EMERGENCY SHELTER DESIGN FOR DISASTER PREPARATION

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Abstract. Indonesia is geographically a country located in an area that is often subject to natural disasters. As a result of natural disasters that damaged residents homes, many people lost their homes and needed temporary shelter to evacuate. However, shelters in practice are often inappropriate and have poor quality and are late or come in damaged condition. The purpose of this study is to develop an emergency shelter spatial design that functions for disaster emergencies. In this study the method used is a qualitative research method with a descriptive approach, this method aims to describe the conditions that currently apply, in order to understand more deeply the needs of disaster victims who are displaced in shelters that are currently being used in the field. Based on several theories used, conclusions will be drawn to become a tool in the analysis. The objects to be observed are several emergency shelter units that were used in the latest disaster, the disaster in Palu, Information and data will be obtained through interviews and field observations accompanied by documentation. This research shows that emergency shelters currently in the field do not yet have spatial functions that can fulfill activities and accommodate disaster victims’ activities well. The results of this study are three alternative plans that have been adapted to the needs of space and function in accordance with the activities and activities of disaster victims in Palu in order to create the expected comfort and privacy. Suggestions for layout and emergency shelter space requirements are manifested in the form of tables and floor plans.

1. Introduction
In general, Emergency Shelters are made of textile or plastic sheets, which is the simplest form of Emergency Shelter provision, this is still accepted by victims of the disaster but serious refugee problems cannot be solved like; Lack of adequate protection, The time span between the disaster and the provision of shelter is too long, Emergency Shelter life is short. In addition, shelters are also uncomfortable to use due to ventilation problems, air, the temperature in the tent and the height of the shelter is limited to standing [1]. When the shelter like this is used for a longer period than expected, it causes the situation and mental disaster victims will be destroyed, because the shelter will become inhumane. Ideally, a place of refuge is not only limited to providing a place to sleep, but also fulfilling other living needs.
The collapsed tent is a clear proof of the weakness of the tent's evacuation contractibility. Tents can collapse due to faulty installation of tents or tent designs not in accordance with the climate of Indonesia with high rainfall, both of which relate to human error. As a result of the collapsed tent, repairs must be done, which will cause delay, or even have to bring back a new tent, which of course has an impact on costs [2].

![Collapsing Shelter Tent in Toraja Indonesia](https://gosulsel.com/2016/03/08/pengungsilongsor-di-torut-keluikan-tenda-dari-bpbd/Accessed28Sep2018)

**Figure 1.** Collapsing Shelter Tent in Toraja Indonesia
(Source: https://gosulsel.com/2016/03/08/pengungsilongsor-di-torut-keluikan-tenda-dari-bpbd/ Accessed 28 Sep 2018)

Victims of the earthquake and tsunami disaster in Palu Indonesia, complained about the lack of refugee tents from BNPB besides complaining that emergency tents could not fulfill their needs and activities such as Bath, wash, toilet activities and personal activities. Tents that are not in accordance with the needs of disaster victims become a clear proof of the weakness of the design of the tent as an evacuation site [3].

![PNPB Evacuation Tent lacks for victims of the Palu disaster](https://www.bbc.com/indonesia/indonesia-45729112 Accessed 28 Sep 2018)

**Figure 2.** PNPB Evacuation Tent lacks for victims of the Palu disaster
(Source: https://www.bbc.com/indonesia/indonesia-45729112 Accessed 28 Sep 2018)

Therefore, there needs to be an analysis to look for an ideal layout plan design from a disaster emergency shelter that can accommodate the needs and activities of disaster victims and can create decent and dignified living conditions for refugees in post-disaster Emergency Shelter in Indonesia.

**Material and Methods**

2.1 *Method*

Design is the optimal solution for the number of actual needs in a particular situation. [4]. Design is the process of designing a program of activities that aims to change the situation to be a better situation [5].

In designing buildings must involve all five elements of the arrangement. The five elements are: Function, Space, Geometry, Link and Scope [6]. In organizing activities using a way of grouping based on general functions with similarity in quality and organization of activities according to their work sequence [6]. The success of a building design depends on how the activity is organized, which in turn is determined by the quality of the activities used as the basis for organizing. Activities have many qualities that can be used to organize these activities based on their relationship with one another [6].
The design of temporary shelter must be adjusted to the location and response. What might be a good solution in one location might not work in another. However, one important feature of temporary shelters is that temporary shelters can be moved, can be upgraded and that materials can be reused [7].

Residential units must provide protection from the weather, sleeping accommodations, space to live and store belongings, privacy and security. While the basic needs for shelters are similar in most emergencies [8].

Proper Shelter design is intended to create a friendly, intimate environment that can facilitate the recovery process of disaster victims through its inhabitants [8].

The appropriate shelter design must reflect user needs, local culture, vulnerability and the capacity of people affected by the disaster and available resources [9].

In designing shelters, users must have enough enclosed space to provide accommodation properly. Important evacuation activities should be done comfortably, and livelihood support activities can be carried out as needed. Minimum closed space is 3.5m² / person [10].

The design of a shelter must be acceptable to the affected population and provide sufficient thermal comfort, fresh air and climate protection to ensure their dignity, health, safety and well-being [11].

From the various opinions above it can be understood that in designing emergency shelters must recognize its users and their needs as well as the character of the weather and its locale. Because the design of the emergency shelter can be said to be feasible when the shelter can reflect and meet the needs, local culture, resilience and capacity of victims affected by the disaster [9]. Therefore, the design of the emergency shelter must be adjusted to the location and response, because an emergency shelter that might be a good solution in one location might not be able to function properly in another [7].

In this study the method used is a qualitative research method with a descriptive approach, this method aims to describe the conditions that currently apply, in order to understand more deeply the needs of disaster victims displaced in shelters that are currently being used in the field. The main material that will be discussed in this study is the Spatial Planning of the Emergency Shelter from 1. Space requirements. 2. Privacy and spatial planning, so that it can produce an emergency shelter design that suits the needs in the field and can create a sense of security and comfort in serving users namely disaster victims.

The design method in this study covers the three stages of the design method without the fourth stage, namely, application (see Figure 3). It starts with the first two stages of the design method, the discover phase and the planning Phase. Both of these stages are useful for getting to know the client and his needs as well as collecting data relating to emergency shelters that will be designed to become familiar with the situation through observation and analysis. The discover process is assisted by the qualitative method mentioned above but for the planning process it will be carried out by means of analysis, in order to determine the design guidelines to be used.

![Figure 3. Basic stages of design method.](Source: Eric Karjaloutu, The Design Method, 2014: 63)
The object to be observed is the emergency shelter unit that was used in the last disaster, the disaster in Palu Indonesia. Information and data will be obtained through interviews and field observations accompanied by documentation. Furthermore, conclusions will be drawn from existing data, so that the nature and criteria in designing an emergency shelter can be used as a reference or guideline to produce an appropriate emergency shelter floor plan design and in accordance with the needs of disaster victims in Indonesia.

The results of the data collected and analysed from the two initial stages of the design method mentioned above will be the basis for continuing the third stage of the design method, namely the creative stage. Where in this stage will explore conceptual options and potential design directions so as to create an emergency shelter floor plan design that best suits the needs in the field.

2.2 Case Study
This research selects the emergency shelter object located in Central Sulawesi precisely in Palu City, the object will be used as a comparative study in determining the needs of disaster victims and the feasibility of an emergency shelter.

The object chosen in this study was an emergency shelter donated by local assistance, this emergency shelter was used by victims of the affected Palu disaster, the shelter was a Shelter from PKPU Human Initiative.

![Figure 4. Shelter from PKPU](Source: Documentation via Arin Aurizal 10 November 2018, Palu)

Shelter from PKPU is located in the village of loli pesua Dongala Palu, this shelter was brought in by an association called PKPU Human Initiative as a donation for victims of the Palu disaster, these shelters come in the form of plastic sheeting/tarpolin coming from local sources and CRS-USAID. Then it was built by a technical team from PKPU and the assistance of the army as well as the interference of residents and children and hence the emergency shelter was named the Smile House (Rumah Senyum). This emergency shelter is 24m2 in size, the room of this emergency shelter consists of two rooms and one terrace. The first room measuring is 4m x 3m, and the second room measuring is 3m x 3m, a terrace room measuring is 3m x 1m, used for outdoor activities such as gathering, relaxing or cooking outside.

Based on the results of interviews and field observations, it can be concluded that the basic needs of disaster victims in evacuating in emergency shelters include: 1. Resting needs include: a. Sleep and lie down. 2. Gathering needs that cover: a. Sit. b. Eat. c. Socialize. 3. Personal needs which include: a. Store goods and food. b. Get dressed. c. Reading and writing. d. pray.

3. Result and Discussion
At the shelter of PKPU, there are two rooms that serve different functions, such as room number 1 which is 3x4 in size, where this space is used as a gathering room, carrying goods and doing other activities, room number 2 which is 3x3 size is used for resting and sleeping activities. It can be seen that this shelter has two rooms with different functions but the function of each room is still mixed and serves a variety of different activities where this causes visual loss of privacy between family members who live simultaneously in this shelter, thus causing disruption to comfort which is one of the important invoices in the recovery process for disaster victims. It can be seen that this shelter has
not been able to accommodate all the needs and activities of users properly where there is a mixture of activities. This problem is caused by this shelter that does not have a good arrangement of spatial planning and space requirements. Some activities cannot be carried out in this shelter because the division of space is not appropriate. With an area of 24 m², this shelter should be able to serve up to 6 people well to live in this shelter simultaneously.

![Shelter spatial planning from PKPU](image)
(Source: Documentation via Arin Aurizal 10 November 2018, Palu)

In designing a shelter, it must recognize the needs and spatial activities of users, namely disaster victims, so that the shelter can support daily activities and respond to the needs of residents. The occupants of this shelter on average consist of 3 to 6 occupants, based on the standard area of the area for shelters Corsellis, Vitale and UNHCR are: Shelters must be a closed space of 3.5 m² / person, in tropical and warm climates not including cooking or kitchen facilities. Or - 21 m² for a family of 6 people. Based on the needs in the field, the most ideal area will be found according to ergonomic data.

| NO | TYPES OF NEEDS  | AREA/PER | AMOUNT OF MAX USERS | TOTAL AREA |
|----|----------------|----------|---------------------|-----------|
| 1  | Resting needs  | 2.6 m²   | 4                   | 10.4 m²   |
| 2  | Gathering needs| 1.17 m²  | 4                   | 4.68 m²   |
| 3  | Personal needs | 0.54 m²  | 4                   | 2.16 m²   |

**Total Area for 4 person** 17.24 m² *(13.5)*

| NO | TYPES OF NEEDS  | AREA/PER | AMOUNT OF MAX USERS | TOTAL AREA |
|----|----------------|----------|---------------------|-----------|
| 1  | Resting needs  | 2.6 m²   | 5                   | 13 m²     |
| 2  | Gathering needs| 1.17 m²  | 5                   | 5.85 m²   |
| 3  | Personal needs | 0.54 m²  | 5                   | 2.7 m²    |

**Total Area for 5 person** 21.55 m² *(17)*

| NO | TYPES OF NEEDS  | AREA/PER | AMOUNT OF MAX USERS | TOTAL AREA |
|----|----------------|----------|---------------------|-----------|
| 1  | Resting needs  | 2.6 m²   | 6                   | 15.6 m²   |
| 2  | Gathering needs| 1.17 m²  | 6                   | 7.02 m²   |
| 3  | Personal needs | 0.54 m²  | 6                   | 3.24 m²   |

**Total Area for 6 person** 25.86 m²

(Source: Personal Data, 2019)

The results of the analysis of space requirements in table 1 show that, the most ideal area for resting at a shelter with a capacity of 6 people is 15.6m², a shelter with a capacity of 5 persons is 13m² and at a shelter with a capacity of 4 people is 10.4m². For gathering activities, the results of the analysis show that, the most ideal area at a shelter with a capacity of 6 people is 7.02m². and in a shelter with a capacity of 5 people is 5.85m², then in a shelter with a capacity of 4 people is 4.68m². Whereas for private activities the results of the analysis show that, the most ideal area in a shelter with a capacity of 5 people is 5.85m², then in a shelter with a capacity of 4 people is 4.68m². Therefore for private activities the results of the analysis show that, the most ideal area in a shelter with a capacity of 6 people is 3.24m² and in a shelter with a capacity of 5 people is 2.7m², then in a shelter with a capacity of 4 people is 2.16m². With the area and space requirements as mentioned above, it is expected that all the needs of disaster victims to evacuate have been addressed, so that shelters can serve disaster victims well. And there is no mixing of activities that cause spoilage and loss of comfort.
In order to achieve the expected level of privacy, each room must be able to perform its functions properly, and the amount of space must already cover the needs and capacity of users. According to White, function, space, links and scoping are one of the elements of spatial arrangement that influence each other to determine the type of activity and group, so as to produce the space needed for activities contained in the field. Therefore, it is necessary to classify activities based on the needs that occur in the field, so as to find the most appropriate plan for elaborating floor plans to serve disaster victims. In this study the activities carried out in the field are included in a diagram that divides them depending on the level of privacy of the activity and whether the activity can be done in an outdoor or indoor area, so the results can illustrate the pattern of activities that require the same type of space.

The results of the privacy analysis and spatial planning above show that activities (intimacy, dressing, sleeping, worship and reading writing) are covered by the bedroom because these activities have a pattern that requires the same type of space. But for activities such as (learning, gathering, eating, socializing, playing, cleaning and cooking washing) are covered by the main room because these activities have patterns that require the same type of space. The two rooms above are in the indoor section, but for the outdoor section there are several activities that have a pattern that requires the same type of space as (socializing and trading).

The design recommendations based on the above analysis will be presented in the form of several alternative design plans, namely for type 4 people, 5 people and 6 people according to the area needed by each shelter. Some of these alternatives will be compared to get the most appropriate floor plan and have a good level of privacy (see Figure 7).
Each alternative in Figure 7 consists of three types of floor plans, which are plans for 4.5 and 6 people, but the difference in each floor plan is in spatial planning and privacy quality. All floor plans are equipped with bedrooms, luggage storage rooms, main rooms, entrance areas, personal storage and terraces outside the shelter. The layout of each shelter has optimized spatial planning in a very limited space with different qualities of privacy and spatial planning. But each plan has advantages and disadvantages, these advantages and disadvantages will be translated into points.

Based on the results of the privacy analysis and spatial planning above, it can be summarized that, the most ideal and appropriate design to maintain user privacy through good spatial planning is the design of alternative 4, which consists of 3 types of floor plans, namely, shelter plans with sizes 4, 5 and 6 people, although there are still some shortcomings that can be considered minimal.

The results of the three plans show that, the space that has been arranged according to the function, activities and the number of victims can meet and serve the needs and activities of the user, namely disaster victims well while still maintaining the privacy of the residents, namely disaster victims. Presenting a wealthy and proper life for disaster victims is one of the basic shelter tasks, so that victims can recover and psychological feelings through staying in the shelter.

**Figure 7.** Comparative analysis of privacy and comfort of the Shelter floor plan.
(Source: Personal Data 2019)
Figure 8. The results of the Shelter Plan Design with a capacity of 4, 5 and 6 people.
(Source: Personal Data 2019)

4. Conclusion
From research and observation and analysis of emergency shelter space can be concluded as follows:
1. Emergency shelters currently in the field do not yet have a space function that can properly fulfill activities and accommodate disaster victims’ activities.
2. Spatial needs in emergency shelters currently in the field are not yet in accordance with the space needs and activities of disaster victims.
3. Emergency shelters in the field do not have privacy for shelter users / disaster victims.
4. The emergency shelter does not currently have a good spatial layout so that one family of a displaced disaster uses a space for various activities simultaneously this eliminates the privacy and comfort of disaster victims.

The three alternative floor plans above have been adjusted to the needs of space and function in accordance with the activities and needs of disaster victims in Palu Indonesia in order to create the expected comfort and privacy. Suggestions for layout and emergency shelter space requirements are manifested in the form of tables and floor plans above. It is hoped that the floor plan and space requirements can be a guide in the design of local emergency shelter plans in the future.

References
[1] E. P.A., A. M.K. and B. E.R.P, "Innovative Shelter for Disasters," Shelter Research Group, Dept. of Arch, Bldg & Planning, Eindhoven University of Technology, pp. 97-110.
[2] gosulsel, "gosulsel," 28 September 2018. [Online]. Available: https://gosulsel.com/2016/03/08/pengungsi-longson-di-torut-keluhkan-tenda-dari-bpbd/. [Accessed 28 September 2018].
[3] A. Utama, "www.bbc.com," 4 October 2018. [Online]. Available: bbc.com/indonesia/indonesia-45729112. [Accessed 28 September 2018].
[4] J. C. Jones and J. Wiley, "Design Methods: seeds of human futur," John Wiley & Sons Ltd, 1998.
[5] H. A. Simon, STUDIES OF DECISION-MAKING LEAD TO PRIZE IN ECONOMICS, United States: The Royal Swedish Academy of Sciences, 1978.

[6] E. T. White, Tata Atur: Pengantar Merancang Arsitektur, Bandung: ITB Bandung, 1986.

[7] G. Saunders, Transitional Shelters-Eight Designs, Geneva: International Federation of Red Cross and Red Crescent Societies, 2011.

[8] J. Lundgren and F. T. Carboni, From Emergency Shelters to Homes: Design of paperboard housing exploring living conditions in post-disaster settlements, Gothenburg: Chalmers University of Technology, 2014.

[9] G. Saunders, Post-disaster shelter: Ten designs, Geneva: International Federation of Red Cross and Red Crescent Societies, 2013.

[10] S. Association, The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response, Third edition, Geneva: Practical Action, 2011, pp. 1-395.

[11] S. Association, "Minimum Standards in Shelter, Settlement and non-Food Items," in The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response, Third edition, Geneva, Action Publishing, 2011, pp. 243-284.