Utilization of solar power for support facilities in the evacuation area during natural disaster

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Abstract. Products with the use of solar power in evacuation activities and displacement of natural disasters are very rarely found. Solar cell products are usually used by people on a certain scale, for example in accessories or lifestyle products. However, technology using solar panels is less developed, especially in products whose orientation is for natural disasters. Many cases were found during the evacuation of natural disasters, including many constraints. Electricity is often a problem in areas where refugees are displaced after natural disasters. The problem of wasteful diesel generator energy resulted in the absence of an effective source of electricity and lighting, besides that information or distribution of the area was still fairly slow due to the portable speaker system and even door-to-door announcements. The method used is by combining aspects of technology into a conventional product by providing features needed in the event of a disaster. The method approach using the X-Problem method consists of immersion, convergence, divergence, and product adaptation designed with an effective and efficient function focus approach. From these problems, an emergency lighting product and emergency wireless loudspeaker can be designed to be provided in each of the evacuation tents. It is expected that the design of the product designed has a very important role in the evacuation process that occurs in the disaster environment, especially in Indonesia. The role of the product in creating an evacuation environment situation is more conducive.

1. Introduction

Natural disaster is a very detrimental to living things around it. Surely the disaster has natural trigger source, for example in the case of a potential earthquake in Bandung caused by a Lembang fault in the area of West Bandung [1]. At present, the city of Bandung and its surrounding areas are facing a potential threat of the Lembang Fault earthquake which is allegedly having a magnitude of 6.5 to 7.

The facilities needed to fulfill the utility of the evacuation area. The thing that is actually small but turns out to be crucial is the lighting. Many refugee camps lack sufficient electricity supply (diesel) and there is not enough lighting at night, which causes refugees to search for resources by burning tree branches or leftover rubbish to produce natural light from a blazing fire. However, this is often a problem because the fire from the burnt spreads to nearby tents which instead causes a subsequent disaster due to human negligence fire.

Electricity is often a problem in areas where refugees fled after natural disasters. Barriers include the difficulty in accessing aid to enter the impacted area because of damaged roads after natural disasters or lack of funding from government or private sources. Although it needs great amount of funding just only to give electricity source to the refugee’s area.
Besides electricity sources, the distribution of information in refugee areas is really slow and ineffective, for example, the distribution of consumptions, necessities (toiletries, sleeping tools, etc.) to referrals if a subsequent disaster occurs, the existing is using portable TOA or even if there are no TOA facilities at all, operators will come and give information from tent to tent. This can be a problem, the narrow range information and misunderstandings that will have bad consequences. Though information is a fatal thing in emergencies such as post-disaster evacuation.

If that case happened, for the purpose of reducing government cost on the issue of electricity distribution, especially lighting for refugee areas and the distribution of quick spread information and effectively, this research tries to create emergency lights and solar powered wireless loudspeakers with solar panels embedded in knockdown tents that will illuminate each room inside emergency shelter (tent).

2. Methods

2.1. Design methods
X-Problem method is used to solve wicked or complex problems for 21st century challenges that oppose conventional planning. This method is a combination of the ISD and ADDIE methods [2].

![X-Problem method diagram](http://www.nwlink.com)

**Figure 1.** X-Problem method.

2.2. Design approach

2.2.1. Immersion. Researcher immerse in the problem and collect data and then plunge directly into respondents who have experienced natural disaster, emergency evacuation teams, and relevant emergency agencies such as BDPB and BNPB [3].

2.2.2. Convergence [4]. Combining aspects of technology into a conventional product by providing wireless features and renewable energy which is commonly called solar cells.

2.2.3. Divergence [4]. Test the functions and features that will be applied to a conventional product whether it is a suitable partner or needs to be developed again.
2.2.4. Adaptation. Creating a prototype with data analysis and output product is a new innovation for development product design field [5].

2.3. Initial design
Referring to the natural disaster rapid data assessment, it obtained directly from a BNPB agency informant that all activities carried out at the refugee camp. It needs special emergency lighting. Thus, the phenomenon of wasteful diesel fuel makes the source of electricity not prolonged and the ineffective distribution of area information will result in the reach of information obtained by refugees being unreached or even finding misunderstandings of information [6,7]. Lighting design and solar powered wireless loudspeakers expected to increase the efficiency and effectiveness of the refugee environment.

3. Results and discussion

3.1. Design concept.
Product designed depart from wasteful energy problems, lack of lighting, and ineffective information in refugee areas after natural disasters [8]. Therefore, the product to be designed is solar powered lamps and loudspeakers that will be provided in each evacuation tent.

3.2. Mind map
The main concept is to build and idea and develop the main idea into sb/sections by seeking as many considerations and alternatives as possible [9]. Product designed with point of view of refugee and the needs of refugees, spread according to functions and needs.

3.3. Main activity
User activity is used during the daytime; announcement of information distribution of necessities or foods. At night it used as adequate lighting and emergency disclosure.

3.4. Competitor products
Competitor products come from solar powered emergency lighting products that still use solar panel boards and spare batteries.

3.5. Product placement layout
The product placement is located in each tent that is used for family and team tents. Wireless network communication is regulated by a tent operator system (central command)

3.6. Final design
Points taken from the mind mapping include lighting, centralized direction, and solar power. The other requirement product is supporting facilities, such as solar cell and USB cable. The position of the solar cell is placed on the roof of the tent, inside of the tent. Turning on the lighting is by pressing the switch button and the wireless speaker using signal center of the operator tent to guide and deliver information well spreaded.
The form taken is the result of analysis of the use of product during emergencies activity and so it must be compact and easy to operate. The aesthetic touch of the color used is a derivative of the logo of the Indonesian Natural Disaster Agency which are orange and blue as adjust the Agency’s identity to products used in the field (refugee camps).

**Figure 2.** Product placement and illustration (Source: Author(s)).

**Figure 3.** Exploded view of body parts (Source: Author(s)).

**Figure 4.** Stacking product for storage and distribution (Source: Author(s)).
Stacking (Distribution): the joint system on the product (form for function) utilizes the shape of the carabiner hook to enter the hole in the side-body of the lamp so that when the product is stacked vertically upward it will add to the bond and so it is not displaced.

Figure 5. Charging socket (Source: Author(s)).

There are two options in the recharging system, if enough sunlight means the product can charge by solar energy but if the weather does not support, this product also can be recharge by USB cable.

4. Conclusion
Emergency lights and wireless loudspeakers are expected to increase the effectiveness and efficiency of activities in refugee areas. Helping disaster management institution facilities to more efficiently and effectively carry out activities in refugee camps. In designing and developing products, testing of validity should be done to avoid a wrong mechanics.

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