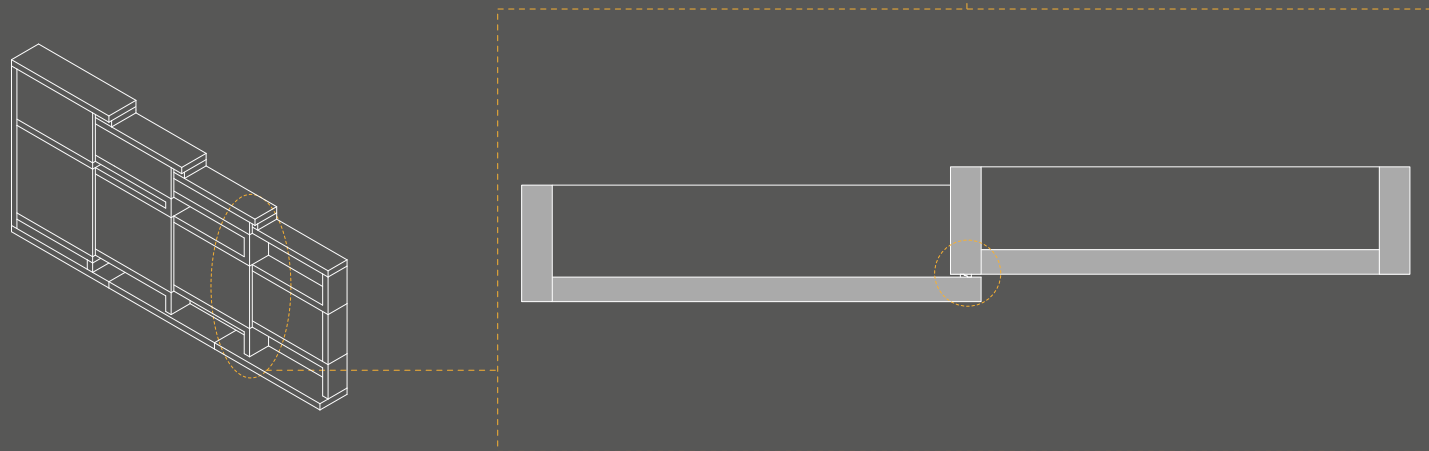


Fig 8.15 Floor Guide For Sliding Walls [Typical Detail]
Unit = mm



DETAILS [Guides For Sliding Roof Panels]

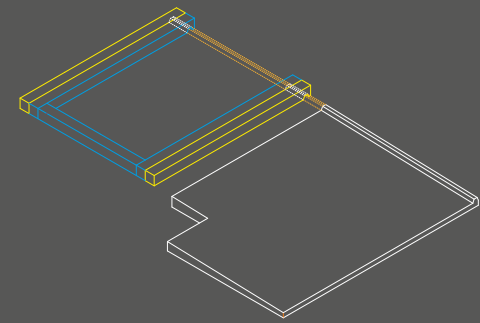
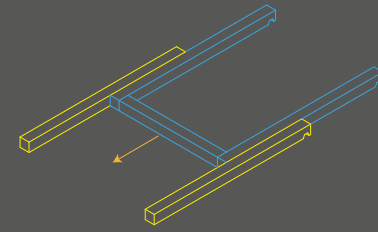
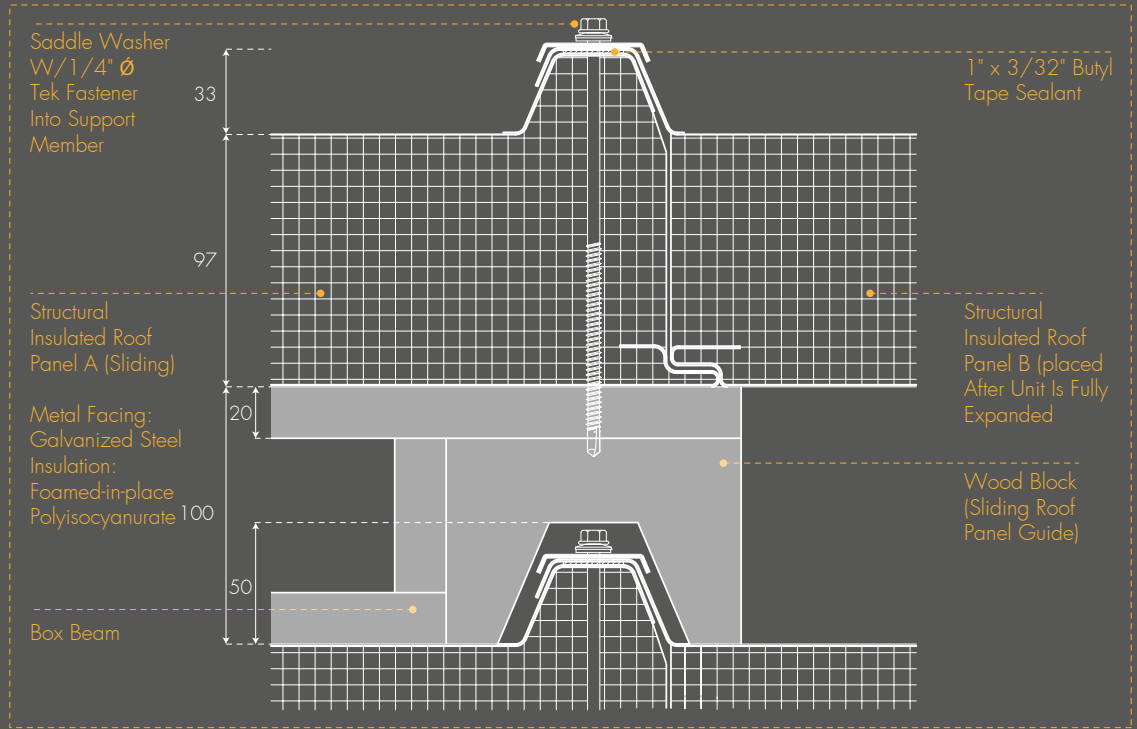
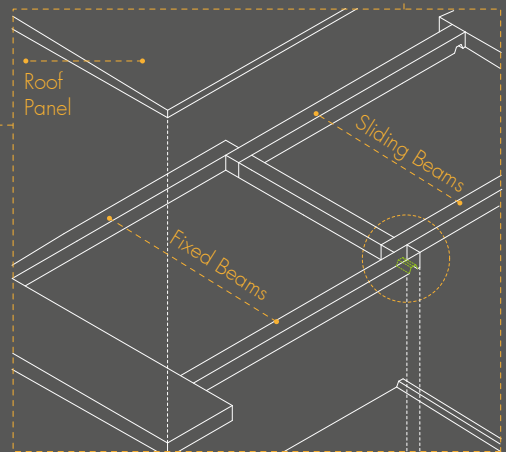
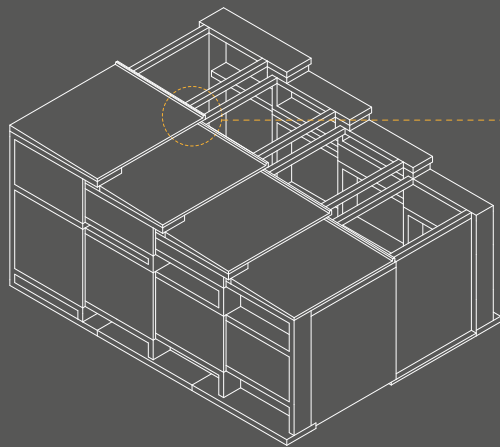


Fig 8.16 Sliding Roof Panel Guide [Hollow Beam Typical Detail]
 Unit = mm



The beams are cut to keep the roof panels in place when they are sliding back and forth.

DETAILS [Hand Installable Screw Piles]

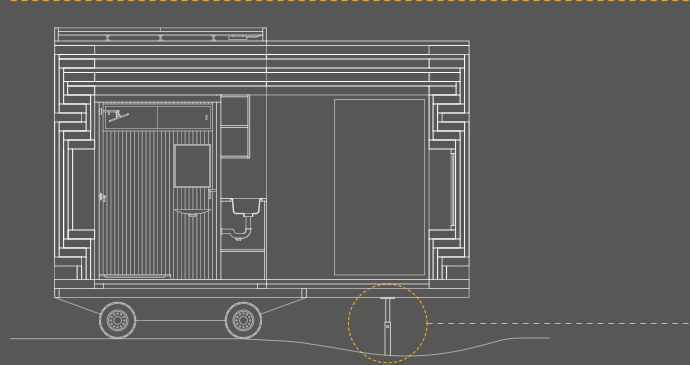
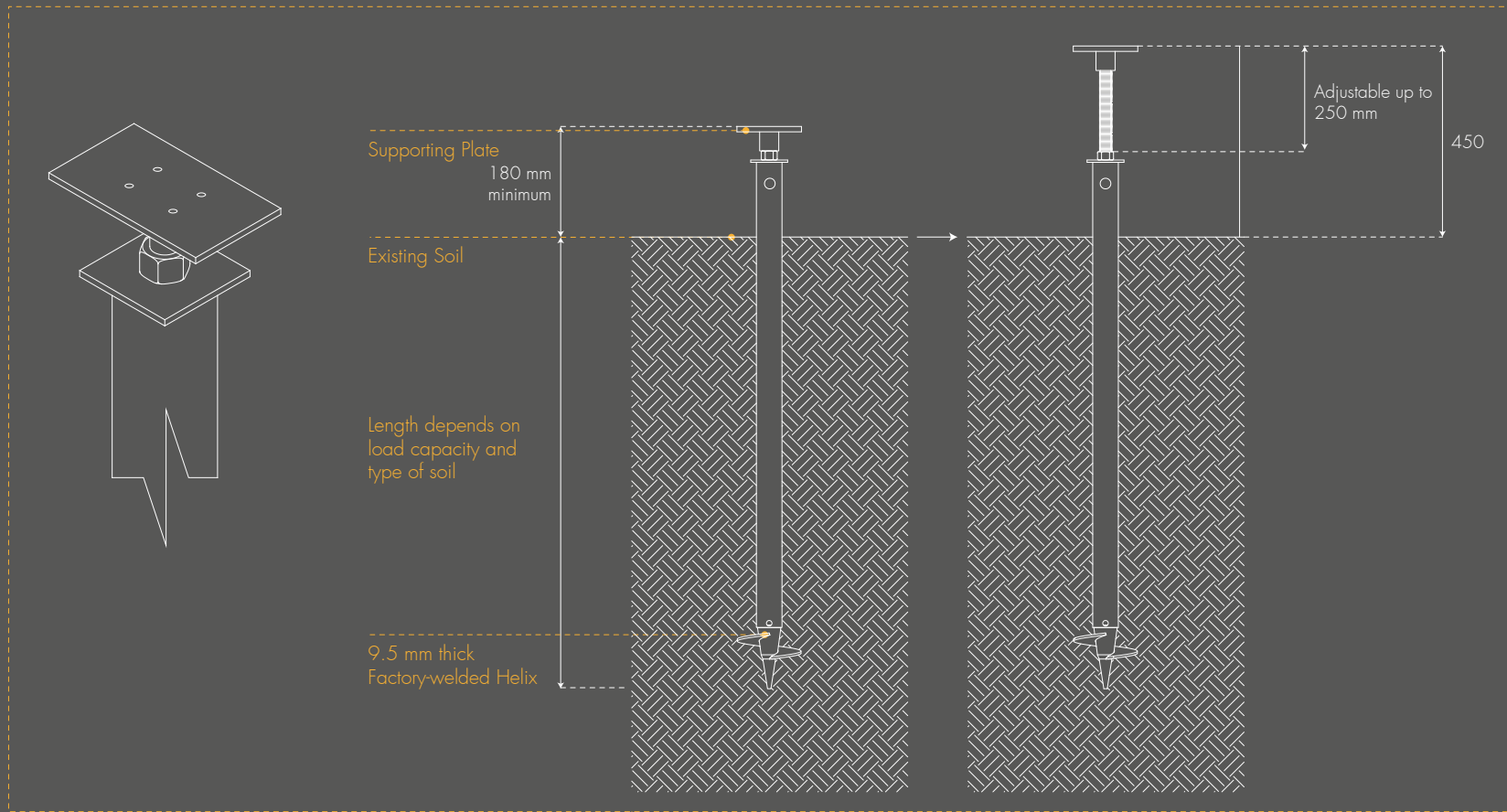


Fig 8.17 Hand installable screw piles
Unit = mm

DETAILS [Windows]

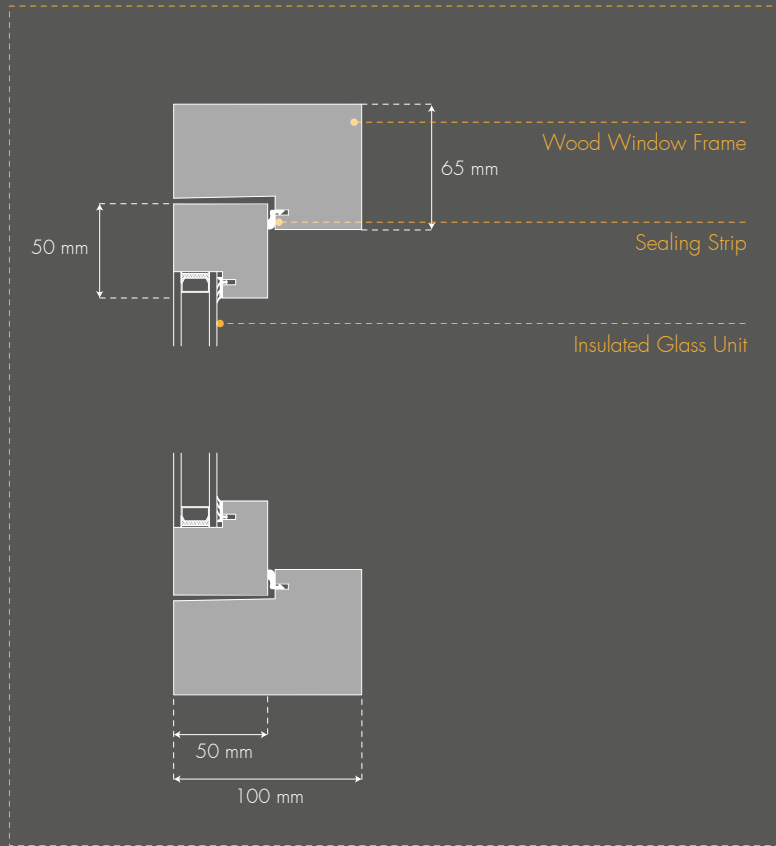


Fig 8.18 Vertical Cross Section

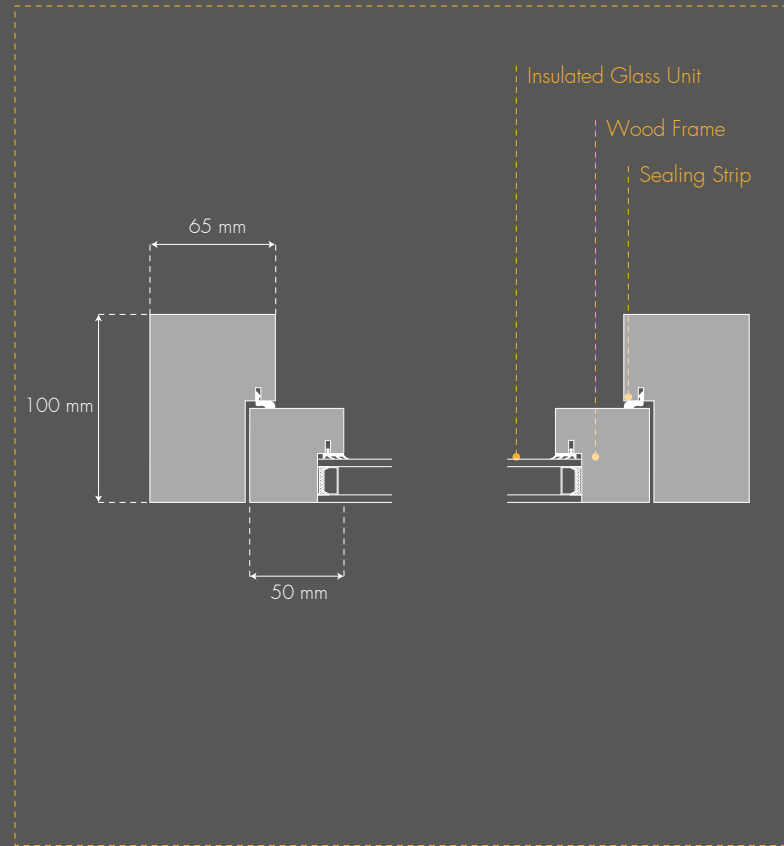
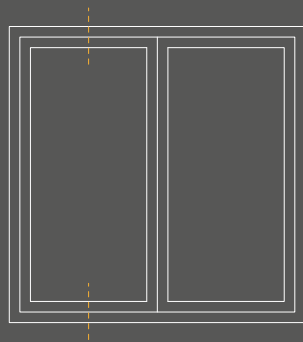
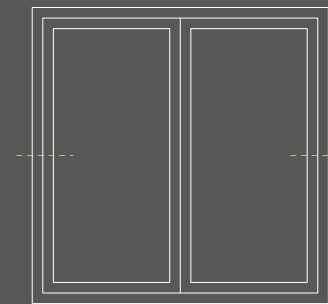


Fig 8.19 Horizontal Cross Section



ELEVATIONS

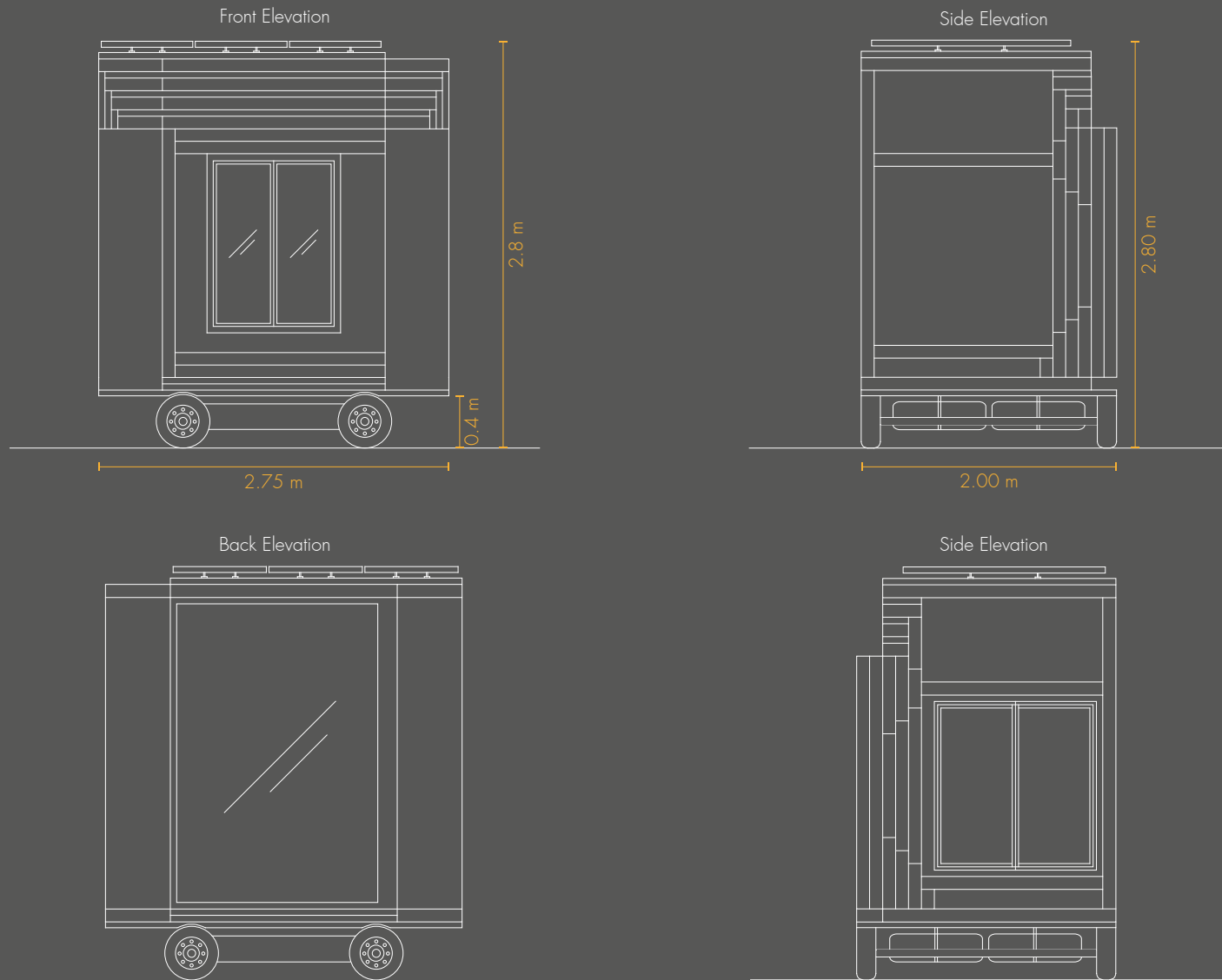
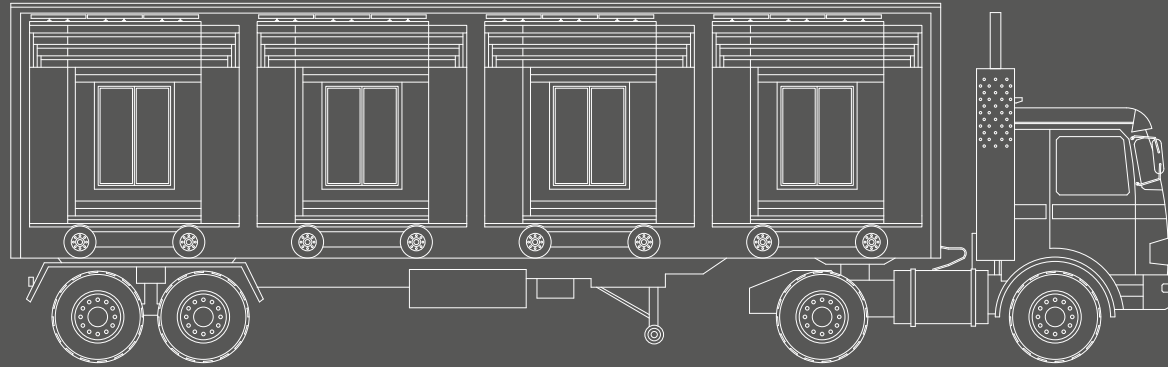
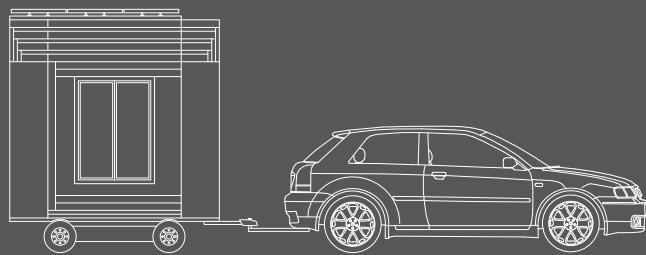


Fig 8.20 Elevations

TRANSPORTATION



1. Units transported to the site by shipping containers

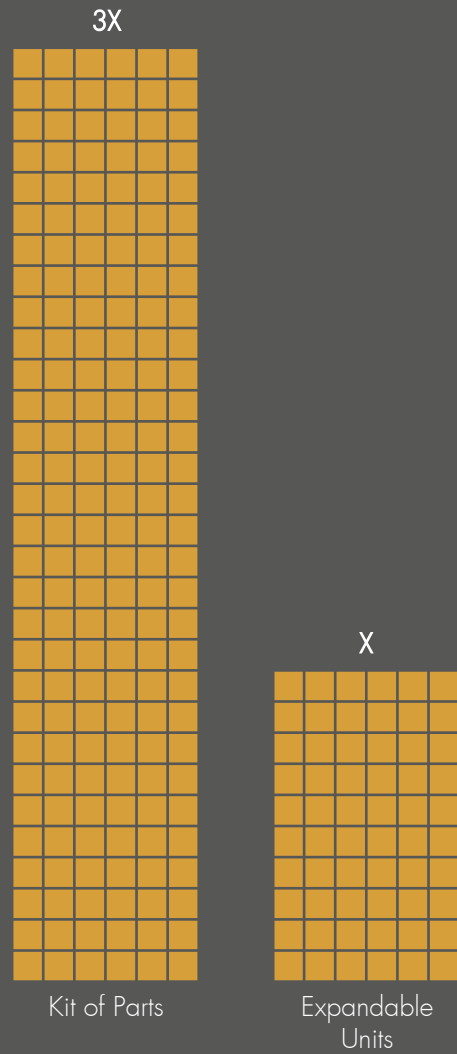


2. Units distributed among the affected population



3. Units can be pushed around and relocated to the desired location

Fig 8.21 Means of transportation



If this dwelling unit is transported to the site as a KIT OF PARTS, it would take 3X more space than if it is delivered as one EXPANDABLE UNIT.

Therefore:

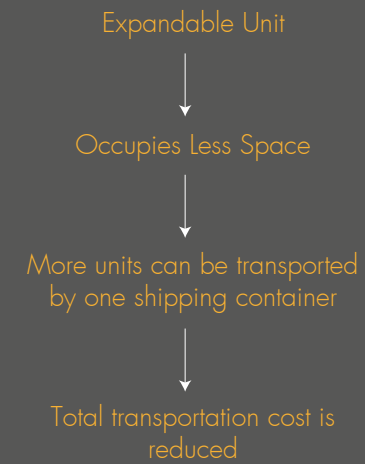


Fig 8.23 Space occupied by expandable unit is 1/3 of space occupied by kit of parts.

EXTERIOR RENDERS



Fig 8.24 These mobile homes can be transported by the disaster survivors to their desired location (close to their own properties) where they can protect their remaining belongings and rebuild their house.



Fig 8.25 This mobile home allows the affected families to live safely and comfortably in their own neighborhood until their houses are rebuilt.



Fig 8.26 Interior Render

LIVING / DINING [Possible Layout]



Fig 8.27 Possible interior layout - Living area/Dining Area

SLEEPING [Possible Layout]



Fig 8.28 Possible interior layout - Sleeping Area

PROTOTYPES B & C

PROTOTYPE B

“Prototype A” is very compact when closed (2m by 2.75 m) which means more units can fit in a 40 ft shipping container and transportation costs will be reduced. Also the living area would be increased by 7 times when the unit is fully expanded. However, because this prototype requires expansion in two directions (as shown below), it would require more technical details, hardware, and structural complexity which would ultimately increase the manufacturing cost of each unit. “Prototype B” is a modified version of the previous model, especially designed to further decrease the manufacturing cost of each unit and make it even more suitable for post-disaster situations where limited funds are available to house as many people as possible. To reduce the structural complexity, this model will be expandable only in one direction.

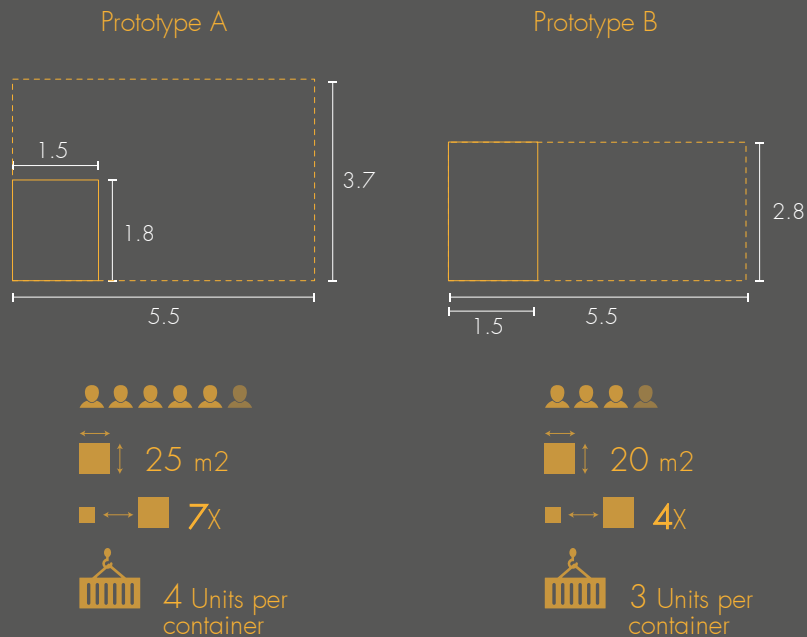


Fig 9.01 Prototypes' comparison

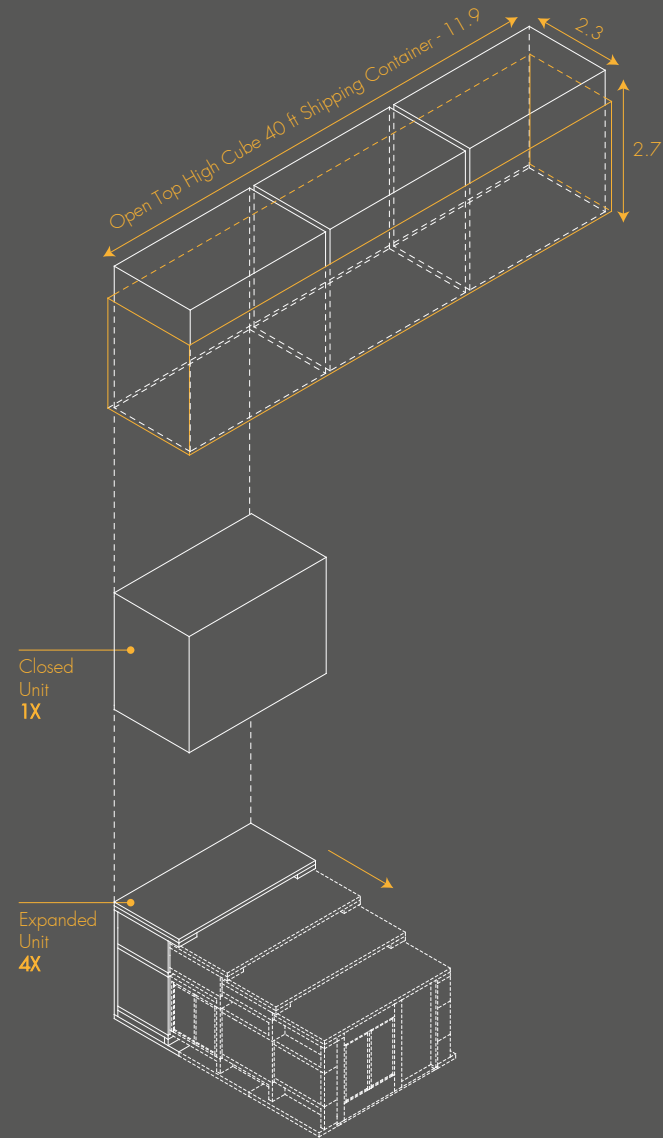


Fig 9.02 Prototype B: Expanding the unit by 4X

PROTOTYPE B - CLOSED UNIT PLAN

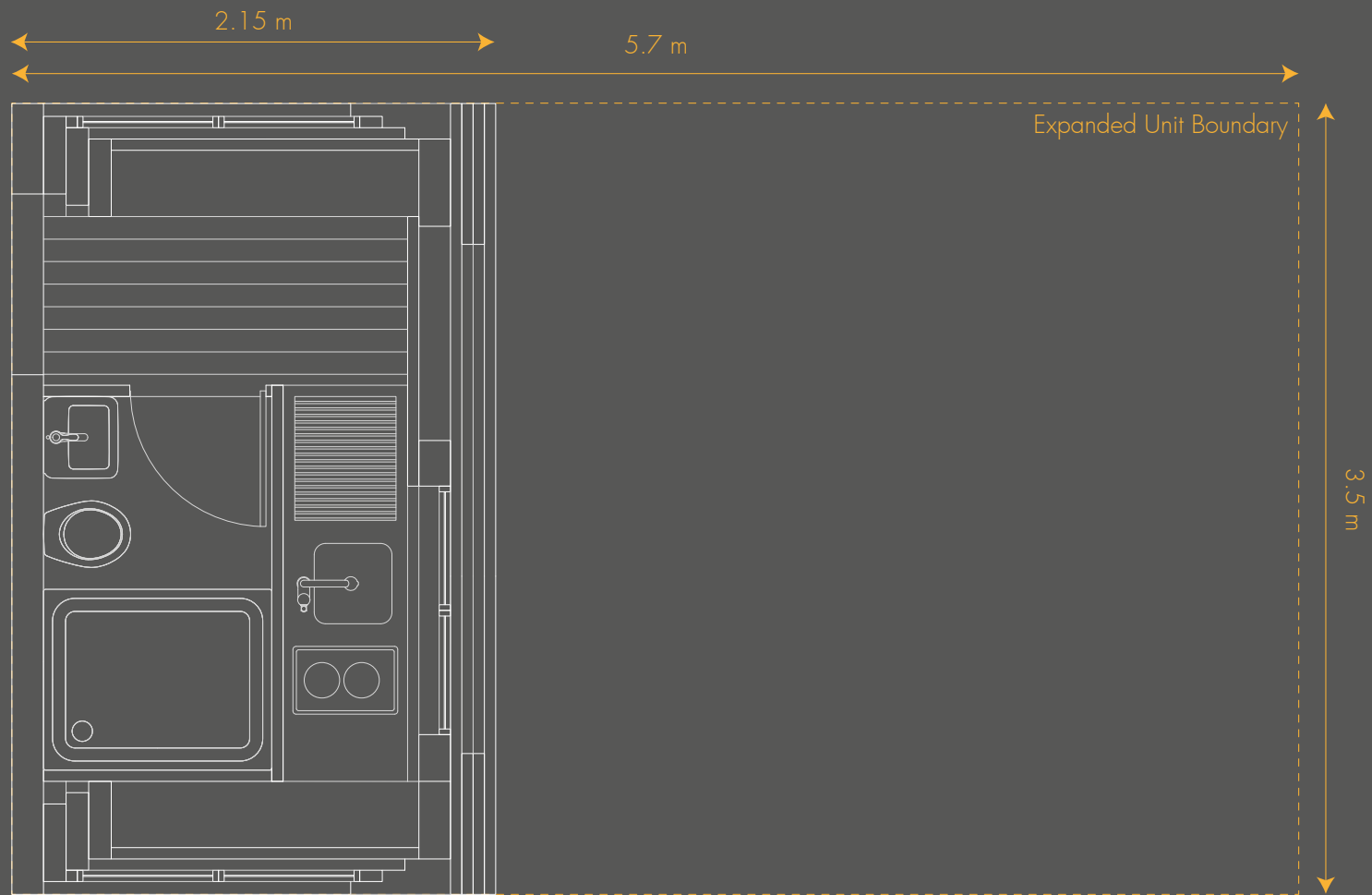


Fig 9.03 Prototype B - Closed Unit

PROTOTYPE B - EXPANDED UNIT PLAN

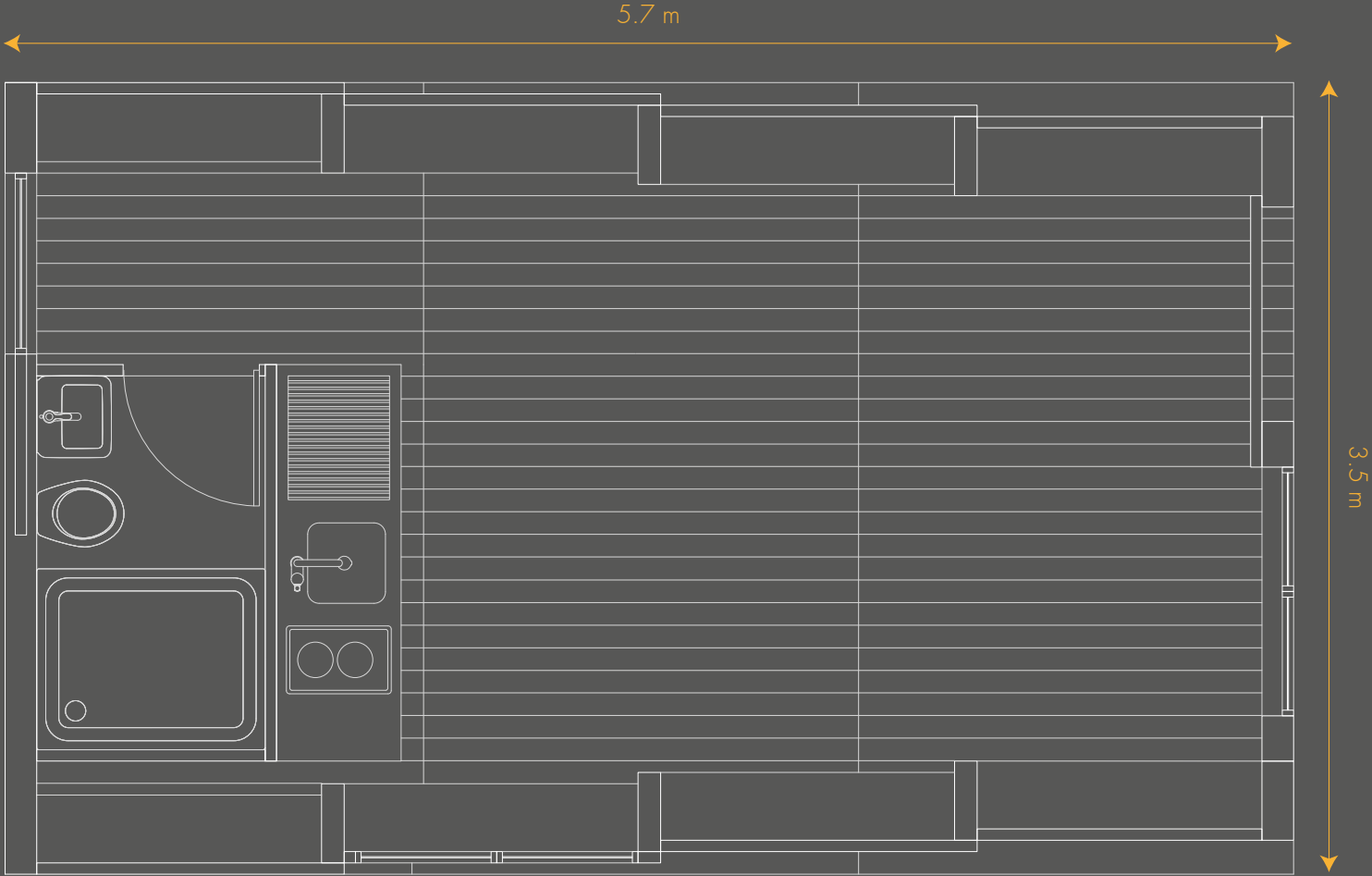


Fig 9.04 Prototype B - Expanded Unit Plan

DINING AREA

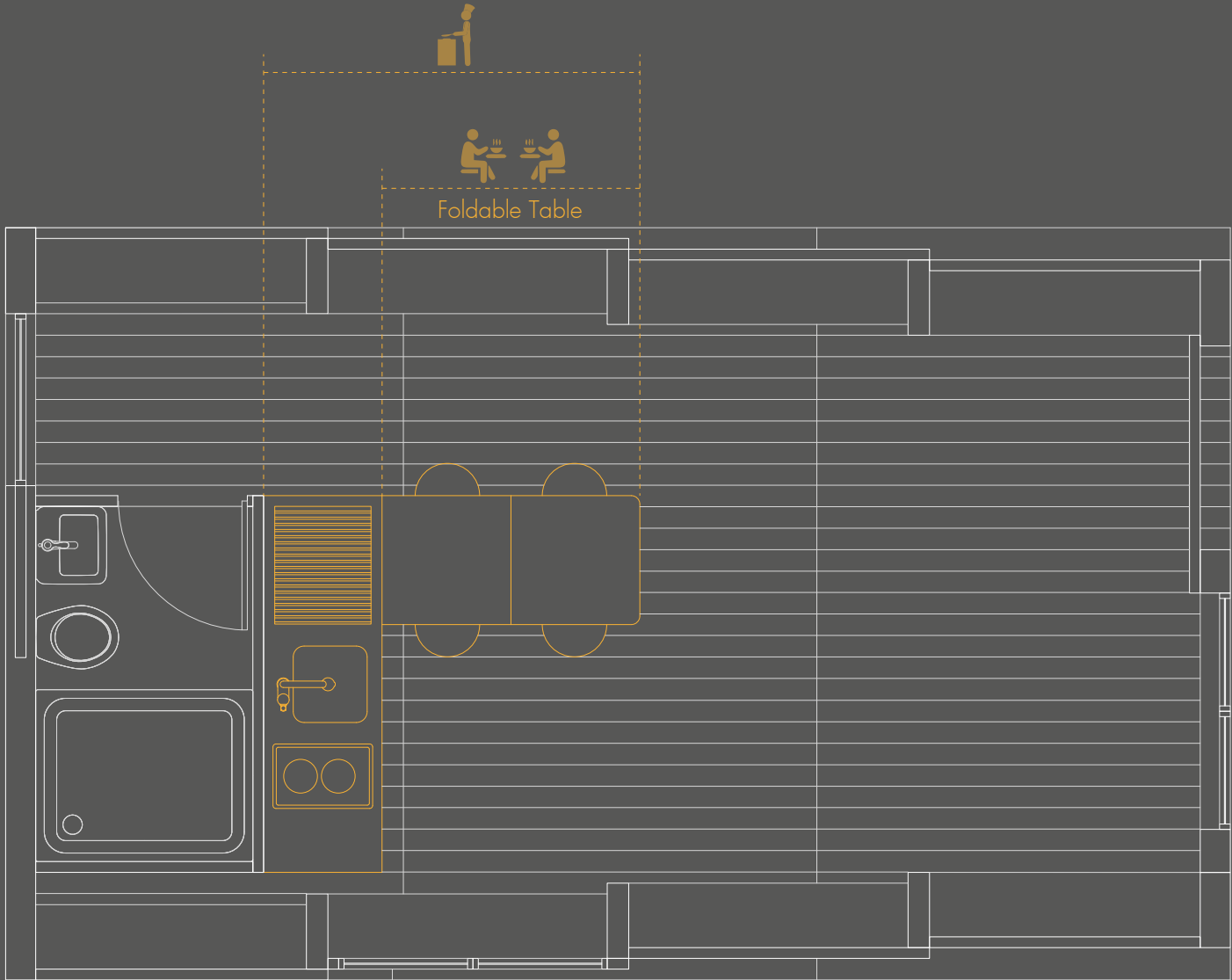


Fig 9.05 Dining Area

LIVING AREA

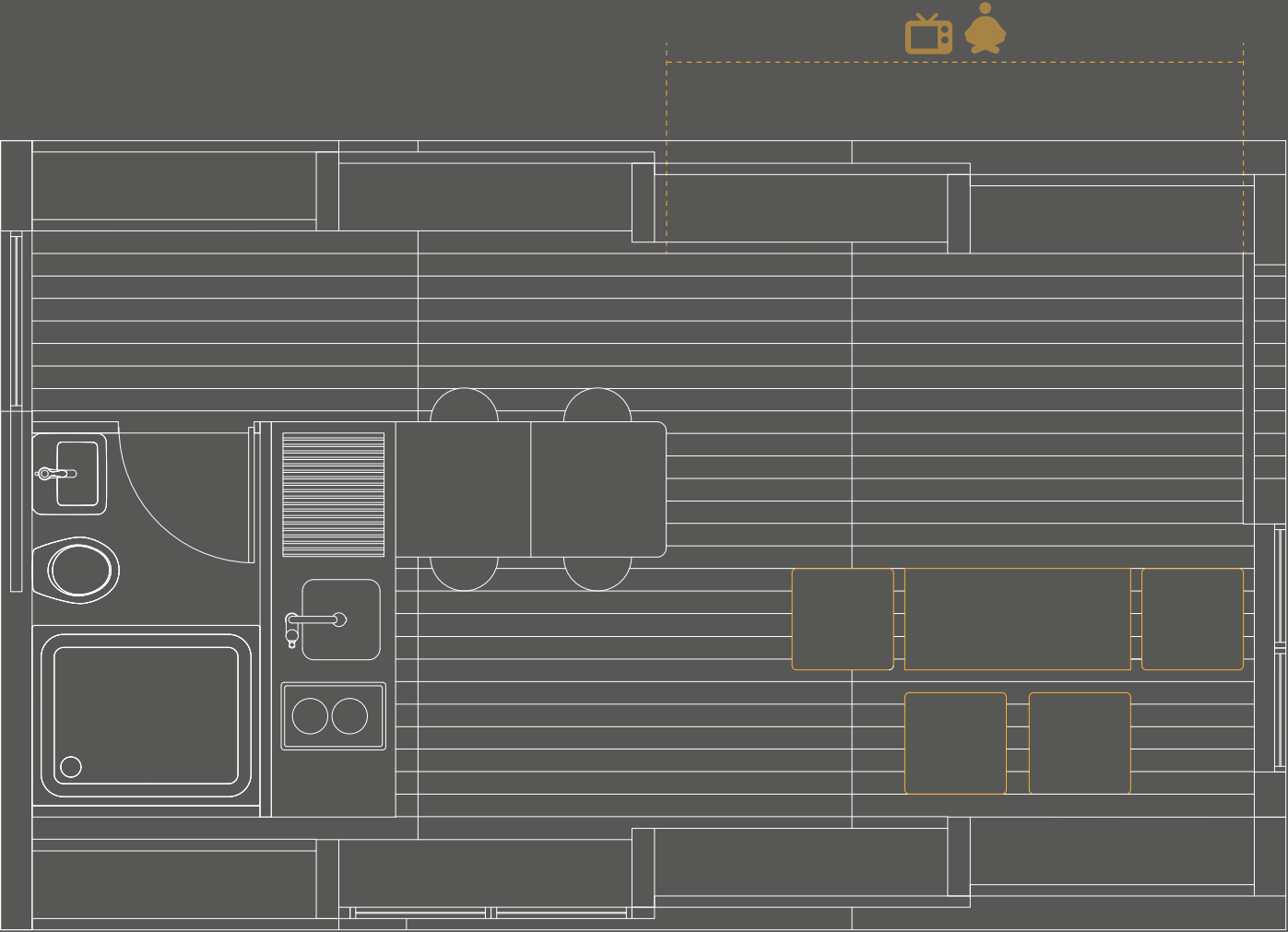


Fig 9.06 Living Area

SLEEPING AREA

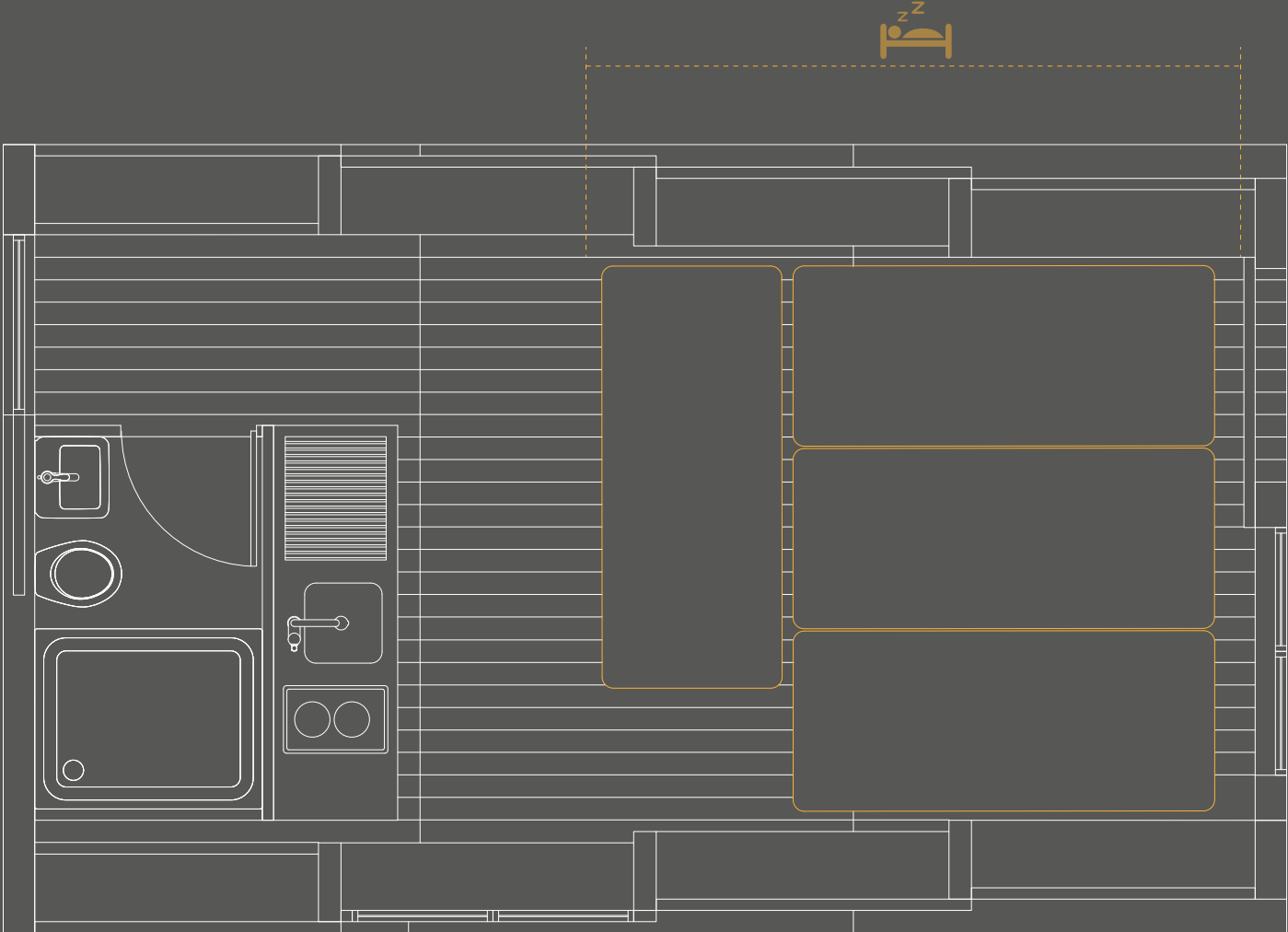


Fig 9.07 Sleeping Area

PROTOTYPE C

"Prototype C" is a modified version of prototype B which is designed without the private bathroom and kitchen units. This prototype can be combined or added to Prototype B to create a bigger living space for large or extended families. Eliminating the kitchen and bathroom units would significantly reduce the cost and weight of prototype C. As figure 9.10 shows, dwelling units can be aggregated to form a semi private public space which could be safely used by the family members. Sanitary facilities and a kitchen space can be later added and shared. Assuming that all the occupants are members of the same family, security and vulnerability would no longer be an issue with using communal kitchens and bathrooms. This solution can be especially effective in cultures where extended families prefer living in close proximity.

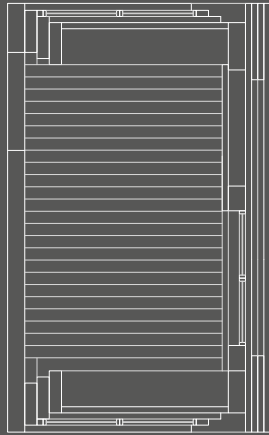


Fig 9.08 Prototype C - Closed Unit

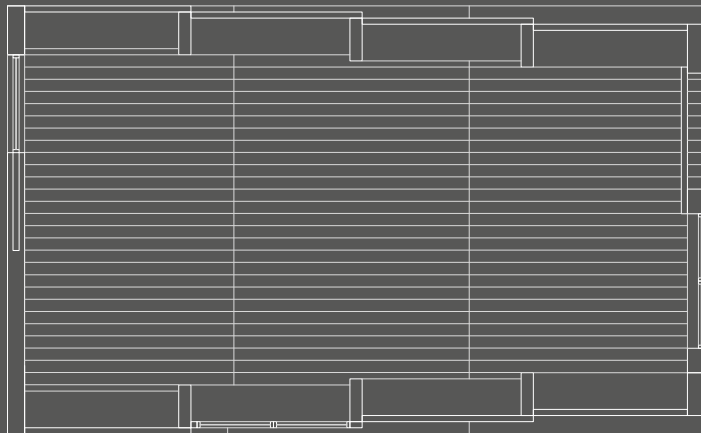


Fig 9.09 Prototype C - Expanded Unit



Fig 9.10 Dwelling units are aggregated to create a private courtyard.

Some of the Possible COMBINATIONS for LARGER FAMILIES

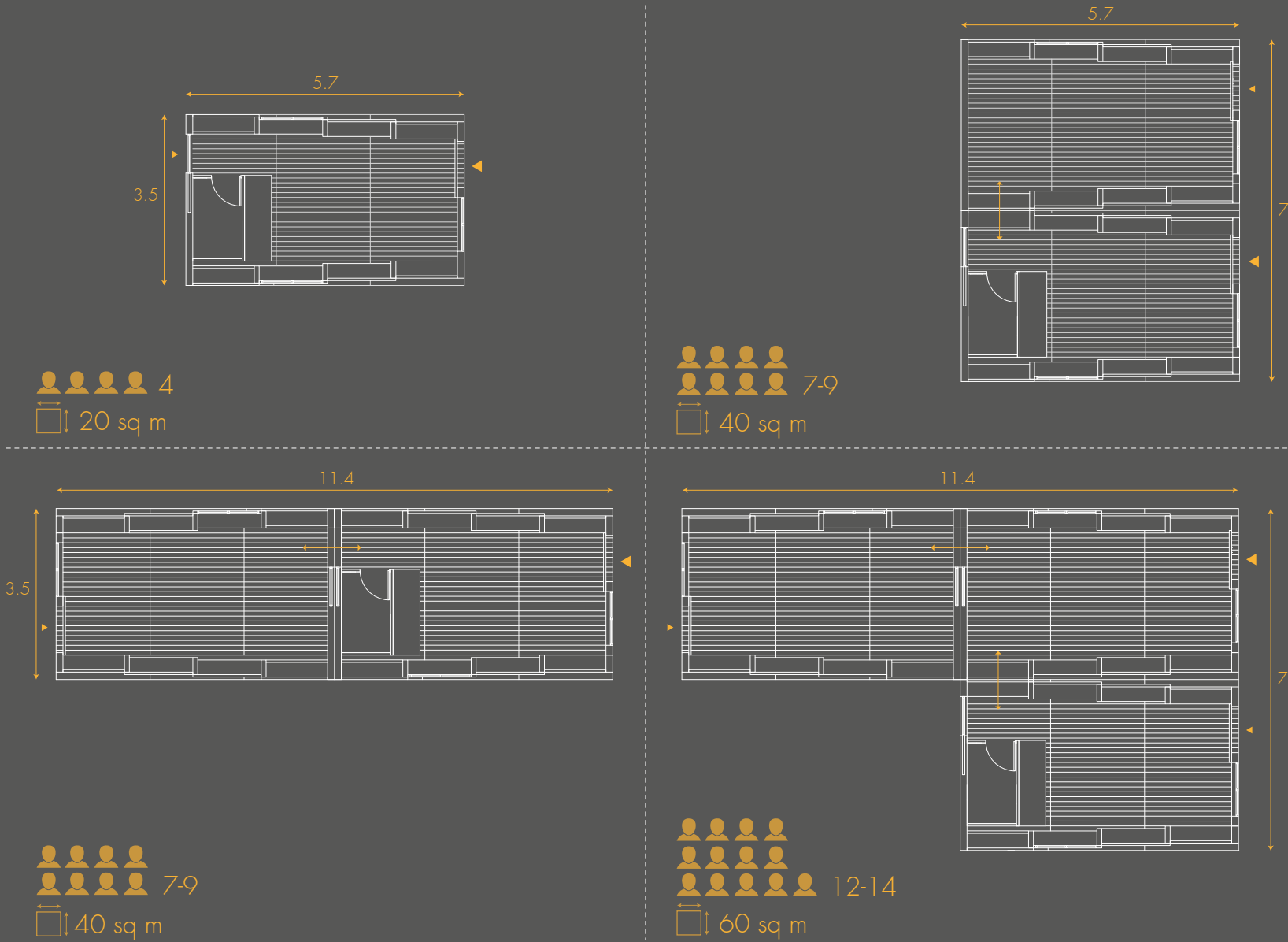


Fig 9.11 Combining units for larger families

Possible AGGREGATION Strategies [Model A]

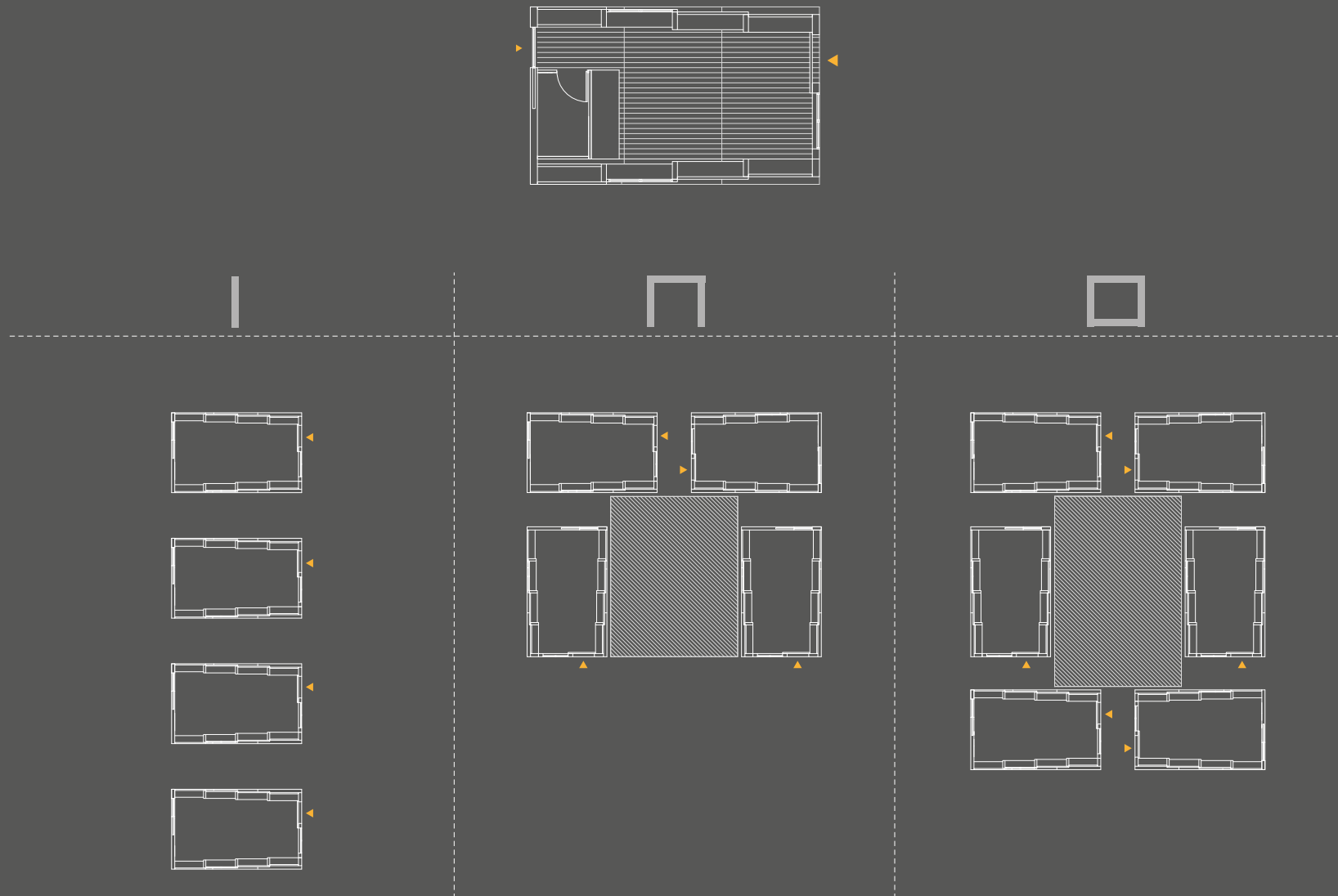


Fig 9.12 Model A Aggregation Strategies

Possible AGGREGATION Strategies [Model B]

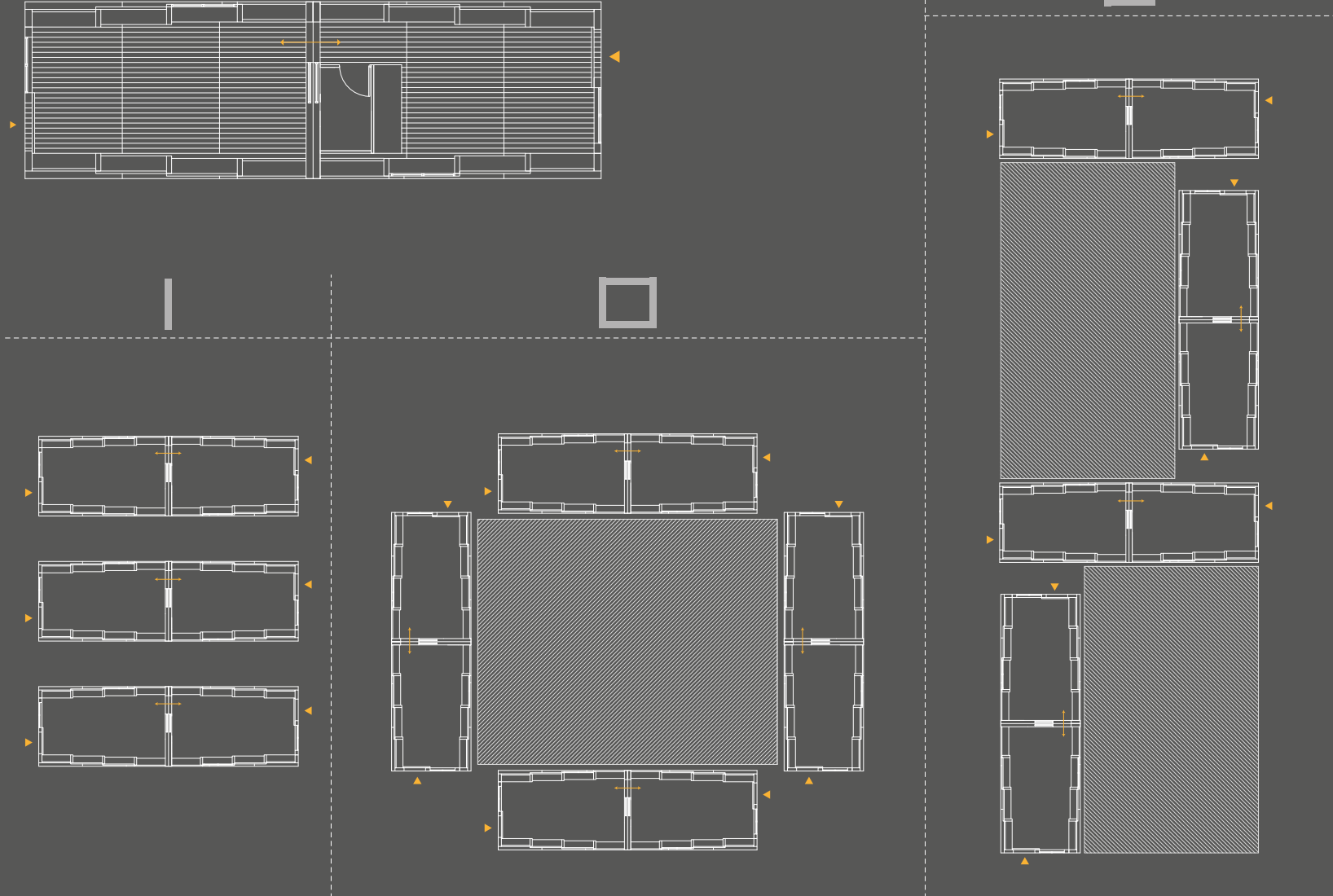


Fig 9.13 Model B Aggregation Strategies

Possible AGGREGATION Strategies [Model C]

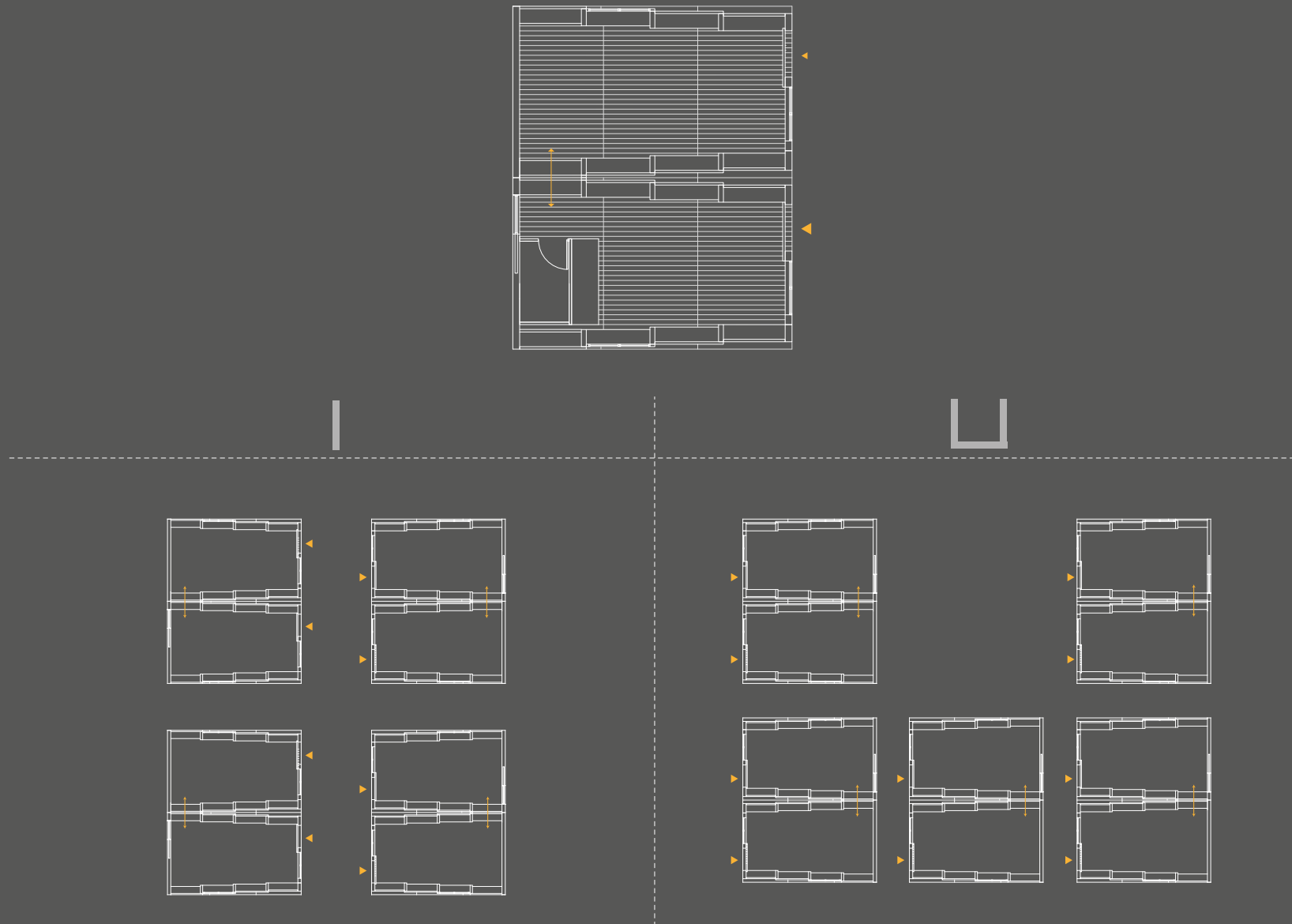


Fig 9.14 Model C Aggregation Strategies

Possible AGGREGATION Strategies [Model D]

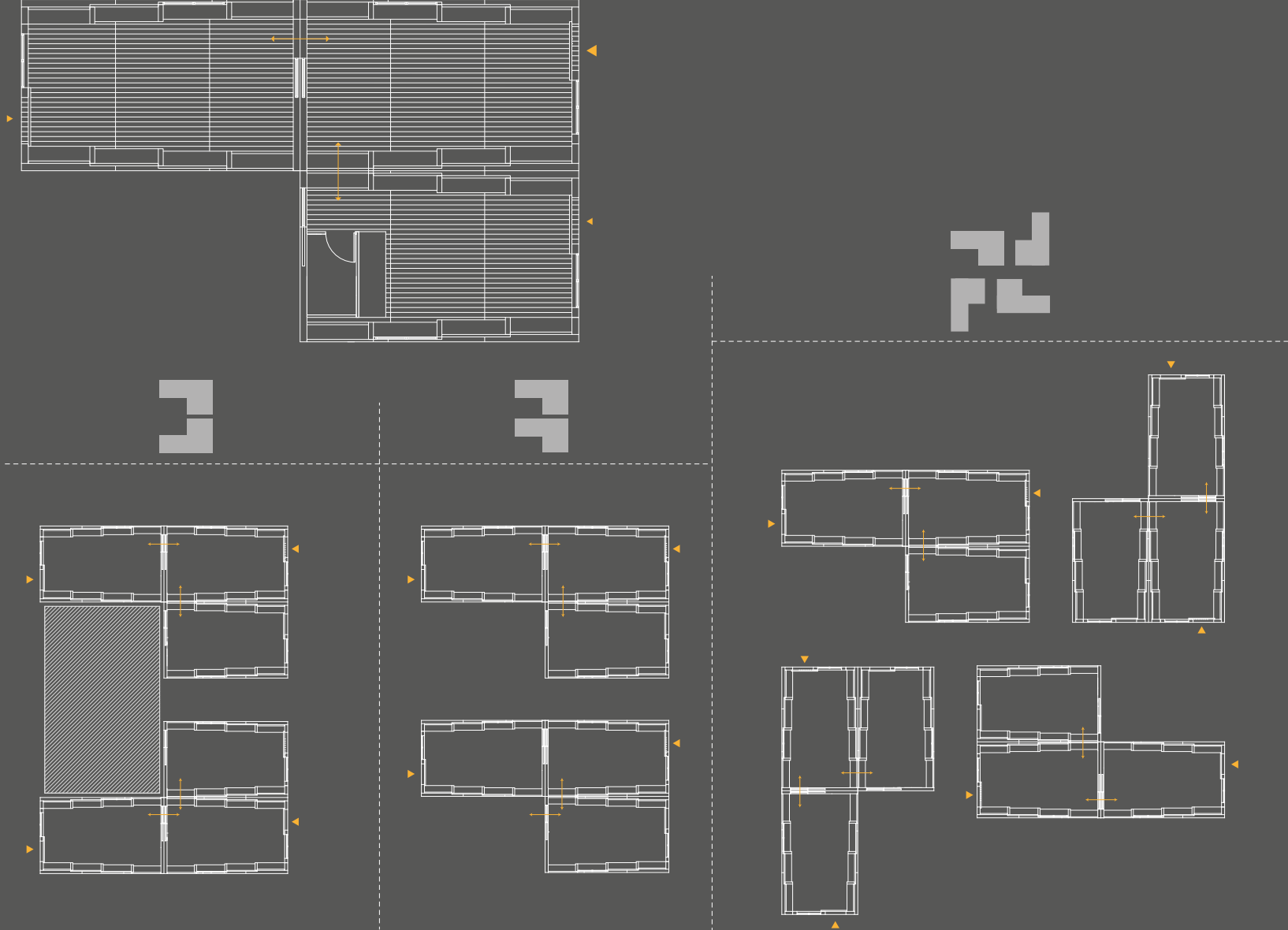


Fig 9.15 Model D Aggregation Strategies

Is This A Universal Solution?

The proposed prototypes (A,B,C) are built of
OSB SIP panels with EPS insulation [Exterior walls] = R-55 - R58
OSB faced Vacuum panels [Facade panels] = R56.7
Metal SIP Panels [Roof] = R49
OSB SIP panels [Floor panels]

Climate Zones:

The proposed design would perform well in hot and cold climate zones. The well insulated exterior shell of the dwelling unit makes the house more energy efficient, keeping it cooler in summer and warmer in winter and saving up to 50 per cent in heating and cooling bills. In addition, insulation reduces condensation in the home and would provide health benefits by reducing mold and damp. For moderate climate zones, these prototypes have to be modified to reduce the amount of insulation which would greatly reduce the final cost.

Disaster's Magnitude & Road Conditions

When a natural disaster strikes, many things such as houses, public buildings, and the infrastructure are completely or partially destroyed. In such situations, it would be very challenging for humanitarian and rescue forces to reach the affected sites and provide help. These dwelling units are built on flat bed trailers so they can be easily set up in clusters, perhaps somewhere far away from the affected area. Placing the units in groups for the first days or weeks would facilitate easier distribution of food, water, shelter, and medicines. It is important to remember that this project would not be suitable for remote areas that are hard to reach, such as remote villages on mountains or where roads are damaged due to earthquake, flood, and etc.

Topography:

This dwelling unit can be set up on hand installed screw piles and therefore it could be placed on flat land or sloped sites (depending on the slope percentage). Screw-piles can be installed in a wide range of subsurface conditions, from very soft to very stiff clays, from loose to very dense sands. However, certain sites such as rocky landscapes would not be a good choice for hand installed screw piles and other forms of foundation must be proposed.

Conclusion:

These prototypes are not intended to be used as a universal solution. As mentioned previously, this project is suitable and feasible for certain climate zones and topographical conditions. In order to be able to perform well in other geographical conditions, more prototypes must be proposed to meet the necessary requirements.

Fig 9.16 Comparing the existing disaster relief dwelling units with the proposed design

PROTOTYPE A		25 m ²	5-6	1-2 People	Off Grid On Grid	Off Grid On Grid	Off Grid On Grid	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PROTOTYPE B		20 m ²	4-5	1-2 People	Off Grid On Grid	Off Grid On Grid	Off Grid On Grid	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IKEA SHELTER		18.5 m ²	5	4 People	Off Grid	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✓	✓
SUPER ADOBE		37 m ²	4-5	4 People	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓
EXO SHELTER		7.5 m ²	4	4 People	On Grid	On Grid	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✓
PAPER LOG HOUSE		16 m ²	4-5	10 People	✗	✗	✗	✓	✓	✓	✗	✓	✗	✗	✗	✓	✓
FEWA TRAILER		23 m ²	4	6 People	On Grid	On Grid	✗	✓	✗	✓	✗	✗	✓	✓	✓	✗	✗

OTHER POTENTIAL USERS

POTENTIAL USERS

The large expenditure on temporary housing can be offset if the designed dwelling units can be reused for other functions after they are no longer needed for post-disaster temporary housing. For example, one option would be to refurbish the units and use them rental housing. The case studies show that natural disasters are always followed by shortage of affordable rental housing. As a result of that, the prices increase and many people cannot afford rents anymore. In Turkey, after the survivors moved to their newly built houses, temporary houses were rented to other families who improved them by adding gardens, new claddings and sometimes additional rooms.⁴¹ Another option is to collect the units once the temporary phase is over, refurbish them, and either store them for the next emergency, something that most governments plan in their disaster relief programs.

WHAT ELSE CAN THEY BE USED FOR OTHER THAN DISASTER RELIEF?

- Refugees temporary housing (Renovation)
- Affordable housing for people with low to moderate incomes (Retrofitting and Upgrading Materials)
- On campus student housing (Retrofitting & Upgrading Materials)
- Guest units for temporary events such as Olympics, festivals, concerts, and etc. (Retrofitting & Upgrading Materials)
- Recreational mobile cabins. (Retrofitting and Upgrading Materials)

Refugees Temporary Housing:

According to the UN's refugee agency, number of displaced people have surpassed that of World War II. The number of refugees reached 65.3 million by the end of 2015. In other words, one out of every 113 people on Earth is either an asylum seeker, internally displaced, or a refugee based on the United Nations High Commissioner for Refugees' statistics. It is important to mention that over 35 million people are currently living in refugee camps or tent cities worldwide and are in dire need of more appropriate long-term dwellings.⁴² According to the former UN human rights worker Kilian Kleinschmidt, "The average stay in a camp is 17 years. For many people around the world, living under plastic sheets and tents could last an entire lifetime."⁴³ Governments or NGOs have the option of either reusing the proposed dwelling units to house their own refugees or sell them to other countries or organizations dealing with the refugees housing crisis.

Affordable Housing For People With Low To Moderate Incomes:

Around the world especially in major cities, renting and housing costs have skyrocketed and are spiraling out of control, cutting deeply into people's standard of living and prompting concerns about a new global housing crisis. Statistics show that many citizens who earn reasonably good income such as teachers, nurses, police officers, and construction workers are finding it increasingly difficult to manage the housing cost.⁴⁴ What is most surprising is how divorced the prices are from the incomes of the vast majority of the global population. As a general rule of thumb, one should not spend more than 30% of their income on rent, however as fig 10.02 shows, the ratio of average rent to average income has passed 100% in some major cities such as Moscow, Tehran, Cape Town, and Beijing. As populations continue to grow, bridging the gap between what is supplied versus what is affordable will become even more challenging. Today, approximately 330 million households do not have access to adequate and affordable housing. Without drastic changes in housing policies, it is predicted about 3 billion people (40% of the world's population) will not be able to afford housing by 2030.⁴⁵ Which such a vast demand in today's market, governments and NGOs that buy these units for disaster relief can later sell or rent them to those in need of affordable housing and earn money for future humanitarian investments.

On Campus Student Housing:

An increasing number of students find it difficult to cover the expenses of college life. For many of them, almost nothing remains to pay for the basic necessities such as food and accommodation after tuition fees are paid. Few students enter university or college without a permanent address but high living expenses leaves many of them homeless. They may find themselves in unsafe or intolerable living situations forcing them to either stay at a friend's place or sleeping in a quiet spot on campus. The proposed dwelling unit can be retrofitted and renovated with materials and appliances of higher quality to be reused as affordable, safe and adequate on-campus accommodations.

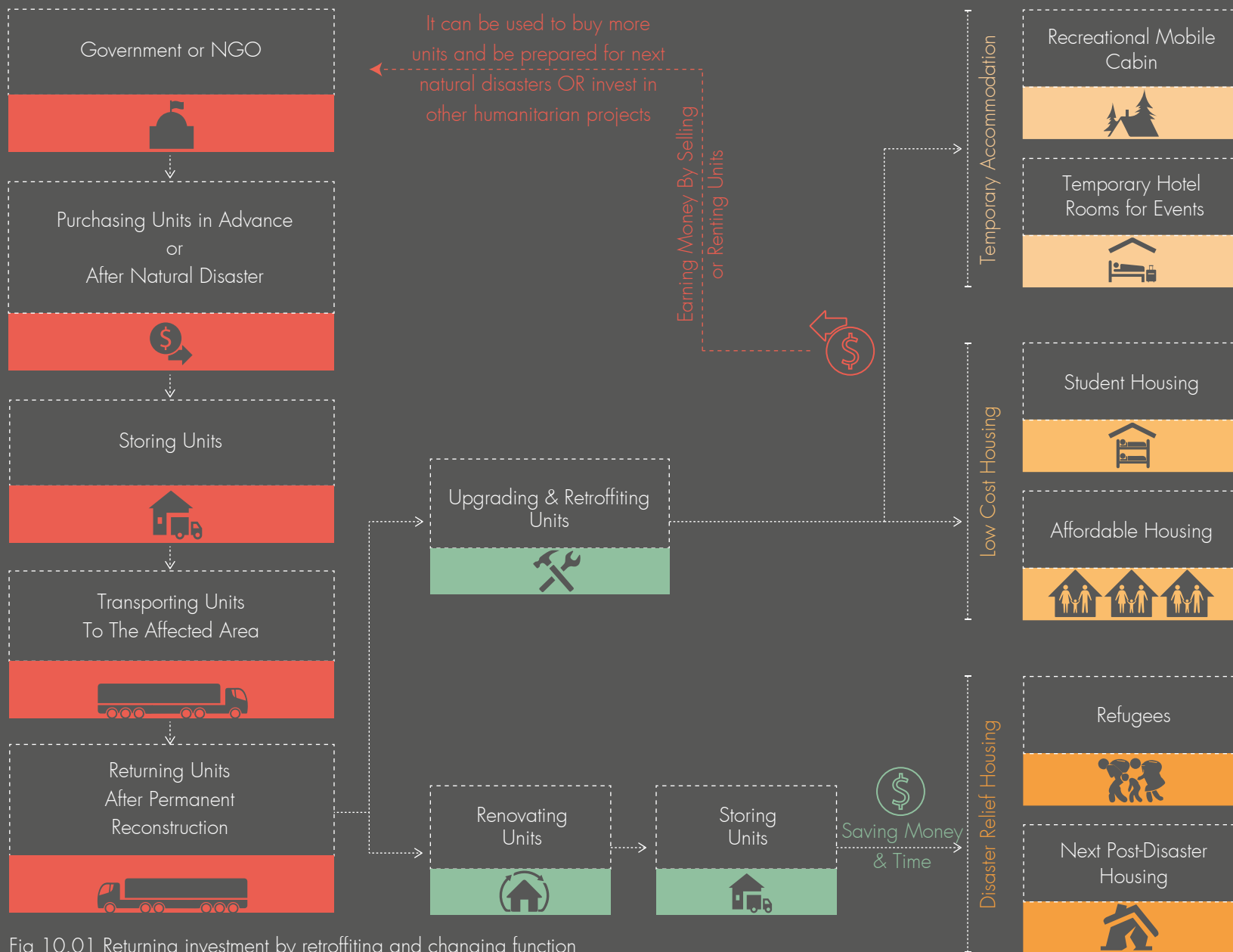


Fig 10.01 Returning investment by retrofitting and changing function

WORLD'S DEMAND FOR AFFORDABLE HOUSING

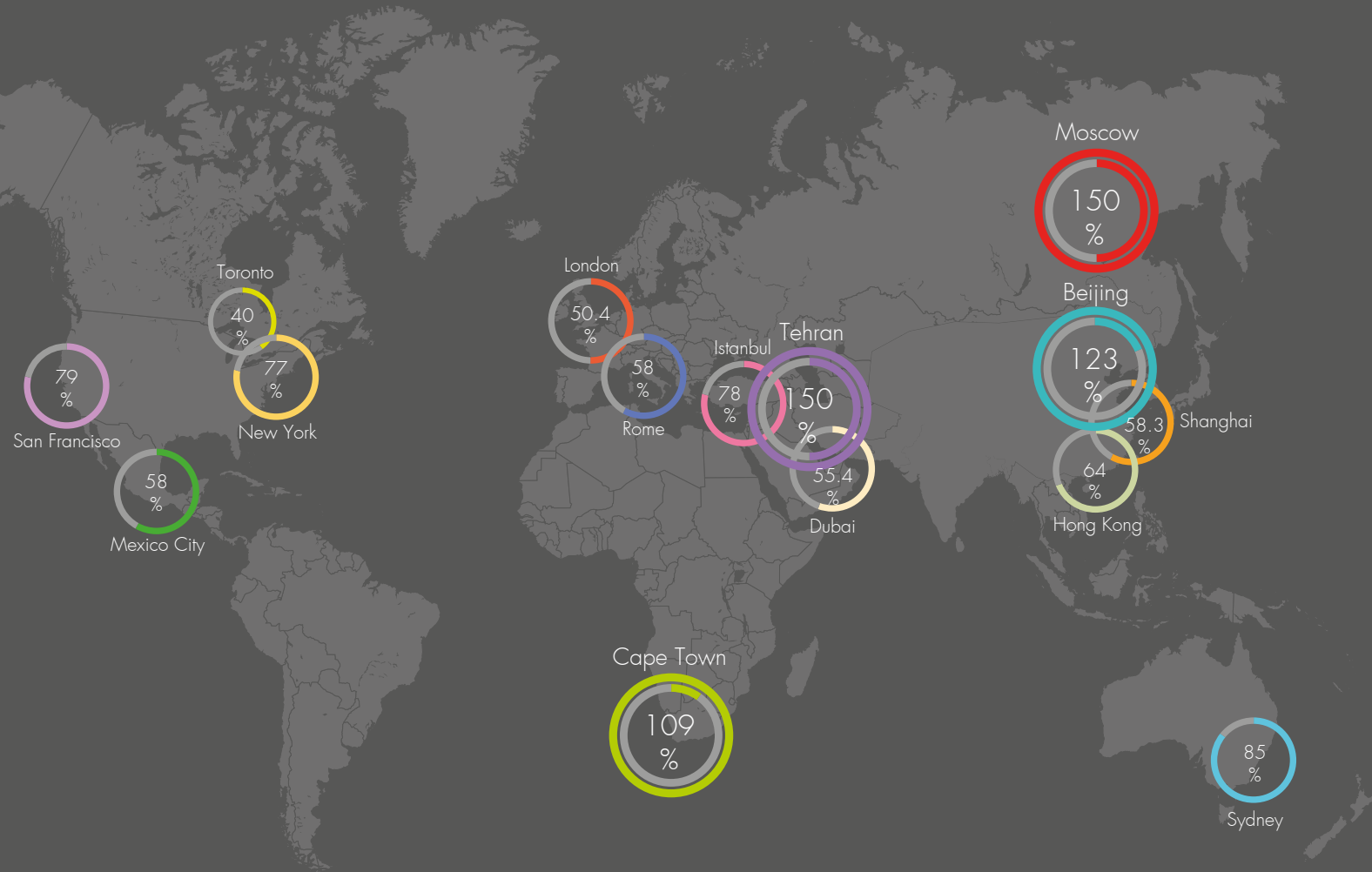


Fig 10.02 Ratio of average rent to average income in some major cities around the world shows that families with moderate incomes spend large portions of their income on rent. In cities such as Beijing, Moscow, Tehran, and Cape town, the average rent is surprisingly higher than the average income.

An Example of Housing Shortage [Nunavik, Canada]



Nunavik suffers from a shortage of housing which causes many problems within families, communities and the entire region.

- The supply of housing units do not equal the demand.
- Some people have to wait for six or seven years to get a house.
- Houses are overcrowded.

Overcrowding increases the risk of:

- Alcohol Abuse
- Violence
- Sexual Assault
- Inadequate upbringing of children
- Infections and chronic lung diseases due to improper ventilation
- Transmission of infectious diseases such as tuberculosis and hepatitis A
- Psychological issues (stress, anxiety, difficulties in impulse control and learning at school)
- Mental illness

Construction Cost:

- Building a 98 m² house would cost around 400,000 dollars.
- The remoteness of communities incurs additional costs (packaging and shipping of materials by ship or air, travel and accommodation for workers).⁴⁶



Fig 10.03 Nunavik's construction materials have to be shipped in. The high transportation cost greatly increases the final cost of the houses.

Who is looking for a new house?

- Young families who want to have their first home
- Newly expanded families who want a larger home
- Those who want to reduce the rent by renting a smaller house

Unit Size	Actual Number	Number Required	Surplus (Deficit)
1 bedroom	107	1088	(981)
2 bedrooms	1222	1015	207
3 bedrooms	706	777	(71)
4 bedrooms	363	433	(70)
5 bedrooms	205	137	(68)
6 bedrooms	6	44	(38)
7 bedrooms	0	11	(11)
8 bedrooms	0	3	(3)
Total	2609	3508	899

10.4 Housing Needs in Nunavik, 2015

Low Income Families Get Priority . The Middle Class Families Have To Wait For Years

“They say that social housing is for people that cannot afford housing, so where is the regular housing? Can I go apartment shopping, where? There is no such thing as that, unless you want to build your own house. I am 22 years old, I should not have to put my life down on land for the next fifteen years. ... People with kids are priority; that is why people are having kids, to get a house.”

“It took me seven years to get a house here because I don’t have kids. I went crazy; I would die for a house. I had money but no children. I had to sleep on my dad’s couch and he lives in a two bedroom with three people. “I work, I am a good citizen, I graduated, I can pay bills, I am a responsible person. Why can’t you give me a house? ” 47

Conclusion:

The proposed prototypes (A & B) can be easily modified to meet the needs of Nunavik’s local people. Using these expandable, compact, and prefabricated dwelling units tremendously decrease the transportation cost and construction cost by reducing the need to hire skilled construction workers to set them up on site.

AFFORDABLE HOUSING/ LIVING AREA [Possible Interior Layout] [Sliding Walls & Folding Furniture]

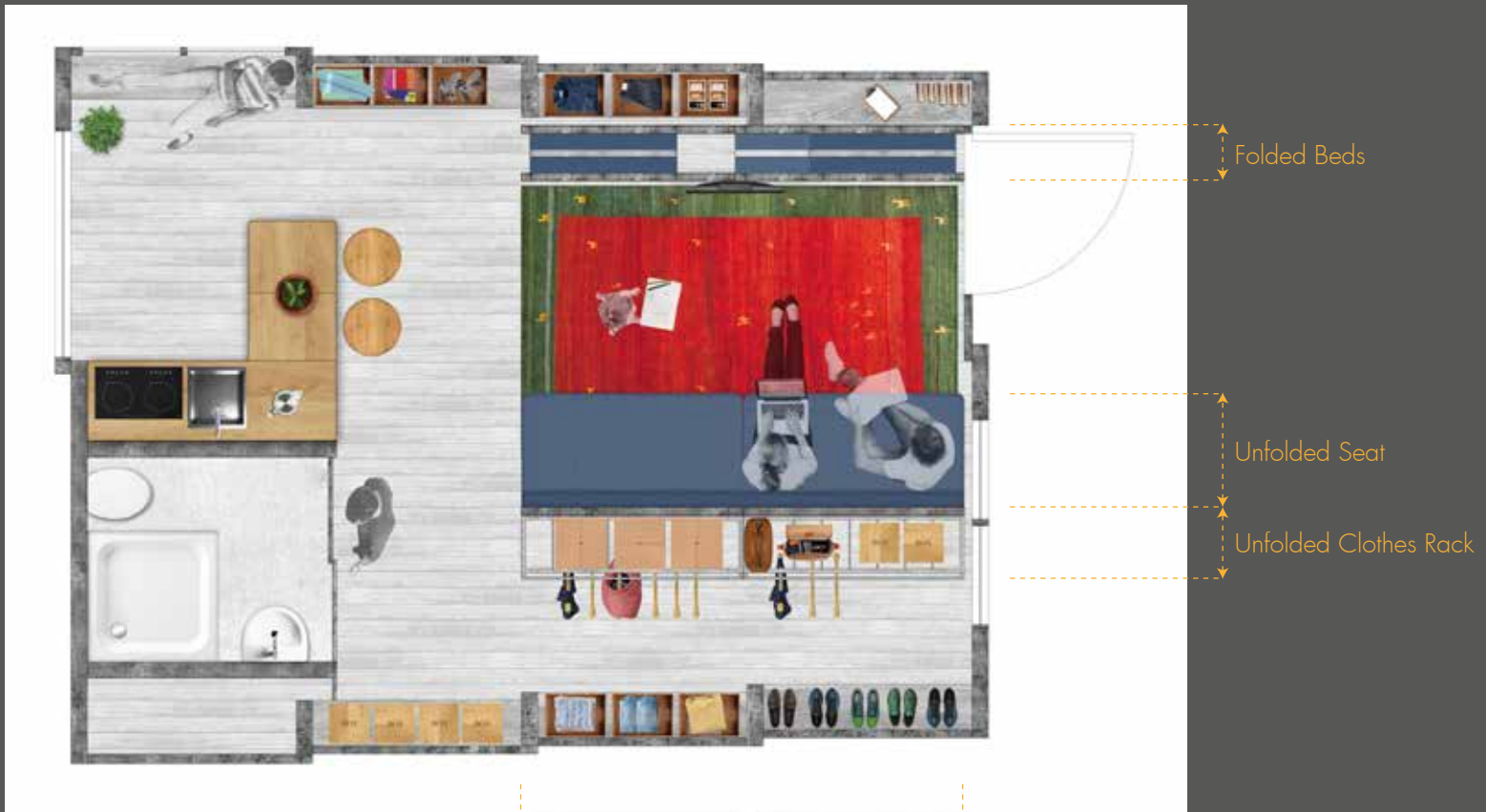
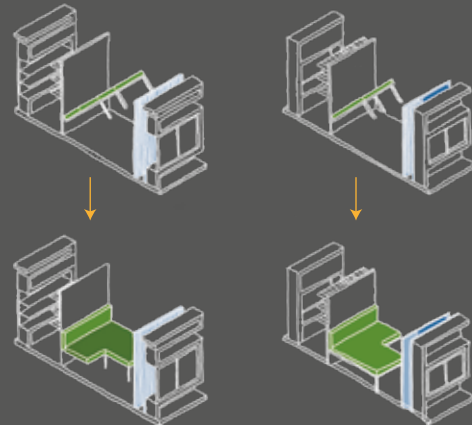


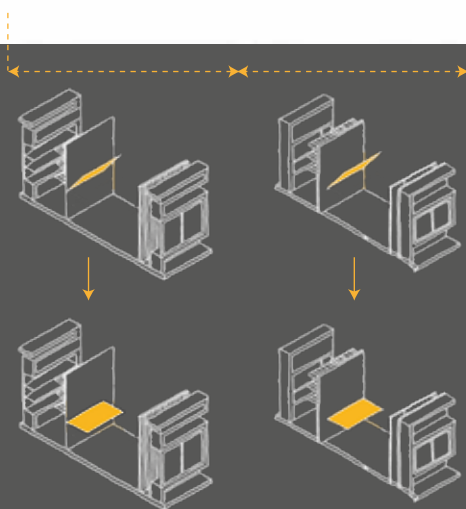
Fig 10.04 Possible interior layout - Living Area



AFFORDABLE HOUSING/ DINING AREA [Possible Interior Layout] [Sliding Walls & Folding Furniture]



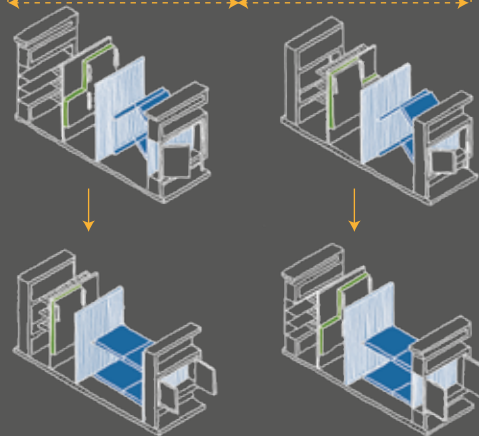
Fig 10.05 Possible interior layout - Dining Area



AFFORDABLE HOUSING/ SLEEPING AREA [Possible Interior Layout] [Sliding Walls & Folding Furniture]



Fig 10.06 Possible interior layout - Sleeping Area



STUDENTS HOUSING

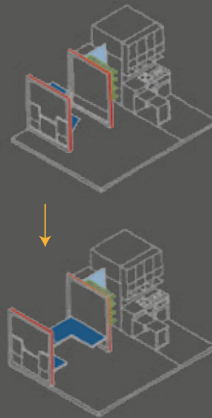


Fig 10.07 Setting up the students' dwelling unit on campus.

STUDENT HOUSING/ LIVING AREA [Possible Interior Layout] [Sliding Walls & Folding Furniture]



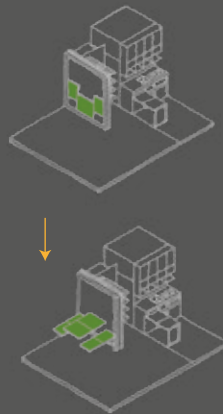
Fig 10.08 Possible interior layout - Living Area



STUDENT HOUSING/ DINING AREA [Possible Interior Layout] [Sliding Walls & Folding Furniture]



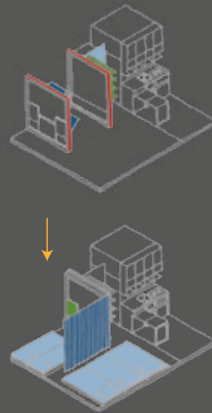
Fig 10.09 Possible interior layout - Dining Area



STUDENT HOUSING/ SLEEPING AREA [Possible Interior Layout] [Sliding Walls & Folding Furniture]



Fig 10.10 Possible interior layout - Sleeping Area



Conclusion

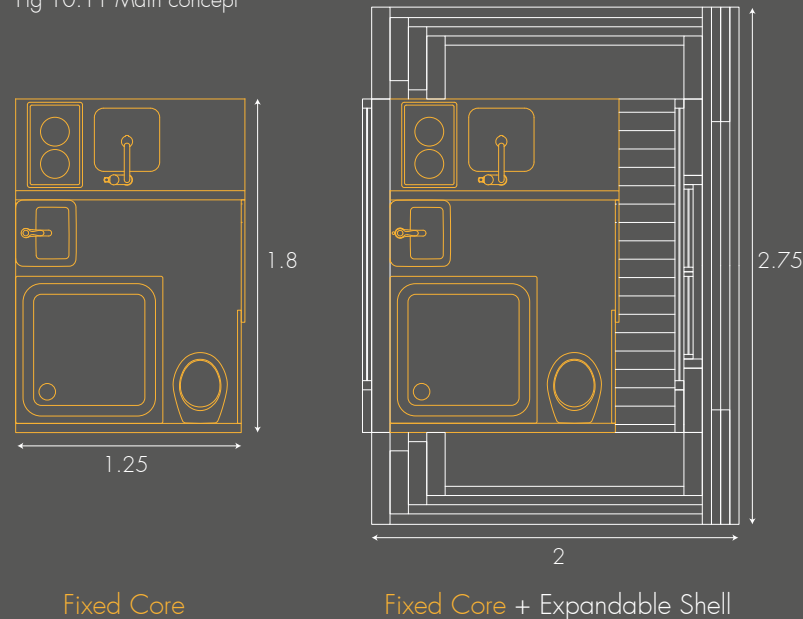
In the past year, 19.3 million people were displaced only due to natural disasters. This is while there are still millions of others who have been living in tents for years and are waiting for more adequate temporary shelters.⁴⁸ At present, the humanitarian community is placing too much confidence on tents and tarps as shelters to the point that most disaster relief programs tend to eliminate the transitional or temporary dwelling phase in favor of using tents as long term housing solutions for the affected population. Although such shelters are extremely economical and allow humanitarian organizations to temporarily house as many survivors as possible in a short period of time, they have a very limited life span and tend to fail when used as a long term solution. It is very critical to note that inadequate disaster relief solutions can quickly backfire and result in serious humanitarian crises. Unplanned and overcrowded shelters, poor sanitation conditions, and insufficient personal hygiene tremendously increase the outbreak of infectious, air-borne, and water-borne diseases (diarrheal diseases and Leptospirosis). Nonstandard living conditions also have a profound effect on the mental health of the affected population and may heighten post-traumatic stress disorders, severe depression, suicide rates, and etc. As many countries are struggling with the available disaster relief shelters and millions of people have been forced to live in unacceptable living conditions, investigating alternative design possibilities can prove to be very valuable for both the humanitarian organizations and the displaced population.

Besides providing a cost efficient, sanitary, and adequate living environment, the proposed design also targets a very important issue that is surprisingly overlooked

in some disaster relief shelter proposals. One of the major reasons the displaced people choose to abandon their well-built and comfortable temporary dwelling units in post disaster situations is because they are located too far from their destroyed properties. Research shows that disaster survivors who were dislocated from their own neighborhoods and were placed in temporary houses, preferred to go back to their familiar environment and live in their own flimsy shacks.⁴⁹ Therefore, this project primarily focuses on providing a mobile, portable dwelling unit which can be easily relocated by the affected population and set up wherever desired. Another critical issue that needs to be taken into consideration is the transportation cost. In order to fit as many units as possible in a shipping container, the proposed design must be compact but at the same time it should be able to expand and accommodate an average family. Since, sanitary facilities such as bathroom and kitchen, and other components such as solar panels, water tanks, water heaters, and filters are also included in the proposal, and because transporting all of these elements as separate packages would be both costly and time consuming, the most logical approach is to design a fixed core and an expandable shell. That is, instead of shipping all the components of the project as a kit of parts which then needs to be assembled by the people on site, this dwelling unit is designed with a "fixed core" that contains a small bathroom and kitchen along with the complementary components such as water tanks, filters, and power sources; then the main living area is designed as an "expandable shell" that can be pulled out once the unit is ready to be set up on site. A series of floor plans were initially explored to

find the smallest area that can accommodate a small washroom and kitchen unit. (1.8m by 1.25 m = Prototype A)

Fig 10.11 Main concept



Once the expandable shell is added to the fixed core, the exterior dimensions are increased to 2.75m by 2m which would still allow four units to fit a 40 ft. shipping container and reduce the transportation costs. It is important to mention that the expansion parameters were selected through an elimination process, where all the available strategies were briefly compared and their pros and cons were analyzed.

The telescopic and folding mechanisms were the ones with the least disadvantages and were therefore chosen as the main design tools. Combining a fixed and expandable design allowed for:

- Compact size : Cheaper transportation and easy mobility
- Private sanitary facilities : Reducing risks of infectious and water borne diseases + Safe and secure sanitation for families especially children and women
- Private kitchen : Reducing the risks of life threatening diseases + safe and secure environment for food preparation and storage
- Expandability : Expanding the living area up to 7 times (Prototype A) + Thick insulated walls with storage space for belongings
- Pre-installed off the grid components such as solar panels, fresh water tank, black water tank, grey water tank, water filtration system, and water heater.
- Single package : Transporting this project as a kit of parts would require one 40 ft. shipping container for each unit; that is if the components of this project were to be delivered as separate packages, the storage space needed would be 4 times as much as the space required by the pre-assembled version.
- Pre-assembled unit : Setting up the dwelling unit in a very short time by unskilled workers.
- Materials : Using quality building materials increases the lifespan of the dwelling unit and requires less maintenance + this unit can be reused for other purposes such as refugee housing, affordable housing, student accommodations, and etc.

Two other prototypes, B and C are also proposed to reduce the final cost even further. Prototype B is designed to reduce the structural complexity and prototype A consists of the expandable shell without the fixed core. While A and B allow for lower manufacturing costs and less structural complexity, "Prototype A" is still more compact and provides a slightly larger living area once expanded on site. If mass produced, both proposals can help ease the suffering of many families around the world who are constantly struggling for their basic everyday needs. The final cost of this project is estimated to be only a few hundred dollars more than "Shigeru Ban's Paperlog House" which has been continuously praised for its innovative and beautiful design but unfortunately lacks private washrooms, kitchens, off the grid power source, and sufficient insulation. By spending a few more dollars, humanitarian agencies and governments can provide the disaster survivors with safer, cleaner, and more comfortable living environments, which would reduce the crime rates and mental health issues, improve the well-being of the affected population, and therefore prevent many potential humanitarian crises which would require long and extensive planning and investment once they take place.

It is very critical to remember that the proposed prototypes are not intended to be used as universal solutions. As mentioned before, this project is suitable and feasible for certain climate zones and topographical conditions; and in order to be able to perform well in other geographical settings, modified prototypes must be proposed to meet the necessary requirements.

ENDNOTES

PRECEDENT ANALYSIS

40. “Hong Kong Micro Apartment by Gary Chang - 24 Rooms / 344 Sq Ft (video),” Jebiga Design & Lifestyle, June 18, 2013, accessed January 18, 2017, <http://www.jebiga.com/hong-kong-micro-apartment-gary-chang/>.

PROTOTYPES B & C

41. Gonzalo Lizarralde, Cassidy Johnson, and Colin Davidson, *Rebuilding After Disasters: From Emergency To Sustainability*, (New York: Spon Press, 2010), 83.

42. “Shelter,” UNHCR, accessed Dec 01, 2016, <http://www.unhcr.org/shelter.html>

43. “Average Stay in a Refugee Camp is 17 Years, UN Expert Says Camps are “The Cities Of Tomorrow”, The Free Thought Project, accessed Dec 02, 2016, <http://thefreethoughtproject.com/average-stay-refugee-camp-17-years-expert-camps-the-cities-tomorrow/>

44. “Affordable Housing Initiative,” Canada Mortgage and Housing Corporation, accessed Dec 01, 2016, https://www.cmhc-schl.gc.ca/en/inpr/afhoce/fias/fias_015.cfm

45. “Affordable Housing - A Global Crisis,” Global Real Estate Experts, accessed Nov 11, 2016, <http://www.globalrealestateexperts.com/2015/12/affordable-housing-a-global-crisis/>

46. “Inuit Women’s Association Of Nunavik,” Saturvitt, accessed August 02, 2015, <http://www.saturvitt.ca/wp-content/uploads/2015/08/Chapter-1-Housing-Shortage-and-Homelessness.pdf>.

47. Ibid.

48. Unknown author, “Global Estimates 2015: People displaced by disasters.” IDMC. July 2015. <http://www.internal-displacement.org/publications/2015/global-estimates-2015-people-displaced-by-disasters/>

49. Gonzalo Lizarralde, Cassidy Johnson, and Colin Davidson, *Rebuilding After Disasters: From Emergency To Sustainability*, (New York: Spon Press, 2010), 71.

BIBLIOGRAPHY

“After the Earthquake: Nepal’s Children Speak out.” July 29, 2015. Accessed December 6, 2016. <http://www.wvi.org/nepal-earthquake/publication/after-earthquake-nepals-children-speak-out>.

Basu, Moni. CNN. 2010. Accessed December 06, 2016. <http://www.cnn.com/2010/WORLD/americas/06/03/haiti.middle.class/>.

BBC. “Rape at ‘crisis’ Level in Haiti Earthquake Camps.” 2016. Accessed December 6, 2016. <http://www.bbc.co.uk/newsbeat/article/12171443/rape-at-crisis-level-in-haiti-earthquake-camps>.

De Soto, Hernando. *Rebuilding After Disasters: From Emergency to Sustainability*. Edited by Gonzalo Lizarralde, Cassidy Johnson, and Colin H. Davidson. New York: Taylor & Francis, 2009.

France-Presse, Agence. “Swiss City Buys Ikea Shelters to House Refugees, Then Ditches Them over Fire Risk.” *The Guardian* (The Guardian), December 19, 2015. <https://www.theguardian.com/world/2015/dec/19/swiss-city-buys-ikea-shelters-to-house-refugees-then-ditches-them-over-fire-risk>.

Goldenberg, Suzanne. "Eight Ways Climate Change Is Making the World More Dangerous." *The Guardian*. 2014. Accessed December 05, 2016. <https://www.theguardian.com/environment/blog/2014/jul/14/8-charts-climate-change-world-more-dangerous>.

“Haiti’s Disaster After the Disaster: The IDP Camps and Cholera.” December 13, 2010. Accessed December 6, 2016. <https://sites.tufts.edu/jha/archives/869>.

“Hong Kong Micro Apartment by Gary Chang - 24 Rooms / 344 Sq Ft (video).” June 18, 2013. Accessed January 18, 2017. <http://www.jebiga.com/hong-kong-micro-apartment-gary-chang/>.

Internal Displacement Monitoring Centre (IDMC) - Norwegian Refugee Council. "Publications." IDMC » Global Estimates 2015: People Displaced by Disasters. Accessed December 05, 2016. <http://www.internal-displacement.org/publications/2015/global-estimates-2015-people-displaced-by-disasters/>.

“Inuit Women’s Association Of Nunavik.” August 2, 2015. Accessed January 16, 2017. <http://www.saturviit.ca/wp-content/uploads/2015/08/Chapter-1-Housing-Shortage-and-Homelessness.pdf>.

Jha, Abhas K, Jennifer Duyne Barenstein, with Jennifer Duyne Barenstein, Priscilla M. Phelps, Daniel Pittet, and Stephen Sena. Safer Homes, Stronger Communities: A Handbook for Reconstructing After Natural Disasters. Washington, DC: World Bank Publications, 2010.

Muñiz, Michelle. "Affordable Housing – A Global Crisis." December 7, 2015. Accessed December 6, 2016. <http://www.globalrealestateexperts.com/2015/12/affordable-housing-a-global-crisis/>.

Nepal, Jagaran. "Case Studies on Immediate Impact of Earthquake, Jaisithok, Kavre." December 1, 2016. Accessed December 6, 2016. <http://www.jagarrannepal.org/case-studies-on-immediate-impact-of-earthquake,-jaisithok,-kavre>.

Newslettergetour. "Product: Better Shelter." 2016. Accessed December 6, 2016. <http://www.bettershelter.org/product/>.

"OSH Answers Fact Sheets." Government of Canada, Canadian Centre for Occupational Health and Safety. 2016. Accessed December 06, 2016. http://www.ccohs.ca/oshanswers/chemicals/iaq_intro.html.

"Phases of Disaster Recovery: Emergency Response for the Long Term." ReliefWeb. Accessed December 06, 2016. <http://reliefweb.int/report/world/phases-disaster-recovery-emergency-response-long-term>.

"The Impact of Natural Disasters on Mental Health." Australian Psychological Society : The Impact of Natural Disasters on Mental Health. Accessed December 05, 2016. https://www.psychology.org.au/inpsych/impact_disasters/.

Unkown Author. "Exo." Accessed December 6, 2016. <http://www.reactioninc.com/exo>.

Team, AD Editorial. "The Humanitarian Works of Shigeru Ban." March 24, 2014. Accessed January 18, 2017. <http://www.archdaily.com/489255/the-humanitarian-works-of-shigeru-ban>.

Welle, Deutsche. "Lack of Toilets Poses Serious Health Risk | Globalization | DW.COM | 23.05.2012." April 2012. Accessed December 6, 2016. <http://www.dw.com/en/lack-of-toilets-poses-serious-health-risk/a-15965852>.

Worldatlas. "Rising Tides: Cities Of The World That May Be Flooded By Climate Change." WorldAtlas. 2016. Accessed December 05, 2016. <http://www.worldatlas.com/articles/high-tides-cities-of-the-world-that-may-be-sunk-by-climate-change.html>.

