



DEVELOPING FEATURES OF WATER FAUCET BY USING USER CENTERED DESIGN APPROACH

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ABSTRACT

Water faucet is a tool to set the water flow that installed in various places. This tool becomes an important facilities in human daily activity. However, there are still some weakness in the existing design especially on use. It was indicated with any complaint from the customer about easy to damage, less innovative, and uncomfortable use. The purpose of this study is to redesign the water faucet which can satisfy user requirement such that complaint will be reduced. Concept of User-Centered Design was used as basis of design and axiomatic design method was also used to determine the design parameter based on user criteria and functional requirements. Survey was conducted to identify the attribute users was looking for. Statistical analysis was conducted to test the hypotheses developed. Results of this study show that the new design of water faucet proposed is valid to meet the users need at 5% significant level that are easy to use, unique, robust and ergonomic.

INTRODUCTION

Water is an essential thing for human life. Based on data from [1], water usage per day on average urban households in Indonesia for lower economic class is 169.11 liters/ person, whereas for the upper middle class is 247.36 liters/ people. Most of them uses a faucet for setting the water flow in house. However according to the preliminary study, some existing design of the water faucet in a market are still cause many complaints for user. 88% of the users expressed dissatisfaction at the existing faucet design which 68% of users said that the design is less innovative, 62% of users claimed that design is easy to leak, and 56% of users said that its design is not comfortable in use. Other users states that the existing faucet is easily corroded, brittle, and expensive in price. This state was caused by the existing faucet designed not considering user from the beginning. Therefore it is important to improve the design of faucet that involve the user in order to reduce dissatisfaction.

User Centered Design (UCD) is a concept in design of products that focusing on users. It involve users actively in the process of design from the beginning until the product is ready to use. So the products can be understood and in accordance with the wishes of users [2] [3].

Use of UCD in designing products have been done by several previous studies, such as motorcycle tire dismounting tool design for one-handed user [4], design of robotic devices for upper limb stroke rehabilitation [5], design of hair washing assistive device for users with shoulder mobility restriction [6], intelligent wheel chair design [7], design of coconut fiber tablet case [8], innovative design of wheel chair [9].

Objective of this study is to redesign the water faucet which can satisfy user requirement such that complaint will be reduced by using UCD approach.

RESEARCH METHOD

Survey

In this study, a survey was divided into three stages. The first is to identify the attribute of water faucet that user desire. And the second is to determine the design parameters. The last stage is to validate the proposed design. The 70 of users was participated by completing some question from questionnaire distributed.

Mapping by axiomatic design

Axiomatic design is a theory that created and developed by [10], This method provides a general framework for designing a product at all levels [10].

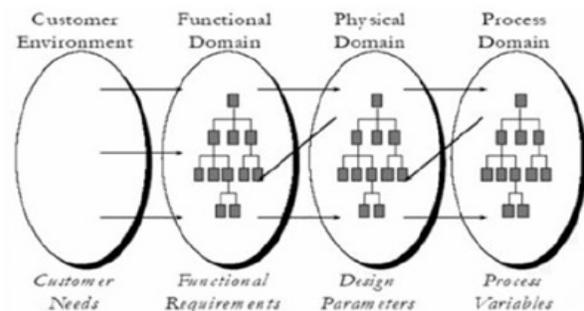


Figure-1. Domain division in axiomatic [10].

Figure-1 describes a mapping process from domain to domain where the right domain should be identified for satisfying left domain [10] [11]. It is started from customer attribute (CA) to the functional requirement (FR). And design parameter (DP) was determined based on the FR identified [11].

Statistical analysis method

Descriptive non parametric statistical analysis is used in this study where Cronbach's Alpha was used to test the reliability and Spearman's rank correlation was used to test the validity of customer attribute [12].



Statistical different test was also conducted by using the marginal homogeneity and wilcoxon different tests. These tests were used to prove the first hypothesis that is conformity between developed design and consumer need. And the second hypothesis is significant differences between the proposed water faucet design and the existing design [12].

RESULT AND DISCUSSION

Customer voice

Result of survey in Table-1 had found four valid and reliable customer attributes.

Table-1. Customer attribute.

No	Customer Attribute
1	Robust
2	Easy to use
3	Unique
4	Ergonomics (Comfortable)

Robust is the sturdy from frequency of use and temperature change. It means that user requires the faucet should not be easy to damage and crack. While easy to use is an attribute that user need in using the faucet efficiently. This is corresponding with what [13] defines. And unique describes that product has different features from the others [14]. It because user wants the faucet design is more interesting. As for the last attribute is ergonomic. It was identified that user wants the faucet design is more comfortable when it is used without causing any pain.

Design parameter of Water Faucet

Table-2, Table-3, Table-4, and Table-5 show the design parameter of faucet developed as a result from mapping process satisfying the customer attribute. Table-2 presents the design parameter that satisfying robust criteria which the faucet should be made using iron (DP 1.1.1.1) with 3 mm of thickness (DP 1.1.1.1.1) and be coated by dyes chrome (DP 1.2.1.1). it was intended to resistant from temperature change.

Table-3 defined the parameter design that satisfying easy to use. It means that the faucet was provided on-off sticker (DP 2.1.1.1.1) for power sign (DP 2.1.1.1) to facilitate users pushing the button. And red LED indicator lamp (4 watts) (DP 2.1.1.2) was functioned to inform user about the water flow. Rechargeable Lithium Polymer battery with 22000 mAh of capacity (DP 2.1.2.1.1) was used to easy charging. Use of ½ inch of water faucet diameter (DP 2.2) was easy to install in any places.

Design Parameter satisfying unique is described in Table-4. Where the faucet was designed by using FM antenna as a censor media with length 0-78 cm (DP 3.1.1.1.1) in order that user may be able to identify water level with flexible. And also green rubber with RGB 3,241,17 (DP 3.2.1.1.1) was used to be accessories for making a different look with the other.

Table-5 presents the design parameter for meeting ergonomic attribute. The design used the up and down handle movement to control the water flow rate and 90° rotation of water temperature (DP 4.1) so that it is more flexible. For providing the comfortability of handle, the 2.2 cm rubber in width put on 2.5 cm handle in width (4.2.1.1).

Table-2. Robust of Water Faucet.

Code	Customer Attribute	Code	Functional Requirement	Code	Design Parameter
CA1	Robust	FR 1	Provides the resistant to usage frequency and temperature change	DP 1	Robust design of water faucet
		FR 1.1	Provides the resistant to usage frequency	DP 1.1	Using the raw materials which is not easily broken or damaged
		FR 1.1.1	raw material is durable	DP 1.1.1	Metal
		FR 1.1.1.1	durable of metal type	DP 1.1.1.1	Iron
		FR 1.1.1.1.1	durable of metal thickness	DP 1.1.1.1.1	3 mm of thickness
		FR 1.2	Provide the resistant to temperature fluctuations	DP 1.2	Applying layer on the surface of metal
		FR 1.2.1	metal surface coatings that are resistant to hot and cold of temperature	DP 1.2.1	Chrome
		FR 1.2.1.1	Process of chrome neater	DP 1.2.1.1	dyes chrome



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Table-3. Easy to use of Water Faucet.

Code	Customer Attribute	Code	Functional Requirement	Code	Design Parameter
CA2	Easy to use	FR 2	Facilitate the user in operate the faucet water	DP 2	usable design of water faucet
		FR 2.1	Provides convenience in operation of water level sensor	DP 2.1	Usage instructions that easy to remember
		FR 2.1.1	Usage instructions are easily understood	DP 2.1.1	applying sticker and indicator lights
		FR 2.1.1.1	content of sticker that easy to understand	DP 2.1.1.1	power sign
		FR 2.1.1.1.1	power instructions are easy to understand	DP 2.1.1.1.1	"on-off" sticker
		FR 2.1.1.2	Indicator lights are efficient in energy and low-voltage	DP 2.1.1.2	Red LED lamp (4 watt)
		FR 2.1.2	The power source that can be used in various installations	DP 2.1.2	Battery
		FR 2.1.2.1	Provide an easy refill	DP 2.1.2.1	Polimer lithium
		FR 2.1.2.1.1	Provide the big power	DP 2.1.2.1.1	2200 mah for capacity
		FR 2.2	Facilitating the installation of faucet in various places	DP 2.2	standard size of diameter water faucet (1/2 inch)

Table-4. Unique of Water Faucet.

Code	Customer Attribute	Code	Functional Requirement	Code	Design Parameter
CA3	Unique	FR 3	Provide different design in features	DP 3	Innovative design of water faucet
		FR 3.1	Multi functional water faucets	DP 3.1	Provide the water level control
		FR 3.1.1	Water level control that works automatically	DP 3.1.1	applying solenoid valve
		FR 3.1.1.1	Flexible water level detector	DP 3.1.1.1	Vertical fm antenna
		FR 3.1.1.1.1	detector that has a long size	DP 3.1.1.1.1	0-78 cm
		FR 3.2	Additional accessories of water faucet	DP 3.2	additional material for handle
		FR 3.2.1	Suitable materials combined with steel	DP 3.2.1	rubber
		FR 3.2.1.1	eye catching rubber colour	DP 3.2.1.1	green
		FR 3.2.1.1.1	The green colour that seen in a dark room	DP 3.2.1.1.1	RGB 3, 241, 17



Table-5. Ergonomics (comfortable) of Water Faucet.

Code	Customer Attribute	Code	Functional Requirement	Code	Design Parameter
CA4	(Ergonomics) Comfortable	FR 4	Water faucet that provide comfort of use	DP 4	Ergonomic design of water faucet
		FR 4.1	Provide a flexible handle movement	DP 4.1	Handle with top-down movement and 90° rotating
		FR 4.2	Shape of handle accordance to hand anthropometry (finger)	DP 4.2	Average philosophy
		FR 4.2.1	applying percentile based on average philosophy	DP 4.2.1	P50
		FR 4.2.1.1	handle width corresponding to the width of index finger and thumb width at P50	DP 4.2.1.1	Rubber width 2.2 cm, handle width 2.5 cm



Figure-2. Design of Water Faucet.

Result of validation

Table-6 present the result of homogeneity test and Table-7 show the result of wilcoxon different test.

Table-6. Marginal homogeneity test result.

User's Requirements	z values
Robust	0,399
Ease to use	0,677
Unique	0,435
Ergonomics (Comfortable)	0,157

The result in Table-6 shows that attributes of the proposed water faucet design is valid to conform the user required at 5% of significant level.

Table-7. Wilcoxon different test result.

Attribute	Asymp. Sig. (2-tailed)
Robust	0,034
Easy to use	0,018
Unique	0,014
Ergonomics (Comfortable)	0,032

While Table-7 shows result of different test between the proposed design and the existing design. The result found that the proposed design is better at 5% of significant level. Thus, based on two condition show that the proposed water faucet design is more robust, easier, more unique, and more comfortable.



CONCLUSIONS

Conclusions of this study are as follows:

- Attributes that users want to the water faucet are robust, easy to use, unique, ergonomics.
- Design parameter for robust attribute such as raw material from steel with 3mm thickness and chrome plated. Then, design parameter for easy to use attribute are on-off sticker for power sign, red LED lamp (4 watt), polimer lithium battery with 2200 mAh capacity, and ½ inch diameter size of water faucet. For unique attribute, design parameter are provide water level control and additional material that is green rubber on the handle. Design parameter of ergonomics attribute are Handle with up-down movement and 90° rotating, and Rubber width 2.2 cm, handle width 2.5 cm.
- Based on validation test, design of water faucet is valid to satisfy customer criteria and different with the other water faucet at 5% significant level.

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