DISASTER RESPONSE TOOLS FOR SURVIVORS

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ABSTRACT

The inadequate response to disasters in poorer countries results in victims suffering grave repercussions after the impact. Disaster prone areas are under constant threat due to their location, and they face a higher risk in the coming years due to climate change. In comparison to developed nations, the lesser developed countries lack the funds, skills, information, infrastructure, and more importantly, political stability, which hinders their ability to efficiently cope with the challenges of natural disasters and their impacts. As a result of studying case studies, visiting temporary shelter sites and interviewing survivors of large scale natural disasters in underdeveloped nations as method of research, it can be concluded that arranging shelters is a crucial part of post disaster response. In most cases, survivors had to build temporary shelters for themselves until they received aid from private and government organisations. Further analyses of the resourcefulness and creativity the displaced have exhibited in assembling makeshift shelters with the limited provisions available to them has established the need for assistance with these tasks. The final design involves a set of tools that provides assistance to the survivors in arranging temporary spaces, suitable for temporary habitation, while also assisting the survivors with their daily activities within that space.

Keywords: Disaster Shelter, Disaster Management, Temporary Shelter

1. Introduction

On April15, 2015, Nepal was struck by a 7.8 magnitude earthquake (Dey, 2015). It destroyed over half a million homes, leaving millions displaced. Initially, people expected the aftershocks to subside within the first few hours, so they gathered in the nearest open spaces. Without a designated place prearranged, people gathered in parking lots, bus parks, vacant land, and parks. Gradually, as it became evident that the aftershocks would continue for a longer period of time, people started making preparations for temporary shelters for themselves. For the first 48 hours, much of the resources were directed towards rescue programmes and setting up emergency medical tents, while the survivors independently made arrangements for water, food, and shelter. International aid arrived on the third day, which included temporary shelters. However, the number of displaced people exceeded the number of shelters donated by a large margin, so people were compelled to continue to use the makeshift shelters they had arranged for themselves (Buckley & Ramzy, 2015).

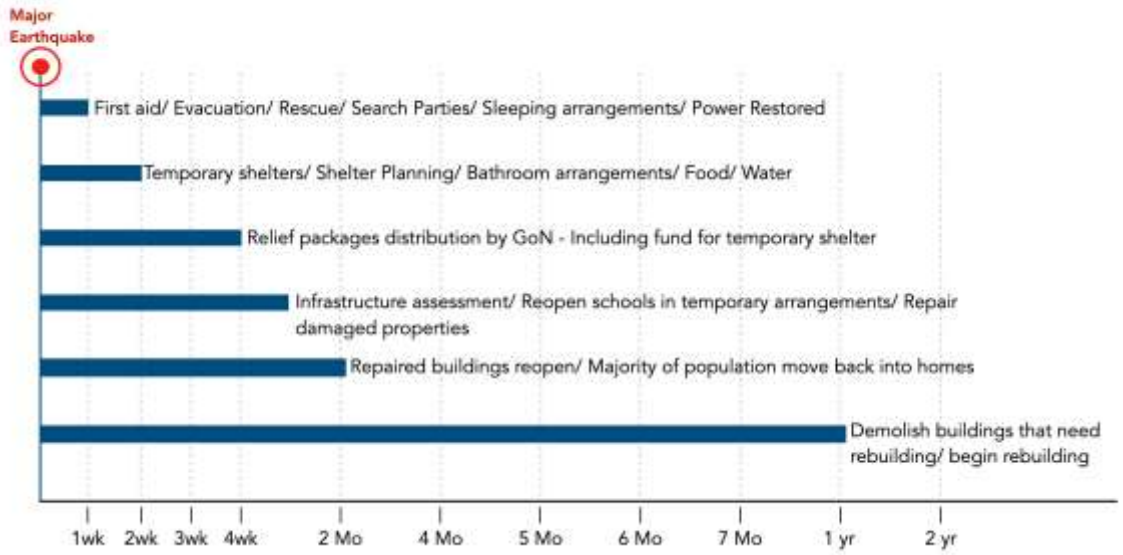

Figure 1 Timeline of events

By the second week (Fig. 1), the larger portion of the population that was not provided with temporary shelters had made additional modifications, including bathroom arrangements and storage spaces, to their improvised structures for a more reliable refuge. These temporary structures were required to serve as short term living spaces where people could recover from the event and focus on rebuilding their lives. Within 2 months of the event, damaged buildings were assessed, after which people were instructed to move back into their homes, and the inhabitants of severely damaged buildings that required renovations or reconstruction were instructed to arrange a more permanent accommodation for themselves.

Although the 2015 earthquake was the second big quake within 100 years in Nepal, the country was highly unprepared for the imminent event. Nepal is located in one of the most tectonically active mountains, which puts it at constant risk of repeated quakes of large magnitude. Despite the certainty of large earthquakes, the government and public remained uninformed and therefore unprepared. Apart from a lack of information, as a poor nation, Nepal lacked the funds and infrastructure to devise proper protocols to provide help to its people, and its political dysfunction interfered with the efficient distribution of international aid. As an underdeveloped nation, Nepal was more vulnerable due to its instability.

Asia-Pacific nations experience more natural disasters than other parts of the world (Fig. 2) (ESCAP, 2015). The region is characterised by continuous tectonic plate movements that result in earthquakes and Tsunamis, and its location makes it prone to cyclones and typhoons (ESCAP, 2015).

Figure 2 Disaster prone regions

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 far better prepared for such events. Japan's geological location and topographical features make it susceptible to earthquakes, typhoons, and tsunamis. However, because Japan has faced many disasters over the years that have had sa ignificant impact, the country has been investing its resources and efforts into reducing the risk of disasters over the years (Abe, 2015). People are informed about evacuation sites designated by local authorities. These areas are usually community centres, 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, the 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 organise its fair distribution. In cases with large scale impact, there aren't enough donated shelters for all families, 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).

2. Objectives of the study

This thesis proceeds in two steps concerning temporary shelters for immediate evacuation and short-term refuge for victims of natural disasters.

2.1 Examining disaster responses in various underdeveloped regions in Asia-Pacific nations. Determining shelter requirements, problem areas and neglected factors through case studies on existing solutions, and looking at various improvised approaches employed by the victims with provisions supplied to them by authorities for shelter arrangements.

2.2 Devise a system that can assist the victims in assembling a temporary structure that can provide them with a reliable refuge, where they recover and focus on rebuilding their lives.

3. Materials and methods

3.1 Identify Refuge Location

Detecting the location where people tend to flee is crucial, as it determines the kind of shelter they will be making arrangements for. It also supplies us with other crucial information, including, the level of security, available resources, and access to provisions.

3.2 Determine Crucial Activities

Post-disaster, survivors, the state, and organisations will prioritise needs that need to be taken care of first, to ensure the safety and well-well-being of people before they proceed to then focus on rebuilding their lives and returning to normalcy.

3.3 Observe the Resourcefulness Of Survivors.

In the process of building makeshift shelters for themselves, Survivors have exhibited resourcefulness and creative problems solving skills. Their personal involvement allows them to identify problem areas and experiment with various solutions until they employ the most successful method. Since they learnt from experience, the solutions are simple and straightforward.

4. Results and discussion

4.1 Observation results

Survivors of natural disasters were found to flee to three common locations for safety. First, Open spaces near their homes, that might be vacant land or within their own property. This option may not allow further modifications to the shelter as some vacant properties might be privately owned. A shelter that does not require permanent installations is suitable for this option, so there are no damages to the property (Fig 3). Second, Parking lots and similar spaces that are not vacant, but can provide temporary spaces where they can take shelter. These spaces may not have grounds that can be dug, and may be paved, which limits shelter options (Fig 4). Third, Open fields and parks that

are public property and can be used as a long term location to accommodate survivors. These areas can accommodate more shelter options as survivors may be able to erect poles or timber for a larger shelter frame.

Fig 3 Open spaces near damaged homes

Fig 4 Taking shelter in parking lots

Fig 5 Taking shelter in parking lots

The first day after a disaster occurs, the first form of help provided is a supply of water. In poorer countries, this is usually undertaken by private organisations. The survivors are required to gather in designated areas, collect the water and carry them back to their shelters (Fig 6). They would either receive large containers of water, or would have to bring their own container. Following this, within a week, these organisations make hasty arrangements to provide survivors with food and plastic sheets for their shelter. These packages are packed in haste, so they are packed in plastic bags and sacks. This would also be distributed at designated locations, where survivors would collect them

(Fig. 7). By this time, survivors also receive plastic sheets and tarpaulins from their government to build their own shelters. Although international aids provide temporary shelters, these donated shelter would not be sufficient for all survivors of large scale disasters (Fig 9).

Fig 6 Water collection point sheets

Fig 7 Supplying food and plastics

Fig 8 Government supplying plastic sheets for shelter

When left to make arrangements with these limited provisions, survivors exhibited remarkable resourcefulness. They salvaged materials from damaged buildings in order to build frames for shelters (Fig 9) and in some cases built shelters using their vehicles (Fig 10), walls and fences (Fig 11) for support. Shelter frames are also spotted to have two smaller pieces of wood or water pipes tied together to form a longer frame (Fig 13), since options are limited when materials are salvaged from the destruction. When the temporary spaces have been inhabited for over a

week, survivors start making modifications in order to make their shelters more secure. Common practices are, placing logs and rocks over the structure to ensure the shelter can withstand wind and storms. This is also done in order to avoid making holes in the plastic sheets so the plastic sheets can last longer.

Fig 9 Salvaging materials from destroyed buildings

Fig 9 Shelters in vehicles

Fig 10 Shelters against fences and walls

4.2 Designing a system

Based on this information and research, a set of tools can efficiently assist the survivors in making shelter arrangements and make their activities in that space less challenging. The tools aid the survivors in carrying out the identified tasks, as this seems to be the pattern in which they respond to disaster situations. Accordingly, these tools are designed to be straightforward, so the survivors are able to save time and effort, and are intended to be delivered to the survivors in the form of sheets in order to save space.

3.5 Development of design through prototyping

The simplest task of carrying water was the initial starting point. A generic water container handle is stripped down to its basic necessary features, which are its corners (Fig 11). This leaves us with a sample triangle, with three sharp corners. The tapered point of the corner fixes the bottle in position, this ensures a tight fit for the bottleneck. The widening of the angle as you move further away from the corner allows the handle to accommodate bottlenecks of varied sizes (Fig 12).

Fig 11 Basic necessary features of handle

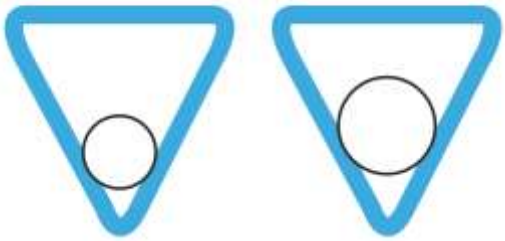

Fig 12 Widening angle accommodates varied sizes

When wedged in between two corners of two separate triangles that are being pulled from either end, the arrangement provides a tighter fit which can make it possible for the survivors to carry containers that are larger and heavier (Fig 13).

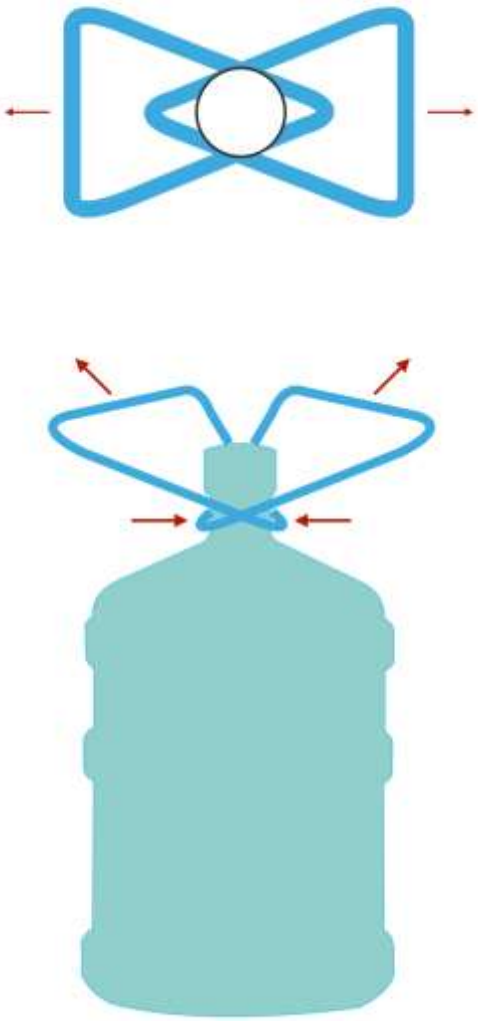

Fig 13 Container wedged in-between two separate triangular handles

The two separate triangles form one continuous loop, at the same time providing a handle for the tool which makes it easier to lift heavier containers for longer distances (Fig. 14).

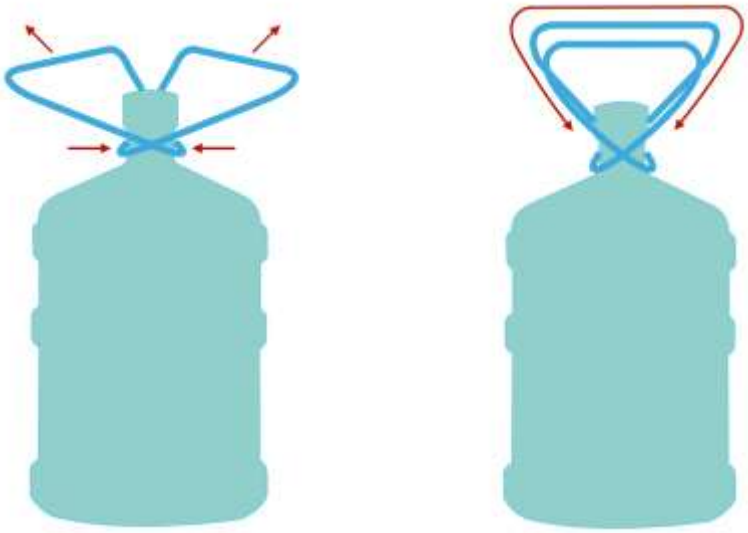

Fig 14 loops of the tool serves as a handle

The prototypes are laser cut out of zinc sheets, a cost effective substitute for stainless steel, to work out the required thickness, size and choice of cut that would be ideal for the function it is intended to carry out. The final prototype, before the final product on stainless steel, is laser cut out of 0.7 mm zinc sheets (Fig 15). The choice of material for the final product, stainless steel, lasts longer than the temporary space it assists survivors to assemble, so they can be pulled apart from the shelter and stored to be used again in the future for similar situations.

Fig 15 .7mm Zinc sheet prototype

4.3 The complete set

The complete set comprises a handle, a funnel, pegs, and clamps. Each tool follows the same concept of utilising corners to carry out their functions. This results in a set of tools that follow the same form, which makes it convenient for flat packing and storage (Fig 16). Additionally, the tools are designed to save more than one function

to reduce the number of tools in one set, thus reducing its weight and use of material, as stainless steel is not a lightweight substitute. This also reduces the number of tools the survivors would have to familiarise themselves with.

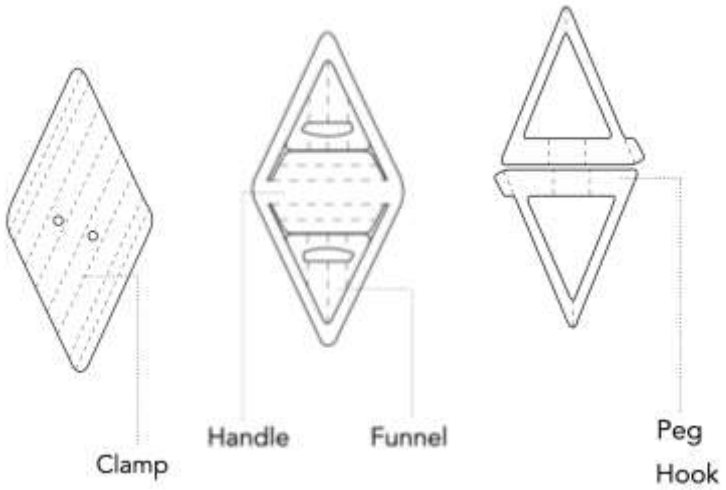

Fig 16 Complete set of tools in sketch

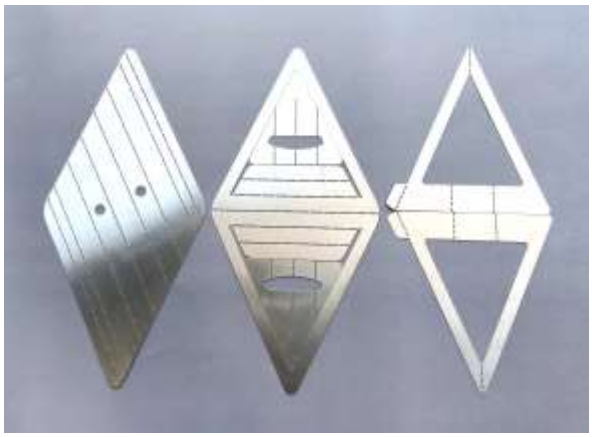

Fig 17 Complete set in stainless steel

The handle can assist survivors in carrying heavy containers, in most cases filled with water from the collection point to their shelter, the mid-section folds out to form a curved grip for a comfortable grasp (Fig 18). The cuts in the grip allow the user to bend the handle to suit their comfort. Furthermore, the bottom of the grip is laminated with tyke sheets, which prevents the sharp edges of the cut to cause harm while being used in 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.

Fig 18 Handle tool

The Peg and hook is a single tool that serves two functions. It works by folding the tool over the plastic sheet with a rock or similar objects of similar weight placed inside it. The rock acts as a stopper that secures the sheet to the tool (Fig 19). It can be used as a peg that can be driven into the ground. This function would be useful when setting up tents and similar shelters in open fields. The pointed end and square head allow the user to either push it into the ground with their hands or use their feet if greater force is required (Fig 20).

Fig 19 How the peg and hook tools work

Fig 20 Two functions of peg and hook tools

The clamp also serves two functions. It can be clasped over frames to pin the plastic sheets to the structure. 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 centre can have ropes or cords to help secure the clamp over the frame better (Fig 22).

Fig 22 Clamp tool

The centred placement of the two holes in the tool has three goals. First, the ropes or cords go through the centre of the clamp. This avoids distorting the cupped shape of the clamp. Second, The ropes go under the clamp and over the plastic sheets, which minimises fluttering of the sheets due to 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, the narrow lines of cut ends of the clamp are intended to allow the ends to be folded outward and away from the plastic sheets (Fig 21).

Fig 21 Clamp over shelter frames

The same tool can also be used at as support for joints where two shorter materials have been tied together to form a longer frame. The 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 joints. By allowing ropes and cords to tie the joint to the clamp (Fig 22).

Fig 22 Support for joint

The Funnel is the simplest tool in the set that can be used for two purposes. It can be fixed at the end of the plastic sheets of the shelter to allow the draining of rainwater, this avoids 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 in containers. The collected rainwater can be used for washing and cleaning purposes in such spaces (Fig 23)

Fig 24 Funnel tool

6. Conclusion

This project is a result of having personally experienced a large scale natural disaster in a poor country and having experienced the 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 a survivor's ability to solve problems. The instability of a state can further exacerbate the issue, and its incompetence leaves the people feeling helpless.

The purpose of this 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 their 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 liveable 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 familiarise themselves with the system, they may discover more ways in which the tools can be used.

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References

Alfred. C. (2017). *Why IKEA's Award-Winning Refugee Shelters Need A Redesign*. Retrieved November 27, 2022, from https://deeply.thenewhumanitarian.org

Araki, Y., Tsuboi, S., Hokugo, A., (2020) Patterns of emergency shelters in coastal plains a case study after the great east Japan Earthquake and Tsunami in Higashi-Matsushima City. *Journal Of Architecture And Planning,* 2020*,* 3, 552-563.

Asad, K, M., (2021). When disaster strikes, developing countries still too vulnerable. Retrieved November 20, 2022 from https://news.un.org

Bashawria, A., Garritya. S., Moodleya. k., (2014) An overview of the Design of Disaster relief Shelters. *Procedia Economics and Finance*. (in press)

Bhagat, P., (2015) *An Earthquake Exposes Nepal' s Political Rot*. Retrieved November 15, 2021, https://foreignpolicy.com

Buckley, C., Ramzy, A., (2015). Frustration grows in Nepal as earthquake relief trickles in Retrieved November 20, 2022 from https://www.nytimes.com

Crutchfield, M., (2013). *Phases of Disaster Recovery: Emergency Response for the Long Term*. Retrieved October 19, 2021, from https://reliefweb.int

Dey, S., (2015). A devastating disaster: A case study of Nepal Earthquake and its impact on human beings. *IOSR Journal Of Humanities And Social Sciences*, 20, 28-34.

Félixa. D., Brancob, J,M., Feioa, A., (2013) Temporary housing after disasters: A state of the art survey. *Habitat international.* (in press)

Harzani, S., Harzani, B, E., (2020) Disaster Relief Shelters| Design Strategies & Impacts on AffectedCommunities, A Thesis for the Degree of Bachelor in Architecture, Planning and Surveying. University Teknologi Mara

Kim, S, E., Li, H, M, D., Nam, J., (2015). *Overview of Natural Disasters and their Impacts in Asia and the Pacific*, ESCAP. Retrieved November 15, 2022, from https://www.unescap.org

Mu Chen, M., (2021), *"Temporary" Housing to Heal: A Missing Piece of Post-Disaster Community Psychosocial Resilience Building*. Retrieved November 23, 2021, https://www.diva-portal.org

Rudofsky, B. (1964). *Architecture without architects, an introduction to nonpedigreed architecture*. New York: The Museum of Modern Art Wilkins, M., (2018). *More Recycling Won't Solve Plastic Pollution*. Retreived November 9, 2021, from https://blogs.scientificamerican.com/

Zhang, W., Wu, J., Yun, Y., (2019). Strategies to increase the accessibility of tsunami shelters enhances their adaptive capacity to risks in coastal port cities: The case of Nagoya city, Japan. *Natural Hazards and Earth System Sciences,* 19, 927-940.