

## Heater lamp product design as hypothermia prevention using qfd (quality function deployment)

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### Abstract

Every year the number of climbers increase, there are at least 70,000 climbers including researchers. The increase in the number of climbers will certainly increase the mortality risk of hypothermia. At least 18 people died from hypothermia in 2014 to 2015. The risk of hypothermia can be reduced by handling such as providing warmth to the patient. Warmth can be created by using a tool that produces the right heat, easy and safe to use, easy to carry and also affordable. This is the basis for researches to conduct research on designing heating products in tents as an effort to prevent hypothermia. This research uses the QFD (Quality Function Deployment) method in processing the results of the consumer's voice, design the product concept, screening and selecting concept and analysis the final product design. Based on the data collection and processing that has been carried out, there are 10 criteria for consumer needs and interests for product, including practical tools to carry, safe to use, can warm the body to have additional functions as cellphone chargers. While the alternative concept chosen in the form of cylindrical tube, using a Li-ion battery, and a frame made of polypropylene plastic. From the chosen concept, then a heating lamp model is designed in the display when used and stored.

**Keywords:** Product design; QFD; Heater Lamp; Hypothermia; Camping;

### Introduction

Camping is often a way to relieve stress for those who are tired with work routines and busyness in the city or researchers who are conducting research. The cold and cool air can calm the mind from the hustle and bustle of pollution in the city. In addition to camping, mountaineering is an activity that are in great demand by various groups. But this activity has risks that can threaten the safety of the climbers. Things that can happen when climbing a mountain or mountaineering such as abdominal pain, sprains, fractures or dislocations of bones, allergic reactions, influenza, diarrhea and to those that can be life threatening like hypothermia. Physical conditions very influential on the risk of hypothermia symptoms. The human body, which has greater heat energy than the surrounding environment, will lose heat constantly until it reaches the same temperature as the environment (Fadli, 2019). To maintain a stable temperature, the body will respond by increasing metabolism and producing heat.

The risk of hypothermia can be reduced by taking proper prevention and treatment of the patient. The current handling and prevention of hypothermia such as using sleeping bags, emergency blankets, jackets and heat from emergency lights. These methods can only be used individually while the price of these tools is quite expensive. This is the reason for researchers to design a heater lamp product, it is a heating product in the tent that can be felt warm in a larger number of people as a prevention of hypothermia symptoms and increasing life expectancy for sufferers, so that the mortality rate due to hypothermia can be reduced.

The existence of a similar product uses a source of propane gas and other gases, so that the heat generated is greater. This product is commonly found in European countries which is used when camping in winter and can warm the room when the temperature reaches -14°C. This product can release toxins from the gas if it is not used properly, besides that the temperature is too hot will damage the tent so this product is not suitable for use in Indonesia. To ensure user safety while still providing warmth in the tent, research was carried out in designing a heating lamp product in accordance with the voice of the customers and processed using the QFD (Quality Function Deployment) method to produce a product design in accordance with conditions that exist in Indonesia (Fonseca et al., 2020; Park et al., 2021).

## Literature Review

### Hypothermia

Hypothermia is a medical disorder that occurs due to a drastic drop in body temperature. Normal human body temperature is in the range of 37°C. Meanwhile, people who experience hypothermia, their body temperature drops to 35°C so that the functions of the nervous system and other organs of the body cannot work normally (Fadli, 2019).

### Quality Function Deployment (QFD)

The development of a product can be done using the Quality Function Deployment (QFD) method. By QFD method we can obtain information about the wants and needs of consumers, the needs of producers and product needs (Ginting, 2018) QFD is an action to design a process in response to consumer needs (Bolar et al., 2017; Harsokoesoemo, 2004). QFD translates what consumers need into results by the organization. QFD allows companies to prioritize consumer needs, create innovative things according to these needs and improve processes to achieve maximum effectiveness (J, 2010; Zadry et al., 2015).

### Quality Function Deployment (QFD) Stages

The starting point in the implementation of the stages of the Quality Function Deployment (QFD) method is the consumer and the wants and needs of consumers (Keller & Kotler, 2009). Basically, there are 3 stages in the implementation of QFD, all activities at each stage can be applied as in a project. The three stages that are passed are as follows (Henuk et al., 2015; Sinulingga, 2011).

1. Voice of Customer Collection  
This stage is the method used by researchers to collect qualitative data or consumer information and information in the form of numbers for each attribute as quantitative data.
2. House of Quality Compilation  
The application of the QFD method in the product or service planning process begins with the formation of the House of Quality matrix or product planning matrix.
3. Analysis dan Implementation  
At this stage, the data input process that has been collected is carried out into the House of Quality which is then analyzed so that later it can be implemented properly and appropriately.

### House of Quality Matrix

The application of the QFD method in the product design process begins with the formation of a product planning matrix or often referred to as the House of Quality (Pawenary et al., 2020). The house of quality or also known as the House of Quality (HOQ) is a tool or instrument in the application of the QFD methodology. In general, in compiling the House of Quality matrix, it can be seen in Figure 1 (Ulrich, K. T., & Eppinger, 2001).

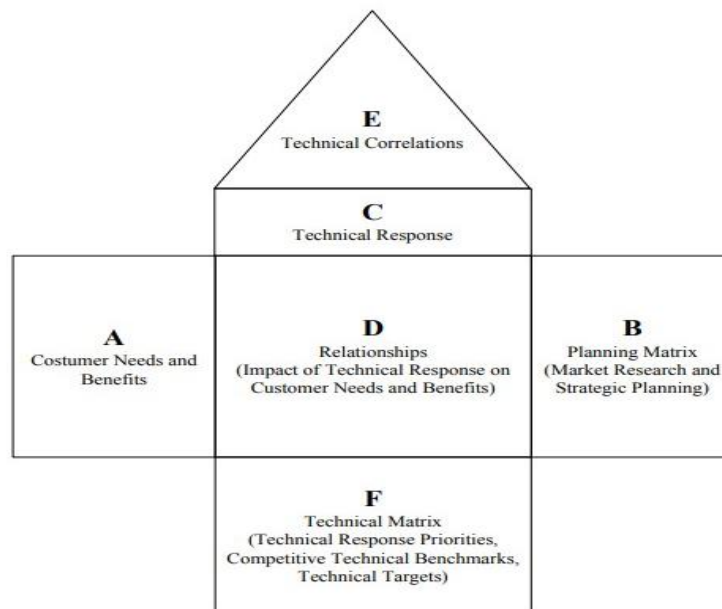


Figure 1. House of Quality

### Materials & Methods

There are several sources of data collection in this study, that is:

1. Primary data is data obtained directly from sources, by interviews and discussions with climbers. Focus Group Discussions (FGD) are conducted to obtain technical responses, where FGD participants are consumers and experts in the field of product design and others. Closed questionnaire data containing the level of interest of respondents to product design specifications with 100 research samples.
2. Secondary data is data obtained through other parties, indirectly, or usually in the form of documentation data or available report data, such as literature studies on QFD (Quality Function Deployment), statistics and r tables.

Processing and analyzing the data used there are several stages, including the following (Wijaya, 2011):

- a. Determine the level of importance  
At this stage, the results of the closed questionnaire determine the weight and hierarchy of importance of each attribute.
- b. Determination of technical characteristics  
At this stage, the team designs and determines the technical response and technical targets to answer consumer needs. Technical response and technical targets are obtained and determined in the focus group discussion.
- c. Create matrix and weight  
Making a matrix contains information on the level of consumer interest, consumer needs, the weight of technical characteristics and the relationship between the matrices with one another by using symbols that have been defined to determine where one technical attribute affects another technical attribute.
- d. Making House Of Quality (HOQ)  
The predetermined matrix is formed into a complete and detailed house of quality. HOQ is made to show the relationship between voice of customer and voice of engineering or otherwise. The output of this stage determines the priority level of consumer needs and technical needs, so that the design that will be created will be obtained.
- e. Alternative development and selection of alternative concepts  
The purpose of developing the design concept is to provide an alternative product model to be produced. The results of the HOQ will be information for researchers in the development of alternatives. From several alternative product concepts, the one that most dominates consumer needs will be chosen. The selection of these alternatives is done by giving an assessment of each alternative based on a scale of 1-5. Before filling out the questionnaire, respondents will be given an explanation that filling out this questionnaire is to determine alternatives that suit the wishes of consumers.
- f. Product design  
Product design is made based on information from the selected alternative concepts.

## Results and Discussion

### Voice of Customers

Based on the results of interviews with climbers, it was concluded that customer needs can be seen in Table 1:

**Table 1.** Conclusion of Customer Needs

No	Customer Needs
1.	The equipment can warm up in the tent
2.	The equipment can be used by more than one person
3.	The equipment has a load that is not too big
4.	The equipment easy to use
5.	Practical equipment to carry
6.	Easy maintenance equipment
7.	Waterproof equipment
8.	Safe equipment to use
9.	The equipment can be a cellphone charger
10.	The equipment can be a tent light

### Level of Importance

From the data on customer needs, a questionnaire with a likert scale was designed to determine the priority level of each attribute needs. From the importance level questionnaire data that has been collected, a priority scale calculation can be carried out by calculating the score and then totaling it and giving it a percentage

$$\text{Level of importance of need 1} = \frac{\sum \text{absolute value needs no.1}}{\sum \text{respondent}} = \frac{447}{100} = 4,47$$

$$\text{Percentage of importance needs 1} = \frac{\text{Level of importance}}{5} \times 100\% = 89,4$$

The results of the recapitulation can be seen in Table 2.

**Table 2.** Priority Scale

No	Customer Needs	Level Of Importance	Percentage (%)	Rank
1.	The equipment can warm up in the tent	4.47	89.4	3
2.	The equipment can be used by more than one person	4.21	84.2	9
3.	The equipment has a load that is not too big	4.41	88.2	5
4.	The equipment easy to use	4.44	88.8	4
5.	Practical equipment to carry	4.53	90.6	1
6.	Easy maintenance equipment	4.4	88	6
7.	Waterproof equipment	4.38	87.6	7
8.	Safe equipment to use	4.52	90.4	2
9.	The equipment can be a cellphone charger	3.97	79.4	10
10.	The equipment can be a tent light	4.34	86.8	8

**Technical Characteristics**

After knowing customer needs and level of importance, a Focus Group Discussion was conducted to discuss Technical Responses to customer needs. The results of the FGD discussions can be seen in Table 3 below:

**Table 3. Technical Responses**

No	Customer Needs	Technical Responses	Technical Target
1.	The equipment can warm up in the tent	The heating medium used is <i>focused beam</i>	Designed to be able to warm the body in a tent with a capacity of 4-5 people
2.	The equipment can be used by more than one person	The mini fan spreads the warmth from the lamp	Warm lights spread throughout the tent
3.	The equipment has a load that is not too big	The frame is made of plastic	Total weight under 3 kg
4.	The equipment easy to use	Types of resources that are easy to use and obtain	The equipment can be used by ordinary people
5.	Practical equipment to carry	Product Dimension	The equipment is not difficult to carry
6.	Easy maintenance equipment	<i>Sparepart</i> sold in the market	Self-replaceable heating media
7.	Waterproof equipment	The product frame uses plastic material	Safe if it rains
8.	Safe equipment to use	The heater uses DC current	No short-circuit
9.	The equipment can be a cellphone charger	Battery Dimension	Fully recharge
10.	The equipment can be a tent light	A heater that is at the same time a light	Light up the tent

**House Of Quality (HOQ)**

After processing several matrix, the matrix is combined to form a house of quality (HOQ) which can be seen in Figure 3 below. This assessment is the result of discussions with customers (customer point of view), the focus of improvement or product specifications that must exist in the product later according to the level of importance. However, some of the specifications that customers want must be evaluated by researchers by looking at the capacity of the ability to meet customer specifications.

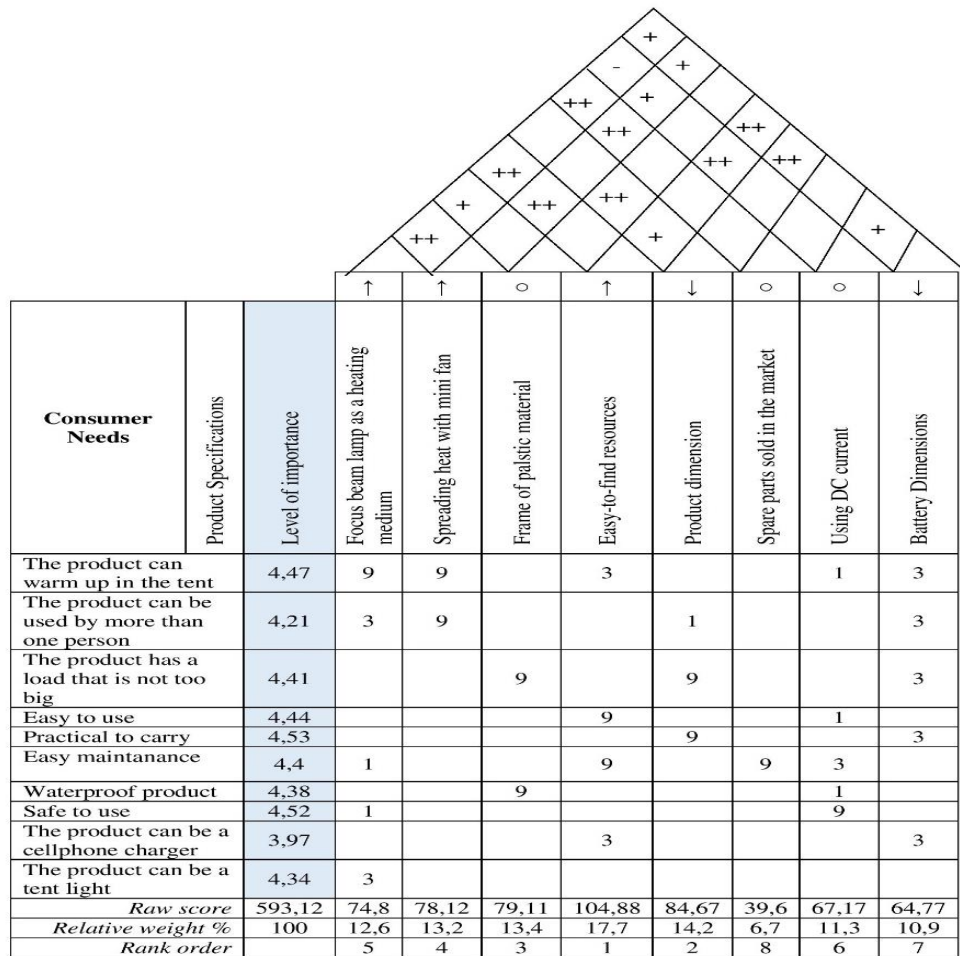


Figure 2. HOQ 1







After the product specifications are agreed, the next thing to do is determine the concept and choose the concept to

be developed in accordance with the product specifications. The development of alternatives and the selection of alternative concepts will be explained in detail.

**Alternative Development**

At this stage, it requires the creativity of researchers and teams in providing ideas for concept development. The alternative concepts can be seen in Table 4 below:

**Table 4.** Alternative Concept Technical Characteristics

	Product Shape	Battery Type	Frame Raw Material
Concept 1	 Tube	 Li-ion Rechargeble	Polypropylene
Concept 2	 Cuboid	 Li-Po Rechargeble	Polypropylene
Concept 3	 Tube	 Li-Ion Rechargeble	Acrylic

In the next process, the comparison with the scoring concept is focused on choosing the best concept based on the highest weight score. The results of the scoring concept can be seen in Table 5 below:

**Table 5** Scoring Concept

Customer Needs	Level of Importance	Concept 1		Concept 2		Concept 3	
		Weight	Weight Score	Weight	Weight Score	Weight	Weight Score
The equipment can warm up in the tent	4.47	4	17.88	4	17.88	3	13.41
The equipment can be used by more than one person	4.21	4	16.84	4	16.84	3	12.63
The equipment has a load that is not too big	4.41	4	17.64	2	8.82	3	13.23
The equipment easy to use	4.44	3	13.32	3	13.32	3	13.32
Practical equipment to carry	4.53	4	18.12	3	13.59	2	9.06
Easy maintenance equipment	4.4	3	13.2	2	8.8	3	13.2
Waterproof equipment	4.38	3	13.14	2	8.76	2	8.76
Safe equipment to use	4.52	4	18.08	4	18.08	4	18.08
The equipment can be a cellphone charger	3.97	4	15.88	4	15.88	4	15.88
The equipment can be a tent light	4.34	4	17.36	4	17.36	4	17.36
Total			161.46		139.33		134.93
Rank			1		2		3

Concept 1 looks superior because it is more stable than the others. After doing the above analysis, the next thing is to describe the overall HOQ which can be seen in Figure 3.

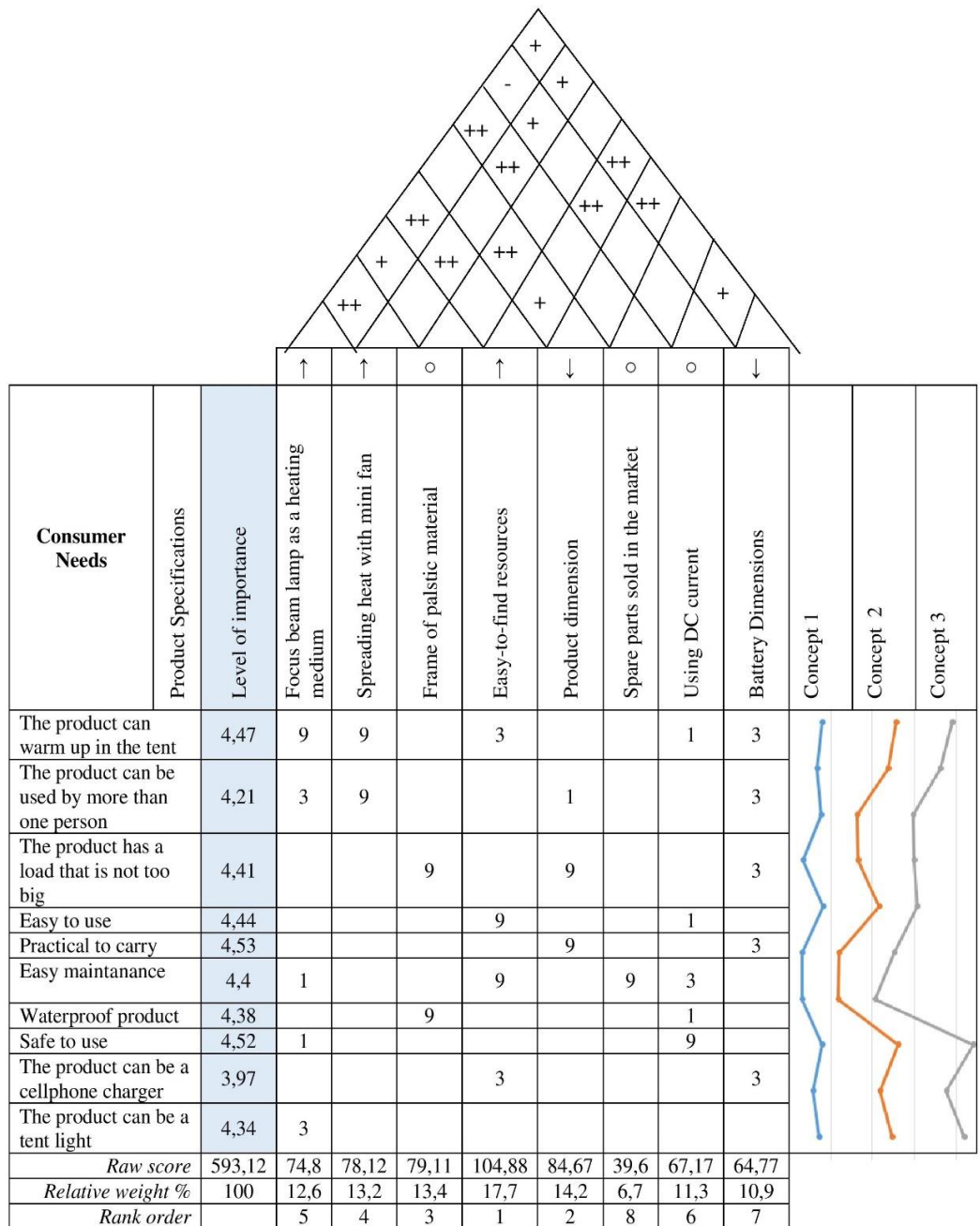


Figure 3. HOQ 2

**Product Design**

After obtaining the HOQ of the product design, the product design is carried out using AutoCAD. Product design refers to the agreed product design HOQ. The following are Figures 4 and 5 which are the design of the Heater Lamp product:

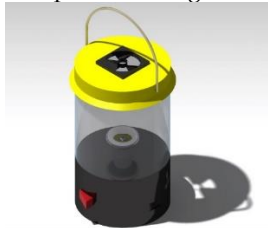


Figure 4. Product Design of Heater Lamp when in use



Figure 5. Product Design of Heater Lamp when stored

## Conclusions

Based on the processing that has been done using the QFD (Quality Function Deployment) method, the importance level value is taken from the results of the priority scale where in the first place is occupied by practical tools to carry with an importance value of 4.53, followed by safe tools to use with a value of 4.52, and so on until the last priority order (tenth order) is that the device can be used as a cellphone charger. As for the rank order, it is the result of sorting the raw score from the largest to the smallest, where the first order is occupied by the specifications "Easy to find resources" and "Spare parts sold in the market" in the last order. For the results of the scoring concept, the best concept was obtained, namely concept 1, where this concept proposes a power source using Li-Ion batteries, the product form is a cylinder and a frame made of polypropylene polymer plastic.

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