DISASTER RESPONSE TOOLS FOR SURVIVORS

BY

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Abstract

The inadequate response to disasters in economically disadvantaged countries could possibly result in victims suffering grave repercussions in the aftermath. Disaster-prone areas are under constant threats due to their location, and they face a higher risk in the coming years due to climate change. Compared to developed nations, less developed countries lack the funds, skills, information, infrastructure, and, most importantly, political stability. These factors collectively hinder their ability to effectively cope with the challenges posed by natural disasters and their resulting impacts.

Based on the examination of case studies, visits temporary shelter sites, and interviews with survivors of significant natural disasters in underdeveloped nations as a research methodology, it can be concluded that the establishment of shelters plays a pivotal role in post-disaster response. In most cases, survivors had to build temporary shelters for themselves until they received aids from private and government organizations. A deeper analysis of the resourcefulness and creativity displayed by those displaced in constructing makeshift shelters using minimal available resources has underscored the necessity for providing aid in these endeavors. The final design involves a set of tools that aids the survivors in setting up temporary spaces, suitable for temporary habitation, while also assisting the survivors with their daily activities within these spaces. Furthermore, a recommendation can be made that as survivors become more acquainted with the system, they might uncover additional ways in which the tools can be employed.

(Total 44 pages)

Keywords: Marketing, Electrolyte Drink, Consumer, Communication

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Chapter 1

Introduction

1.1 Background and significance of the problem

Asia-Pacific nations experience more natural disasters than other parts of the world (Fig 1.1) (ESCAP, 2015). The region is characterized by continuous tectonic plate movements that result in earthquakes and Tsunamis, and its location makes it prone to cyclones and typhoons (ESCAP, 2015). Coincidently, most regions in Asia and the pacific, that are most prone to natural disasters are also the lesser developed countries. When faced with disasters, these countries are most vulnerable due to their weak healthcare services and infrastructure (Guterres, 2021). In the last 30 years these areas have been exposed to 2850 natural disasters, which is the highest number so far, and this area is said to be at higher risk in the next 20 years due to climate change.

Developed countries that are prone to natural disasters are proven to be better prepared for such events. Japan's geological location and topographical features makes it susceptible to earthquakes, typhoons and tsunamis. However, because Japan has faced many disasters over the years that have had significant impact, the country has been investing its resources and efforts into reducing the risk of disasters over the years (Abe, 2015). People are provided with information on evacuation sites designated by local authorities. These areas are usually community centers, nearby schools and in some cases inns and hotels that have been marked safe by the authorities. People are also provided with guidelines to self-assess the safety of sites for evacuation.

By contrast, the poorer countries, however, lack funds and infrastructure to be able to formulate an effective disaster response system and are heavily reliant on flown-in foreign aid. The public would also not have direct access to donated shelters, and it would take time to organize its fair distribution. In cases of large-scale impact, there would not be enough donated shelters for all survivors, so people would have to continue to use the shelters they prepared themselves, until they would be able to move back into proper homes. This could take months or years, depending on the damage. It is crucial that the victims are provided with safe spaces for the next few weeks and months following the disaster, as it could leave them battling with stressful living conditions while trying to rebuild their lives (JBP, 2020).

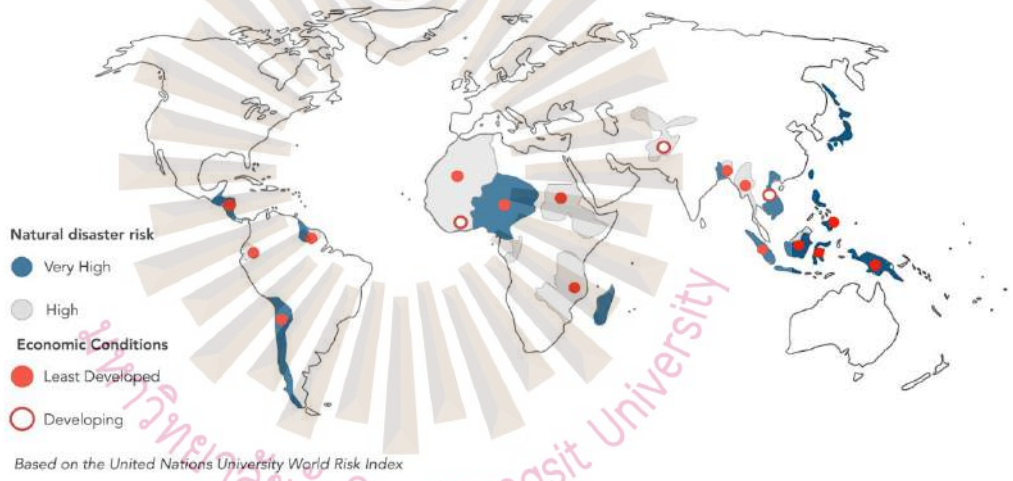

Figure 1.1 High risk areas for natural disasters around the world

Source: Researcher

1.2 Research Objectives

Identify urgent post disaster issues in relation to temporary living spaces, and analyzing inefficiencies in existing solutions to design a set of tools that assists the survivors in performing tasks more efficiently.

1.3 Research Questions/Assumptions

The actual event itself lasts for a couple of minutes or a few seconds, and while majority of the damage is done within that time, the aftershocks that follow can cause further damage to poorly built residences. The next few weeks, up to six months, can be spent trying to overcome challenges faced post disaster in order to recover from the event. It is during this time that temporary shelters play a vital role in providing people with a temporary living space, while they focus on investing their efforts into reconstruction and rebuilding of their homes, so that their lives can return to normal

In contrast to disaster response system in developed countries, where effective measures have been taken to ensure preparedness and recovery, the undeveloped countries face various challenges due to political instability, lack of resources, and information. Available resources would be engaged in rescue operations in the aftermath of a disaster, so help would not be immediately available to the displaced survivors. Although International aid provides tent shelters among other provisions, in case of large-scale disasters, number of survivors exceeds the number of donated tents, so the survivors would be compelled to live is makeshift shelter they built for themselves (Buckley & Ramzy, 2015).

Temporary tent accommodations are widely used as temporary shelters immediately and for the following first few days after the disaster. The popularity of tent structures, however, is not due to lack of options. Innovative companies like Ikea have explored possibilities and limits of temporary shelters, producing an award-winning temporary structure that was known to be an improvement on the current options available to the displaced (Alfred, 2017). It takes into consideration the durability, energy sources, complexity of construction, challenges of transportation and security. However, flown-in shelters are not financially feasible for the survivors, or the organizations that have limited budget for the displaced. There is also needed to take into consideration that shelter solutions need to cater to requirements of privacy, while

still aligning with the cultural practices and family structures of the community (Alfred, 2017).

Due to recent concerns regarding impacts of climate change, efforts have shifted to design solutions that address the after-life of temporary shelters. Some design solutions have produced reusable shelters from recycled plastic, which can be reprocessed and used again. However, recycled plastic has issues of its own. Reprocessing plastics contributes to health problems, climate crisis and it is also an expensive process. so, it gives the illusion of a solution when in fact it is giving corporations the excuse to produce more plastic (Wilkins, 2018).

Some climate resilient shelters provide longer lasting solutions, where shelters have been made more durable to have a longer lifespan. While on a positive note, durability could mean economical. On the other hand, long-lasting would mean using it again and again, and easy to transport would indicate that once it has served its purpose in one place, it can be packed and sent somewhere else to be used by someone else. This means the next occupant would be living in a shelter that had once been inhabited by other people. This raises the issue of providing survivors with homes where they can live with dignity (Rudofsky, 1964).

This study aims to detect urgent issues that would be faced by survivors immediately after a large-scale disaster regarding arrangements for temporary living spaces. Help survivors feel in charge of their situation and be involved in building temporary shelters where they can take refuge in while focusing on rebuilding their lives. In addition, it intends to address the issue of the afterlife of a disaster shelter, keeping in mind that this decision lies in the hands of the user. It addresses basic and vital issues of living in temporary spaces, and provides the survivor with a system that makes the process of shelter building straightforward, and their tasks within that living space easier.

1.4 Research Framework

Research plan was required to be carried out to study case studies and visit shelter sites that could provide evidence of successful application of theoretical solutions.

1.4.1 Study case studies of large-scale disaster aftermaths in undeveloped countries, and their post disaster response to identify common patterns in decision making and problem solving. Common issues and priorities within a certain timeframe from the event are identified, and patterns in short term and long-term responses are compared to locate the solutions that have been selected to be further explored by the survivors. Simultaneously, case studies of Japan's post disaster response a a developed nation, along with existing protocols for disaster events have been studied as comparison.

1.4.2 Visit temporary shelter sites along the outskirts of Kathmandu Valley were visited to examine issues that come with living in a temporary shelter, and to note the popular solutions to these problems. Unlike shelters that are built post disaster, the temporary shelters in the outskirts have been inhabited for a longer period of time, thus supplying more explored problems areas. As these shelters are illegal constructions, they share a similar issue with temporary disaster shelters in that these dwellings are required to be non-permanent. This similarity provides a common ground where inhabitants face comparable problems, and as a result, can share the progress of decision-making.

1.4.3 Design a system that provides assistance to survivors to build temporary living space and provide assistance with certain vital activities.

1.4.4 Produce a set of laser-cut prototype tools made of zinc coated aluminum to explore possibilities of multiple functions.

1.5 Definition of Terms

Disaster Response Actions coordinated by organizations and the government after a natural disaster in order to rescue victims, provide medical help, make shelter

arrangements for the displaced, providing crucial information and formulating plans for reconstruction and recovery.

Disaster shelters A safe temporary living space where survivors can take refuge.

Natural Disaster Disastrous events that occur in nature that cause great damage and lead to loss of lives and property. Earthquakes, floods, hurricanes, tornadoes, landslides, wildfires, volcanic eruptions, droughts, tsunamis, avalanches are some common natural disasters.

Chapter 2

Literature Review

2.1 Emergency Phase of Disaster Response

2.1.1 Shelter Establishments in Underdeveloped Nations

April 2015 witnessed displacement of approximately 2.8 million people in Nepal, after an earthquake of 7.8 magnitude destroyed and damaged over 300,000 homes (Ministry of Home Affair & International Organization for Migration, 2013). During evacuation, the displaced resorted to utilizing various options for shelters. There were hasty repairs made to livable parts of damaged buildings, improvised shelters were set up behind vehicles, and makeshift accommodations were arranged using bedsheets or plastic sheets.

Although there were 19 designated areas for formal camps, only 9 were used to set up shelters, given that the impact of the earthquake was low when compared to the magnitude of the event. By SPHERE standards, one person is required to occupy an open space of 3.5 m square, to ensure privacy and security. As a result, this hindered the efficient distribution of help to all survivors. On the other hand, survivors have been seen to prefer taking shelter nearer to their homes and community, as opposed to formal designated spaces. Thus, resulting in more spontaneous shelters outside designated areas for camps. It was also noted that people with undamaged homes also choose to take refuge in temporary shelters due to constant aftershocks.

Another hurdle faced by the aid suppliers was accessibility. Some remote villages that suffered tremendous loss did not have proper roads that could allow transportation of aid and supplies. To exacerbate the situation, the earthquake was followed by floods and landslides that blocked existing roads. This left the villagers to

tend to their own needs and build their own makeshift shelters using materials that were available to them.

Similarly, in Haiti, the first week after the 7.2 magnitude earthquake in 2010, tarpaulins were distributed to the displaced for shelter arrangements. Lack of immediate shelter arrangements led to disputes and violent arguments, revealing the desperation for a safe refuge felt by the displaced. One plastic sheet per person was distributed in a span of three months to avoid the need to set up more permanent settlements because the government believed temporary constructions would prove to be a hindrance during the recovery phase. Large number of families resorted to salvaging materials from the destruction and damaged buildings to use the donated plastic sheet and build their makeshift shelters. Due to this, providing technical support was strategized to ensure the safety of these constructions, and to ensure that scarce resources, which otherwise could have been used for more long-term solutions, were not utilized for these temporary arrangements (IASC, 2011).

While the majority of the population took refuge in designated camps, there were some shelters that were built in informal locations due to social ties. These locations were private properties, partially damaged houses, and private streets. (IASC, 2011). This posed a problem for managing camp sites, as they we small spontaneous settlements which may not be able to receive technical support as swiftly due to their informal location.

During the emergency phase of disaster response in Underdeveloped countries, the aim is to ensure that the survivors have sufficient material to build their makeshift shelters. The shelter can be modified to suit the needs the inhabitants. However, for all shelter options, few general standards should be met.

1) Shelters are required to protect from natural elements.

2) Provide space privacy and emotional safety.

3) Provide space for storage.

4) Construction of the shelter should take into consideration the culture of the community.

5) Shelter needs to suit the weather or adapt according to changes in weather.

6) It is preferable and more appropriate if the shelter is built using local materials and resources, to minimize cost and effort.

7) A minimum space of 3.5 m square of open space is required for each person.

8) Shelter should reach a minimum height of 2 m.

9) Shelter should provide a minimum of 4.5 to 5.5 m square for each person in colder climates. A kitchen is required to be built inside as inhabitants are expected to stay indoors in cold climates.

2.1.2 Shelter Establishments in Developed Nations

Nagoya City in Japan is one of the most disaster-resilient cities in the world (Yun & Zhang, 2019). The city has categorized its designated shelters into two categories (Nagoya International Center, 2019):

1) Designated Emergency Assembly Point

Areas designated for immediate evacuation in order to be safe from the disaster. The location of these areas differs according to the type of disaster.

2) Designated Evacuation Shelter

Spaces for victims whose homes have been damaged by the disaster to take refuge until they can move back or have a new residence.

Furthermore, Private companies are in collaboration under Japan Bosai Platform since 2014 in an effort to reduce the disastrous impact of natural disasters. The shelters provided by JBP are aimed to provide temporary
refuge for people whose residences were affected by earthquake, tsunami, landslide, cyclone, storm surge, flood, volcano, wildfire, tornado and avalanches. The purpose of these temporary structures is to provide housing for these people so they can recover from the disaster until permanent arrangements are made (JBP, 2020). The association's aim is to pursue better management of disaster response, recognizing the increasing

devastation of climate change, not limiting its focus on Japan alone, but other vulnerable regions as well (JBP, 2020).

2.2 Genre of Required Temporary Shelters

While there are four categories of shelters (Bashawri & Moodley, 2014), The shelters required immediately and up to a few months after the disaster fall under three categories (Fig 2.1).

1) Emergency shelters that are used for a short period of time, where people can immediately evacuate in order to protect themselves from the disaster. They are used for the first couple of hours or the first few days (Felix et al., 2013). These shelters are usually used for victims that require medical attention (Harzani, 2021). In this type of shelter, the primary focus is to provide victims with medical attention, therefore, these shelters do not provide privacy or security. These shelters provide space only for basic medical help (Harzani, 2021).

2) Temporary shelters that are used by victims who have not been physically injured for short term use. These shelters can be private tents, or temporary structures within communal spaces. They are inhabited for a few weeks, where people focus on emotional and psychological recovery. Victims are not encouraged to stay for longer than a few weeks or over a month in these shelters as they would be built on a tight budget. However, these types of shelters aim to provide more privacy and security (Harzani, 2021).

3) Transitional shelters are arranged by the victims by relying on their resourcefulness (Bashawri, 2014), and can sometimes be modified to be more permanent residences that can be repurposed in the future. In some cases, these shelters are also prefabricated homes set up by skilled labor (Shiozaki et al., 2014). The shelters are built with more durable materials, and they provide more space for living. These shelters also give pricier to the families where they can carry out their daily activities (Harzani, 2021).

The Shelters required after this period are more permanent and require skilled labor to assemble. While some are still categorized as temporary, these shelters are able

to upgrade to permanent housing, and can be used for a long term. Permanent modifications can be made in order to provide the privacy and security a permanent home would provide.

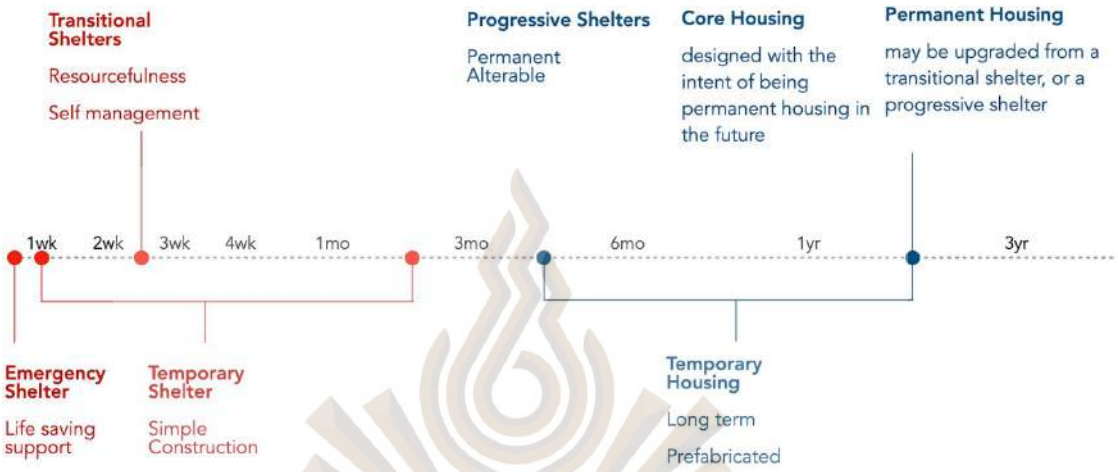

Figure 2.1 Required temporary shelters according to length of stay

Source: Researcher

2.3 Factors Affecting Construction of Shelters

2.3.1 Location

Traditionally, construction of disaster shelters can be categorized into under two methods of construction.

1) Off-site construction of disaster shelters, where the shelters are built away from the destruction site. The design solution would typically be made in factories, and then transported to be put together on site.

2) On-site construction of disaster shelters, where the raw materials are transported to the sites where they are used to build temporary shelters.

In both cases it is crucial to consider the weight and size of shelters and materials. This could affect the cost and time taken for shipping.

However, third category has emerged as a popular option is underdeveloped countries, where survivors use local materials, or materials salvaged from destruction sites, in order to build makeshift shelters for themselves. Although a popular choice during such desperate situations, there is a high chance these salvaged materials would be damaged, which might affect its functions. There is a lack of choice regarding the quality and uniformity of these materials, which might prove to be a challenge during construction.

On the other hand, flown in options highly depend on transportation, which is a challenge if the transportation networks have suffered damage. Transportation of such large scale during catastrophic destructions also face challenges on the financial front.

2.3.2 Environmental Impact

Natural disaster leads to destruction that results in a large amount of waste. Is it crucial to take into account the amount of waste temporary cheaters could create. On-site emergency shelter constructions are built with little planning and consideration for the afterlife of materials that have been used.

Although financially more feasible, these constructions generate more waste as long term use was not a consideration during construction. Comparatively, off-site constructions that are prefabricated allow more options for usage in the long run.

The usage of salvaged materials could have potential risks in terms of safety issues and contamination. These materials require expert evaluation before being deemed safe, and the necessary equipment required to make this evaluation could make it a costly and slow process. However, it can be argued that allowing salvaged materials to be used for construction of disaster shelters could help with waste management of destruction sites.

2.3.3 Attributes of a Community

Construction of living spaces does not only reflect the culture of a place. Construction of these spaces are also affected by environment, climate and social norms. The users of these shelters are the people of the community that have been affected. It is crucial that the living space is fitting for its occupants. In order to recover from major disasters, participation of the community is crucial, therefore it is important for the victims and survivors to accept these shelters and take temporary refuge in order to recuperate and work towards rebuilding.

2.3.4 Dependency on Workforce

Availability of workforce plays a vital role during the recovery phase post disaster. Bringing in skilled labor would prove to be costly, not only because they need to be brought in from other locations, but accommodation facilities would also need to be arranged for them. It is financially more feasible to have on site work force, especially when a large amount of work needs to be complete within a limited amount of time. It is beneficial to explore how the skilled workforce can work together with the community during construction of shelters.

The above information leads to deduce that construction of a complete disaster shelter is characterized by numerous complexities. That apart from technical aspects of the shelter that are dictated by external conditions and factors, an even more significant challenge lies in designing for the inhabitants.

Chapter 3

Research Methodology

3.1 Identifying Commonalities in Various Scenarios

3.1.1 Salvaging of Materials

While survivors receive financial aid from the government to rebuild their homes, the distribution of finance takes time as it requires evaluation, estimation and final distribution. It is also a near to impossible task to provide flown in shelters for all victims of large-scale disasters. Until then many survivors have shown initiative to build their own temporary shelters by visiting the ruins and salvaging materials that were in operational condition (Fig 3.1). Such initiative was observed in natural disaster survivors of most underdeveloped countries.

In most cases, private organizations and the government are able to provide plastic sheets and tarpaulins for shelter purposes. Consequently, some organizations have donated tools to help with the construction of these shelters.

Figure 3.1 Salvaging of materials in Indonesia (Right) and Nepal (Left) for Shelter
Source: thejakartapost.com, 2018

3.1.2 Technical Choices

Technical support and advice were provided in order to improve these makeshift shelters. Certain helpful recommendations were made to improve the quality of these shelters.

1) Salvaged timber for frames could vary in size and quality, at times different materials, like metal pipes, would be salvaged if deemed useful. Heavier materials could be used for the frame as it would need to be sturdier, while lighter materials could be used to build the roof. A significant suggestion was to add a slope to the roof to allow drainage of rainwater (3.2).

Figure 3.2 Shelter frame built with sloped roof as per suggestion
Source: reliefweb.com, 2010

2) Choosing the correct method of the plastic sheets to the frame can extend the lifespan of the sheets. Inadequate sheet installations can result in holes and tears. A significant suggestion was to prioritize the roof as it is most vulnerable to weather conditions (Fig 3.3).

Figure 3.3 Adequate sheet installations to prevent wear and tear

Source: reliefweb.com, 2010

3) Appropriate reinforcements can enhance the performance of the shelter. A stronger frame and roof can improve the structures' resistance to wind and rain. A significant suggestion was to recommend that the victims familiarize themselves with the tools in order to be able to use them in varied situations (Fig 3.4).

Figure 3.4 Use of hurricane straps to secure structures

Source: reliefweb.com, 2010

In remote areas, where technical help was not immediately available, people have demonstrated resourcefulness and ingenuity in identifying problem areas and addressing them. In hilly regions of Nepal, where the wind is strong, the local people detected that the constant flutter of the plastic sheets due to strong wind caused premature tearing of the material. Using nails or making holes to secure the rope were

dismissed as it could exacerbate the situation. As a result, logs, bricks and stones were used as weights to anchor the sheets to the frame (3.5).

Figure 3.5 Use of logs as weights on shelters
Source: reliefweb.com, 2010

3.1.3 Investigation of Activities in and Around Shelters

Drinking after was supplied by the government to official camps sites, while the more spontaneous settlements were left to purchase drinking water from the few undamaged stores that were open. Private organizations were also involved in supplying drinking water to the informal settlements. However, in both cases, people were required to queue at a designated spot to collect drinking water, which they had to carry back to their shelters.

Other basic provisions like blankets and food were distributed in a similar manner. Supplies that were transported to far locations and remote villages were distributed to the people at a designated location, where the villagers would have to go to collect them and make the journey back to their shelters with supplies (Fig 3.6).

Figure 3.6 Collection of supplies at designated locations

Source: globalgiving.org, 2015

3.2 Visiting Slum Areas to Observe Construction Methods

The author visited slums areas in the outskirts of Kathmandu valley in Nepal to study the temporary shelters that were inhabited by families in the community. Some similarities in requirements and decision making were detected between the two scenarios.

1) Salvaged materials were used for most of the construction. Consequently, materials of varying length, size and quality had to be assembled. This implied that nails could not be used as the materials were not always composed of wood. Binding the materials was accomplished with ropes or wires, which was not a permanent fixture and could be unwound if there was a need to change materials (Fig 3.7).

Figure 3.7 tying of two shorter materials to make longer frame

Source: Researcher

2) Roof of all shelters were raised in order to allow drainage of rainwater (Fig 3.8).

Figure 3.8 Raised roof for rainwater drainage

Source: Researcher

3) Plastic sheets and tarpaulins were fixed to the frame to ensure its resilience against wind and strong weather. However, in contrast to disaster shelters,

these structures employed wires instead of weights, to secure the sheets to the frame. The difference in this technical decision is due to the difference in scenarios. Shelters in slum areas face financial limitations, while disaster shelters encounter the challenge of resource scarcity (Fig 3.9).

Figure 3.9 Use of wire to secure materials to frame

Source: Researcher

4) Additional methods to secure the sheets to the frames were also employed. In instances where timber was used, nails were hammered to them, and the plastic sheets were secured to these frames using wires so that they would not be carried away by the wind (Fig 3.10). While this approach effectively prevented the plastic sheets from fluttering and getting damaged, the holes in the plastic sheets did shorten their lifespan. Conversely, the use of wires needed easy to replace the plastic sheets when required.

Figure 3.10 Additional methods of secure sheets to the frame

Source: Researcher

3.3 Identifying Areas for Assistance

According to the information above, the author has made a selection of areas that could potentially benefit from some assistance.

3.3.1 Optimizing the Use of Location

Gathering from the information above, it is evident that the survivors not only take refuge in designated camps, but they also build shelters in informal locations. This could imply several possibilities.

1) Building shelters in privately owned land that cannot have existing constructions (Fig 3.11). These plots can provide the ground for erection of stable frames. Poles and pegs can be driven into the ground for a more secure construction.

2) Utilizing open spaces near communal areas like parking lots. These areas would usually have paved grounds, so people would be required to come up with creative solutions to set up shelters.

3) Making use of vehicles for constructing temporary shelters (Fig 3.12).

4) making use of fences and walls as support for shelters (Fig 3.13).

Figure 3.11 Shelters built on privately owned land

Source: usatoday.com, 2010

Figure 3.12 Using vehicles for shelter

Source: theguardian.com, 2015

Figure 3.13 Using fences on sidewalk to build shelters

Source: thehimalayantimes.com, 2015

3.3.2 Assembling of Materials

The primary challenge seems to lie in procuring materials of consistent size, shape, and quality. Certain factors need to be considered in the situation.

1) Selecting a method of assembly that works for all types of materials is essential.

2) Due to diverse cultural and social impacts, considering the resourcefulness people exhibit in order to provide assistance in strengthening their methods of assembly is crucial.

3) Selecting methods that minimize or cause least damage to the materials in order to extend their lifespan can be beneficial for the user.

3.3.3 Associated Tasks

A selection of tasks that need to be carried out within the first few hours in days following the event seem to be crucial in ensuring safety and survival of the displaced.

1) Initial help comes in the form of food and water supply. This is distributed at specific locations within formal camp sites. This implies that people taking the fusion spontaneous locations would be required to travel to distribution points to collect the supplies, and then carry them back to their shelters. However, formal camp sites encompass large open areas, so people who have chosen to take shelter at designated sites would still have to queue at specific locations to collect their supplies and carry them back to the shelters (Fig 3.14).

2) Apart from drinking water, water supply for other activities related to washing and cleaning is essential in maintaining a certain level of hygiene within the camp sites.

Figure 3.14 queuing for drinking water supply at formal camp sites
Source: chinadaily.com, 2015

3.4 Design Process

3.4.1 Selecting Essential Activities

After evaluation of the gathered information the author has detected the required tools that could assist the inhabitants of the shelter in the process of shelter building and related activities.

1) Tool for assisting with carrying of water supply, especially heavier containers.

2) Tools to assist with securing plastic sheets and similar materials to the shelter frames and alternate supports.

3) Tools to assist with fortifying joints of materials that have been tied together for extension.

4) Tools to assist with drainage and collection of rainwater.

3.4.2 Focusing on Essential Features

Considering the tools needed to be used by the survivors, they have been stripped down to their basic essential features to make it more inclusive and simpler to comprehend. Starting with a container handle, all secondary features were removed, condensing it down to three corners that were the fundamental features (Fig 3.15).

The tapering of the corners allowed bottlenecks of all sizes to be wedged in securely, while the opposite side could serve as a handle (Fig 3.16).

Figure 3.15 Simplifying of handle to keep necessary features

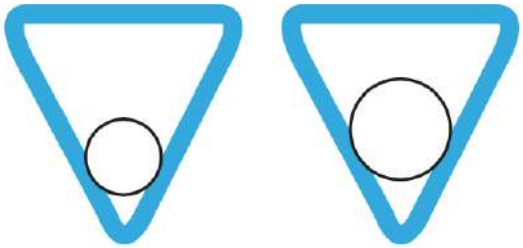

Figure 3.16 Bottlenecks of varied sizes can be wedged between tapering corners

This was further modified to loop around the bottleneck to secure the container more securely. This could ensure a tighter fit for bottlenecks of all sizes and weights (Fig 3.17).

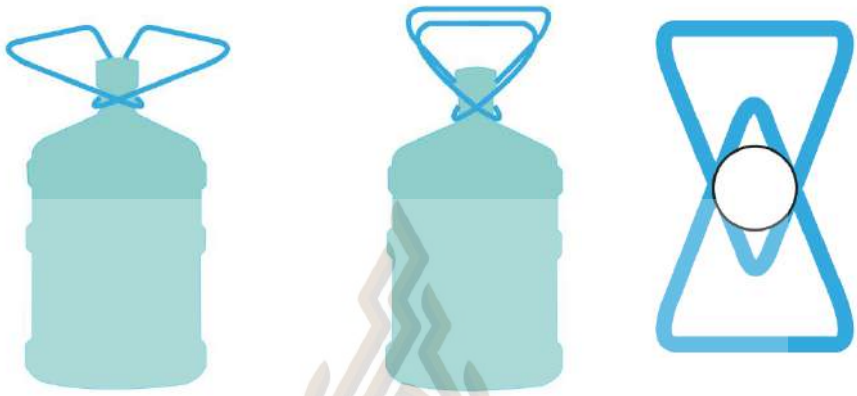

Figure 3.17 modified loop for a tighter fit

3.4.3 Sketch Design

The initial sketch worked towards developing tools that started as flat sheets, that could be transformed into tools as per the user's need (Fig 3.18 and Fig 3.19). This could also allow the products to be flat packed during shipment to achieve cost effective transportation.

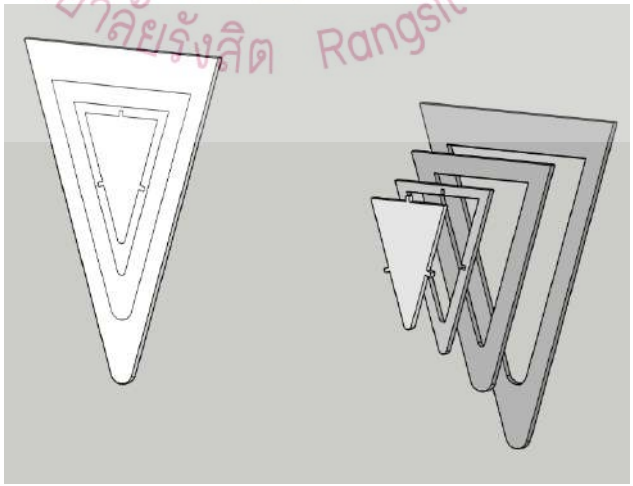

Figure 3.18 Initial sketches in flat sheets

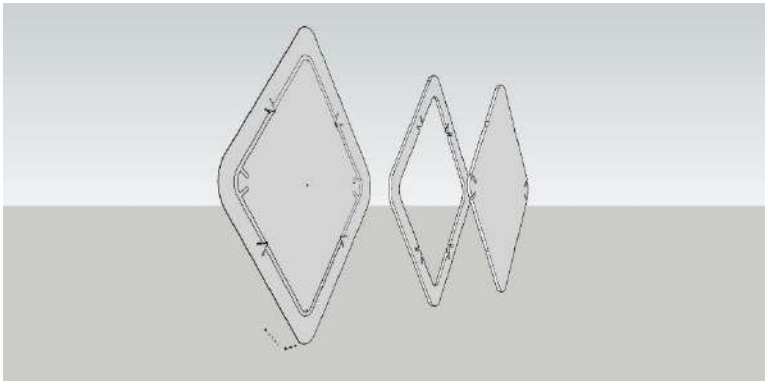

Figure 3.19 Initial sketches in flat sheets

3.4.4 Prototyping

Initial Prototypes used flat paper cards to explore the nature of 2D materials (Fig 3.20). It later employed aluminium sheets coated with Zinc during laser cutting phase (Fig 3.21). Following deductions were made as a result.

1) Sheets required grooves or cuts to enable easier modifications.

2) The perfect thickness that allowed flexibility while still being durable was 0.7 mm

3) Exploring of various ridges and grooves to allow bending of sheets concluded that V-cut sheets could be bent once, after which the action would be irreversible. Dotted incisions proved to serve this purpose better (Fig 3.22).

4) Stainless Steel sheets were best suited for this design solution as it is highly resistant to corrosion which ensured its durability, it is readily recyclable, and requires less maintenance.

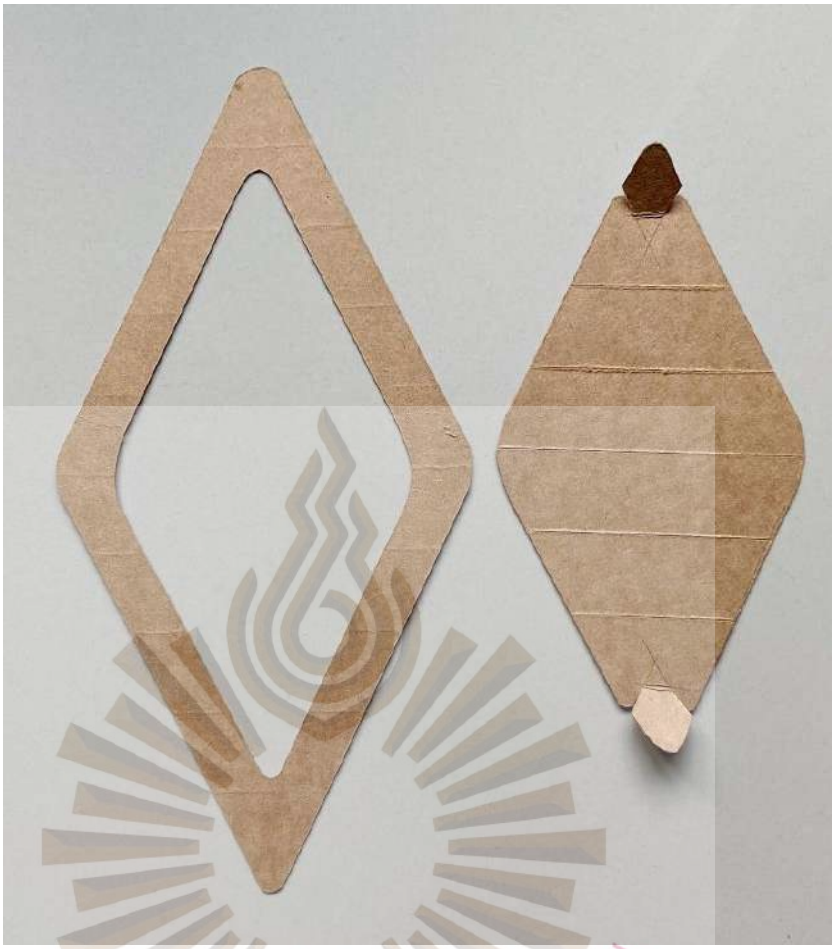

Figure 3.20 Prototype in paper cards for exploration

Source: Researcher

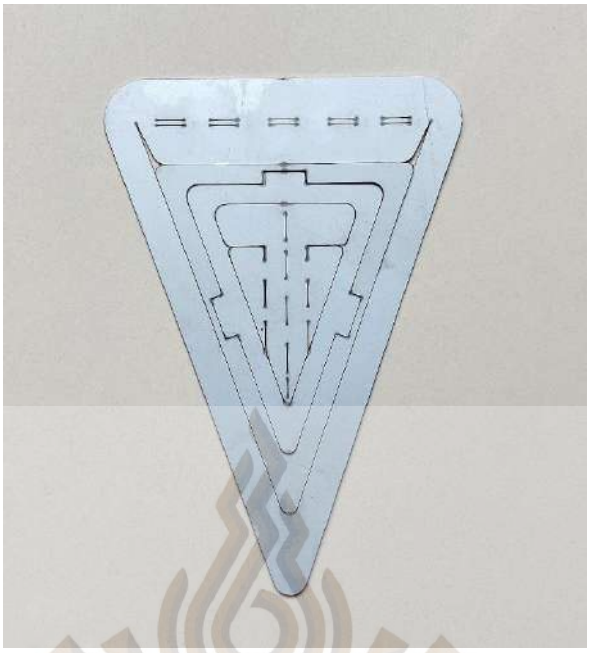

Figure 3.21 Initial protype in Zinc coated aluminium sheets

Source: Researcher

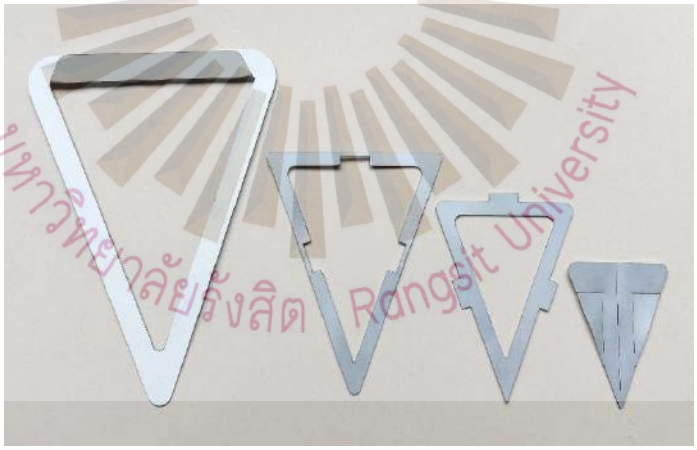

Figure 3.22 Adding dotted cuts to allow bending of sheets

Source: Researcher

Chapter 4

Research Results

4.1 Fundamental Concept of Design

The products are designed with the goal of performing the following functions.

1) the tools assist the user in utilising their resourcefulness.

2) Easy alteration of tools serves more than one function as per the requirements of the user.

3) Reversible alterations allow the tools to be packed in its primary form as 2-D sheets, saving time and storage space, while also allowing cost-effective shipping.

4) The tools provide assistance that promote assembly techniques that are suitable for temporary shelters, as opposed to employing methods that lead to permanent modifications to temporary shelters.

4.2 System Components

4.2.1 The Complete Set

The complete set comprises a handle, a funnel, tags, and clamps (Fig 4.1). Each tool follows the same concept of utilizing corners to carry out their functions. This results in a set of tools that follow the same form, which makes it convenient for flat parking and storage. Additionally, the tools are designed to serve more than one function to reduce the number of tools in one set, that's reducing the weight and use of material, as stainless steel is not a lightweight substitute (Fig 4.2). This also reduces the number of tools the survivors would have to familiarize themselves with.

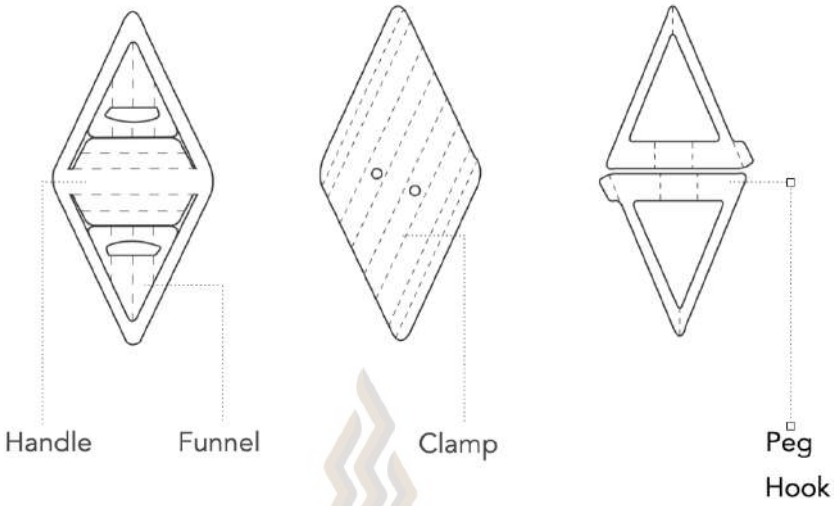

Figure 4.1 Sketch of complete set of tools

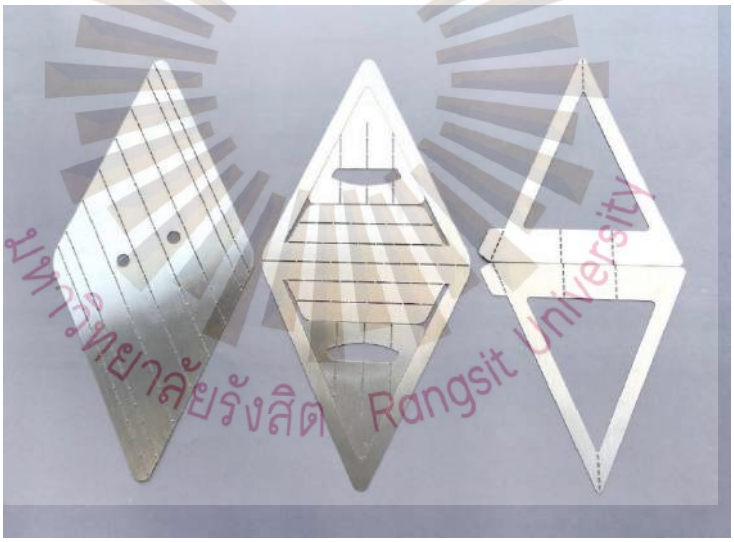

Figure 4.2 Complete set of tools in stainless steel

4.2.2 Handle Tool

The handle can assist survivors in carrying heavy containers, in most cases filled with water, from the collection points to their shelter (Fig 4.3). The midsection folds out to form across the group for a comfortable grasp. The cuts in the group allows the user to bend the handle to suit their comfort (Fig 4.4). Furthermore, the bottom of

the group is laminated with Tyvek sheets, which prevents the shop edges of the cuts to cause harm while being used in carrying heavier containers. The laminating of the tool is a simple process that involves using adhesive spray over metal and then covering it with Tyvek. The process can be easily replicated by the users in the future, should they want to replace the lamination.

Figure 4.3 Handle tool

Figure 4.4 Modification of handle tool

4.2.3 Peg/ Hook Tool

The peg and hook to is a single tool that serves two functions (Fig 4.5). It works by folding the tool over the plastic sheet with a rock or similar objects of similar weight placed inside (Fig 4.6). This allows hanging of plastic sheets from fences and walls (Fig 4.7). The rock acts as a stopper that secures the sheet to the tool. It can be used as a peg that can be driven into the ground (Fig 4.8). This function would be useful when setting up tents in open fields. The pointed end and square head allow the user to either push it into the ground their hands or use their feet of greater force would be required.

Figure 4.5 Peg/Hook tool

Figure 4.6 Modification of peg/hook tool

Figure 4.7 Using peg/ hook tool to hang plastic sheets from walls

Figure 4.8 Use of peg/hook tool on ground

4.2.4 Clamp Tool

The clamp also serves two functions (Fig 4.9). It can be clasped over frames pin the plastic sheets to the structure (Fig 4.10). This avoids the need of tying the plastic sheets or making holes in them to secure them to the frame, prolonging the lifespan of the material. Meanwhile, the two holes in the center can have ropes or cords to help secure the clamp over the frame better.

The centered placement of the two holes in the tool has three goals. First, the ropes or chords go through the center of the clamp. Second, the roots go under the clamp and over the plastic sheets. This minimizes flattering of the sheets due to strong wind and storm and as a result reduces the shifting of the sheets against the tools, which can cause the sheets to tear. To further prevent this, and the dotted cuts at the edge of the clamp are narrow wall to allow the ends to be folded outward and away from the plastic sheets, avoiding contact with it.

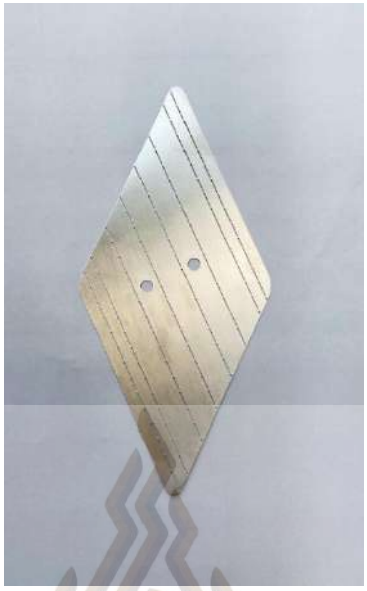

Figure 4.9 Clamp tool

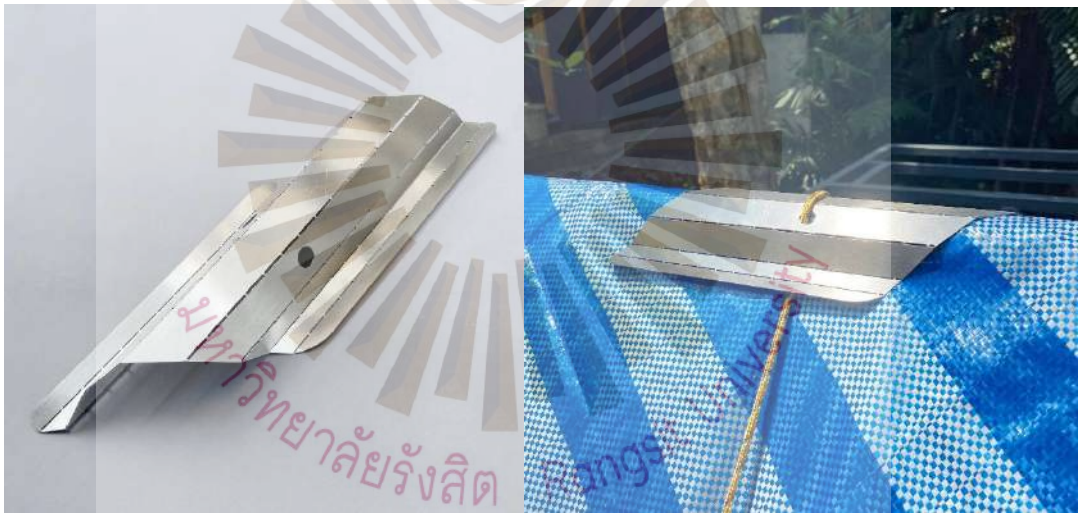

Figure 4.10 Scenarios showcasing use of clamp tool

The same tool can also be used as support for joints where two shorter materials have been tied together to form a longer frame. The quadrilateral shape of the tool proved to be more efficient in avoiding an unsteady joint than any other shape otherwise would. This time, the holes in the tool provide extra support to these joins, by allowing ropes and cords to tie the joint to the clamp (Fig 4.10).

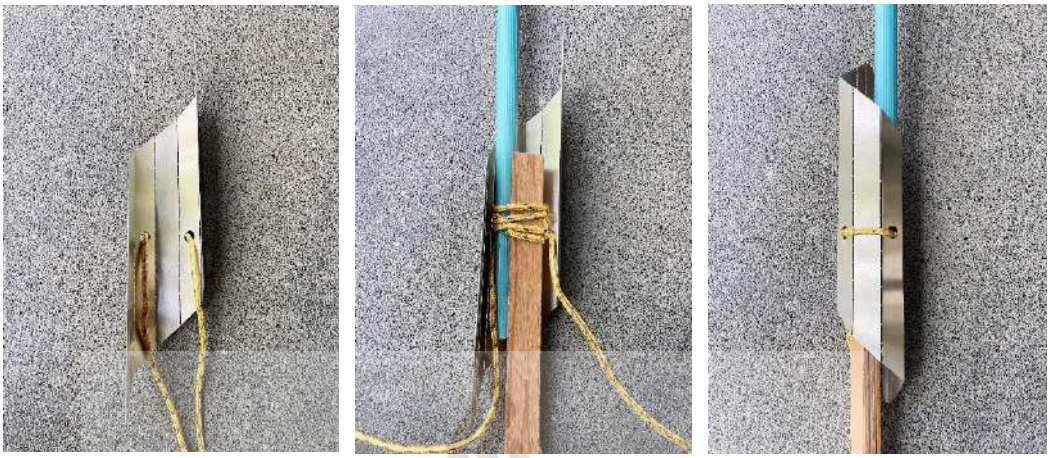

Figure 4.11 Scenarios showcasing additional use of clamp tool

4.2.5 The Funnel

The funnel is the simplest tool in the set that can be used for two purposes (Fig 4.11). It can be fixed at the end of the plastic sheets of the shelter to allow drainage of rainwater, this prevents the rainwater from collecting on the roofs of the shelters. In addition, it can also channel the rainwater into containers so the survivors can collect it for various purposes (Fig 4.12).

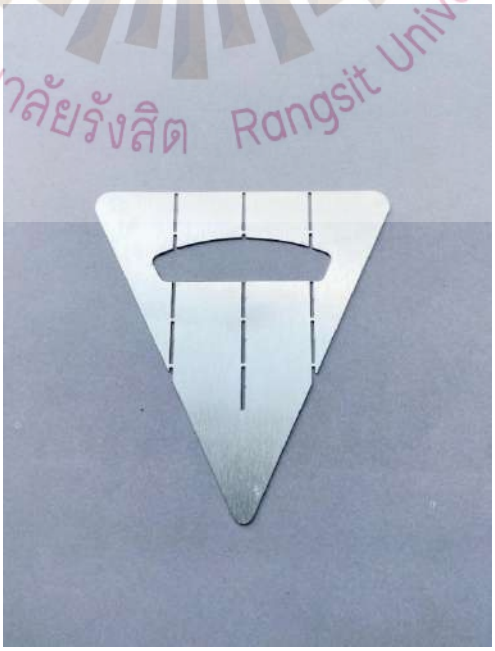

Figure 4.12 Funnel tool

Figure 4.13 Scenarios showcasing uses of funnel tool

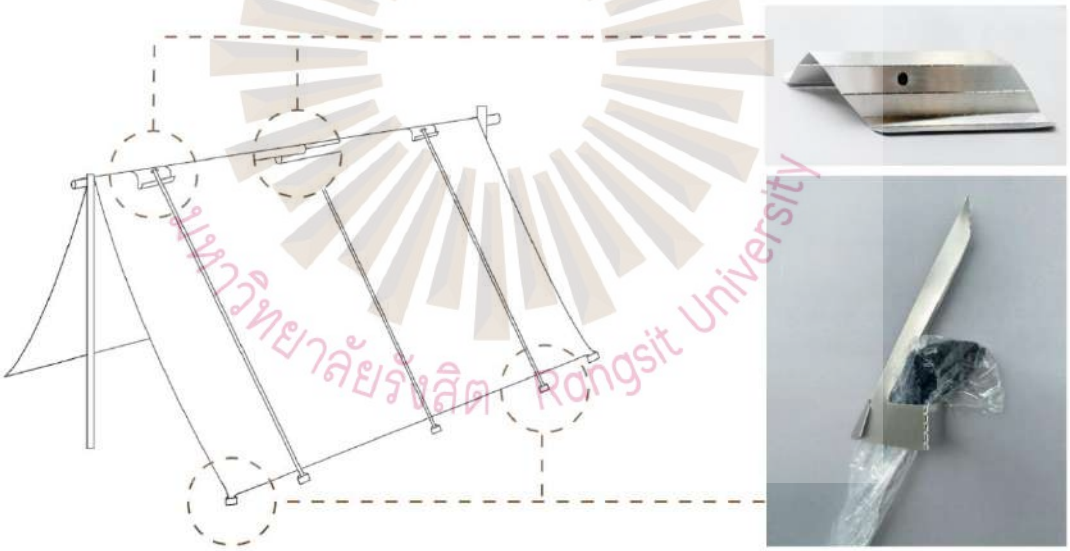

Figure 4.14 Scenario A: Tools can be used for setting up tents in open field

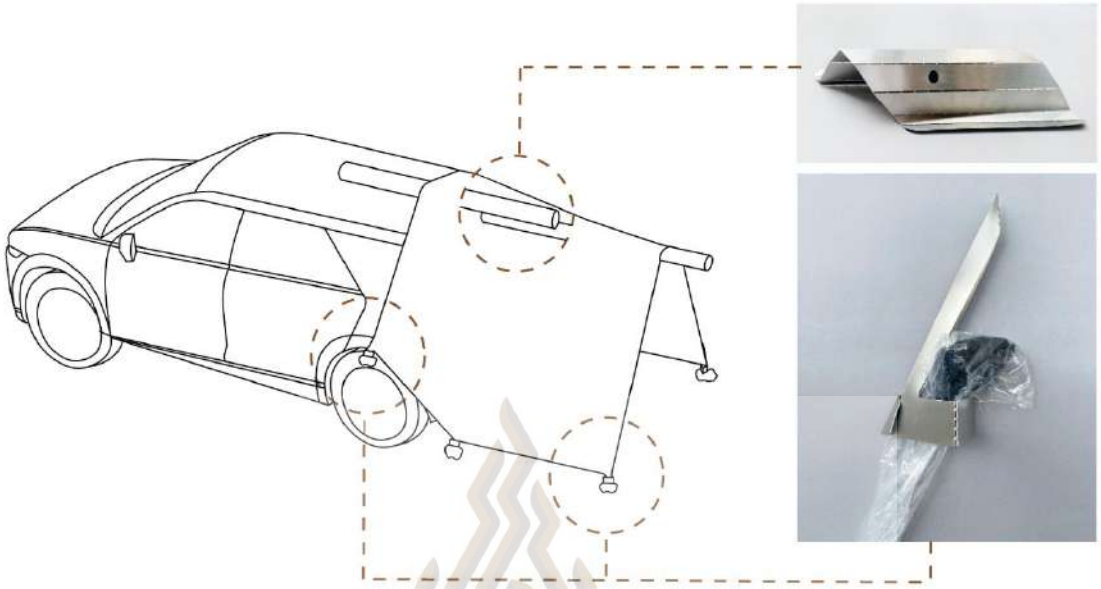

Figure 4.15 Scenario B: Tools can be used to build shelter around vehicles

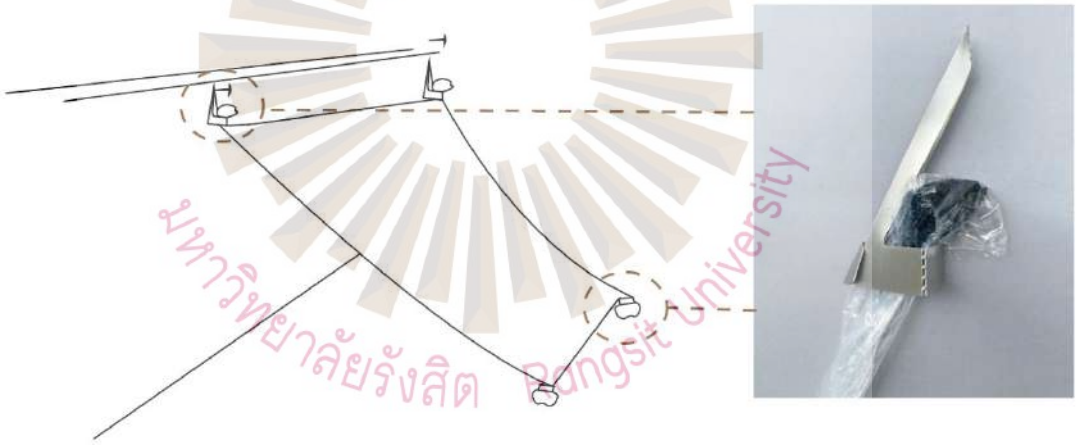

Figure 4.16 Scenario C: Tools can be used for building shelters using walls and fences

Chapter 5

Conclusion and recommendations

5.1 Conclusion

This project is a result of the author's personal experience with a large-scale natural disaster in a poor country and having experienced a series of decisions that it requires the survivors to make. The devastation not only results in loss of property and lives, but it also tests the survivor's ability to solve problems. The instability of a state can further exacerbates the issue, and its incompetence leaves the people feeling helpless.

The purpose of the system is to help people feel in charge of their situation during such occasions, where they can be fully involved in building a temporary space to take safe refuge in, which is the first and crucial part of working towards rebuilding their lives post-disaster.

Survivors would have to build a shelter based on instinct and common knowledge, which means they would have to go through multiple trials and errors until they are able to build a livable space. The tools are a result of observing post-disaster events and decision-making patterns that survivors exhibit. It addresses basic and vital issues of living in temporary spaces and provides the survivors with a system that makes the process of shelter building faster, and their tasks easier.

Furthermore, as survivors begin to familiarize themselves with the system, they may discover more ways in which the tools can be used (Fig 4.16).

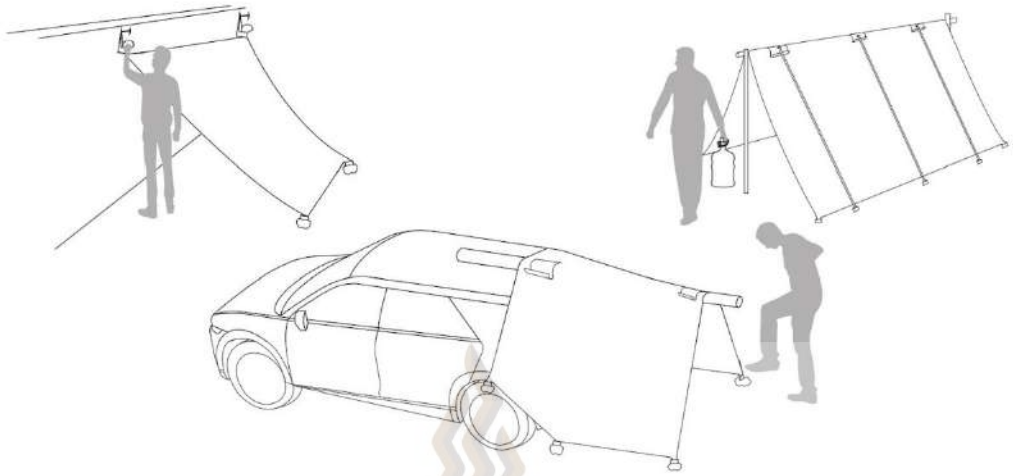

Figure 5.1 Overview of how tools could be used during disaster situations

5.2 Recommendations

There were some noteworthy recommendations that have been made for further improvements to the system.

1) Exploring more materials as a replacement for stainless steel, that might have similar advantages of using stainless steel, but with the additional benefit of being lighter in weight.

2) The sheets could be stamped instead of laser cut during larger production of the products. This avoids sharp edges that result from laser cutting metal sheets.

3) Apart from laminating the tools with Tyvek, one complete set could be packaged using Tyvek sheets, which can be used by the user for various purposes.

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