ERGONOMICS AND INNOVATION DESIGN OF THE DISABLED WHEELCHAIR

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ABSTRACT

For the disabled people, difficulties in daily life to do some activities are still becoming main problem specifically they have not normal legs. This condition requires an auxiliary appliance to easy in moving. One of the appliance is wheelchair. However use of the existing wheelchair still gives rise to complaint such as pain in buttock (90%), waist (93%), hands (86%), thigh (90%), and back (93%). Furthermore the chair is also easy to broke (83%), difficult to manuver and move (83%), as well as expensive price (67%). Thus, it is crucial to improve or redesign the wheelchair. Objective of this study is to redesign the wheelchair ergonomicly and innovative in order to be able satisfying user need. The Quality Function Deployment (QFD) method is used to determine the spesification design of the wheelchair. Survey was done to identify user requirements of the design. Statistical analysis is implemented to test hypothesis. The result of this study shows that the proposed design of the wheelchair is valids to satisfy user criteria at 5% of significance level that is more comfortable, more strong, more economic, more easy to use, more easy to repair and more easy to user's move.

Keywords: Wheelchair, Disabled, Ergonomic, Quality Function Deployment, Innovative.

1. INTRODUCTION

As a normal mankind necessitates a good daily lifes as well as for disable people. Many disabled try to do daily activities by obstacle in moving such as walking. Therefore the disabled requires assistance tools in order to easy doing activities especially for those who don't have normal legs like *hemiplegic, amputation, polio* and *cerebrovascular accident (VCA)*. A study found that the increase number of disabled people are not followed by the availability of adequate facilities because it does not meet user expectations [1]. According to [2], the facilites should be able to help them. [3] expresses that a person who has physical or mental disorders will be hampered in carrying out activities. Based on data from [4], the number of disable people in Indonesia is 11.580.117 which 3.010.830 people have the physical disabled.Therefore, this fact encourages for being done some improvement with designing the better auxiliary appliance i.e wheelchair in spite of [6] had developed an ergonomic wheelchair in his study however the design requires the further modification being more innovative and able to overcome complaints.

Based on the preliminary study, it was found there is still some user complaints in use the wheelchair that is on buttock (90%), waist (93%), hands (86%), thigh (90%), and back (93%). In addition, the chair is also easy to broke (83%), difficult to manuver and move (83%), as well as expensive price (67%). Thus, it is crucial to improve or redesign the existing wheelchair. Objective of this study is to redesign ergonomic and innovative wheelchair that can satisfy the user requirements.

2. THEORETICAL BACKGROUND

The method used this is Quality Function Deploymet (QFD). QFD is a method used to plan and product development structured that allows the development team to determine their needs and wish to consumers with clear and evaluate each intended products provided systematically in order to satisfy the desire and needs of the consumers [4]. On the process of design and product development, QFD used at the evaluation concepts of the product [7]. There are four phase used in QFD, first phase is planning the product (House Of Quality), second phase is planning components (Part Deployment), third phase is planning process (Planning Deployment), and fourth phase is planning operation the product (Manufactuirng or Production Planning) [10]. See in figure 1.

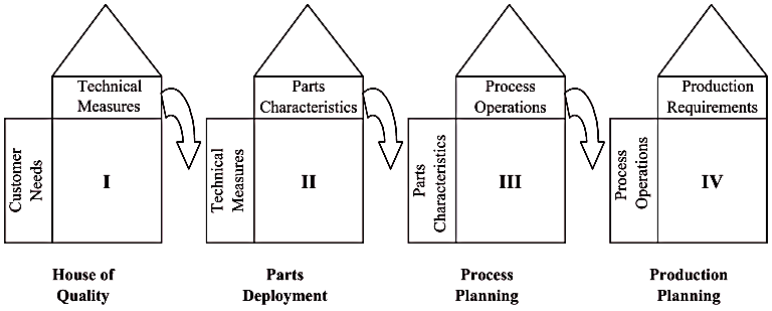

Figure 1 The Four Phase of Model QFD *[10]*

3. RESEARCH METHOD

3.1. Survey

Survey was conducted to identify the user criteria of wheelchair, the design parameter, and to validate the purposed design. Quesionnaire were developed and distributed to 30 respondents (disable user). Their ages ranged from 15 to 60 years old.

3.2. Mapping Process Method

Mapping process was conducted to determine the design parameter for satisfying customer criteria. HOQ comprises six main parts, as shown in Fig. 2. It is a structured and systematic way to transform the customer needs for a product into prioritized technical measures that can be further deployed to develop process and production plans. A process of the method is started from determine "whats" (customer needs or voice of customers) and "how" (technical requirements) that can satisfying customers.

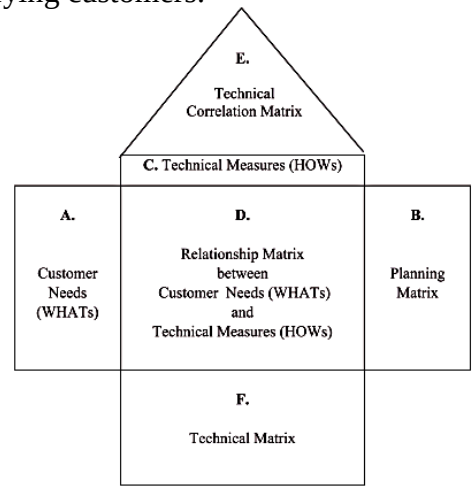

Figure 2 House of Quality *[8]*

3.3. Statistical Analysis

Descriptive non parametric statistical analysis was used to map the customer attribute to physical design parameters. In this study, a non-parametric statistical method is used. Test validity is level of ability to show the extent a measurement instrument can measure what the want measure [11]. Validity done by the method Spearman's Rank Correlation test. The Method used to determine level of reliability is alpha cronbach coefficient [11]. Furthermore the marginal homogenity test is performed by using a method of stuart-maxwell test of marginal homogenity and wilcoxon test used to know the difference between the current wheelchair and the proposed wheelchair [12].

4. RESULT AND DISCUSSION

4.1. Customer Requirements

Customer voice identified from a wheelchair user which six attributes valid and reliable customer.

Table 1 Customers Attribute

No	Attribute
1	Comfortable
2	Strong
3	Economic
4	Easy to use
5	Easy to repair
6	Easy to user move

4.2. House of Quality

From the results of data calculation can be obtained product planning matrix (House Of Quality). There are several components in the manufacture of House Of Quality (HOQ) see in figure 3 and Fig. 4. shows virtual design of wheelchair based on the identified design parameter.

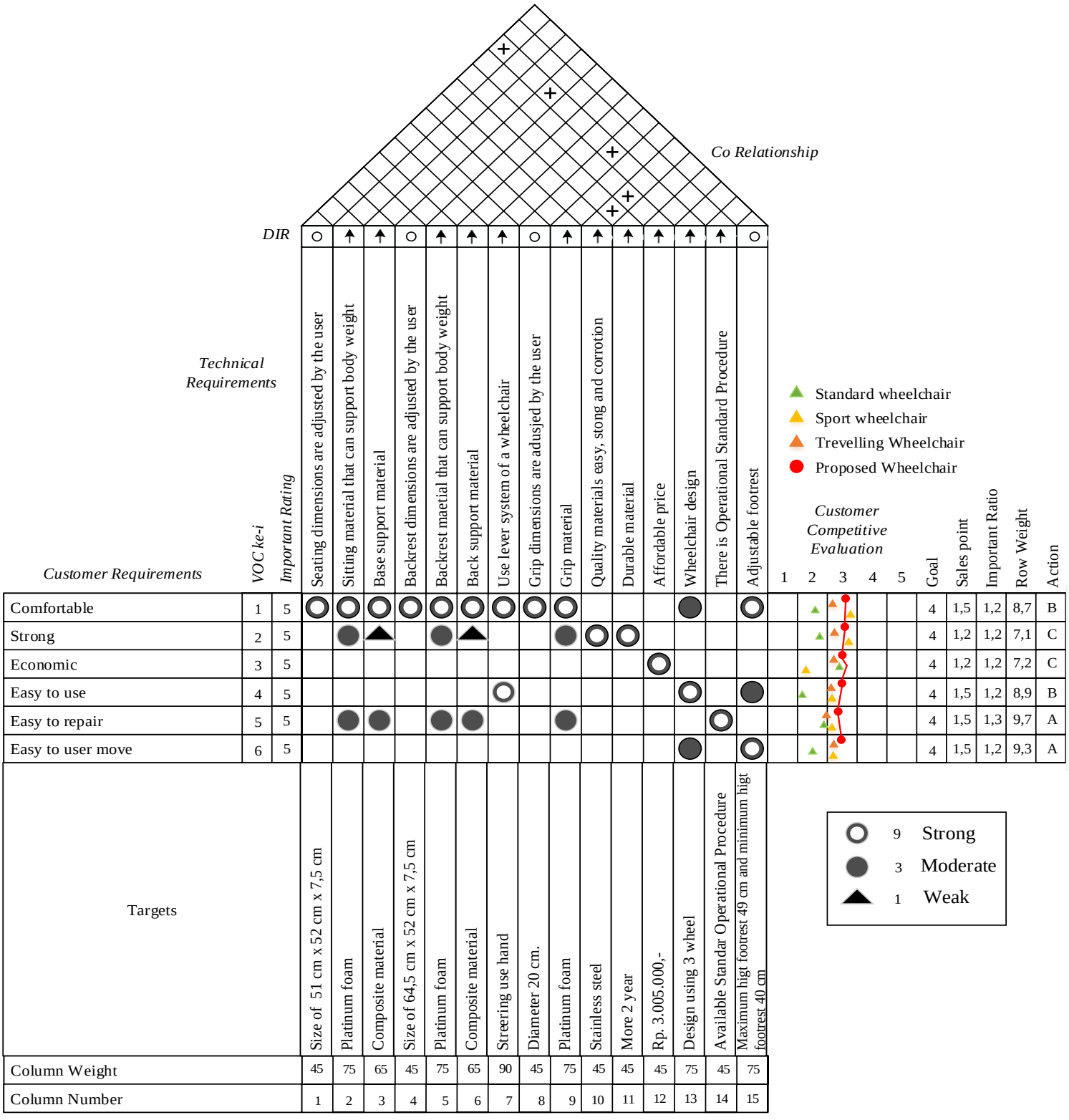

Figure 3 House of Quality wheelchair

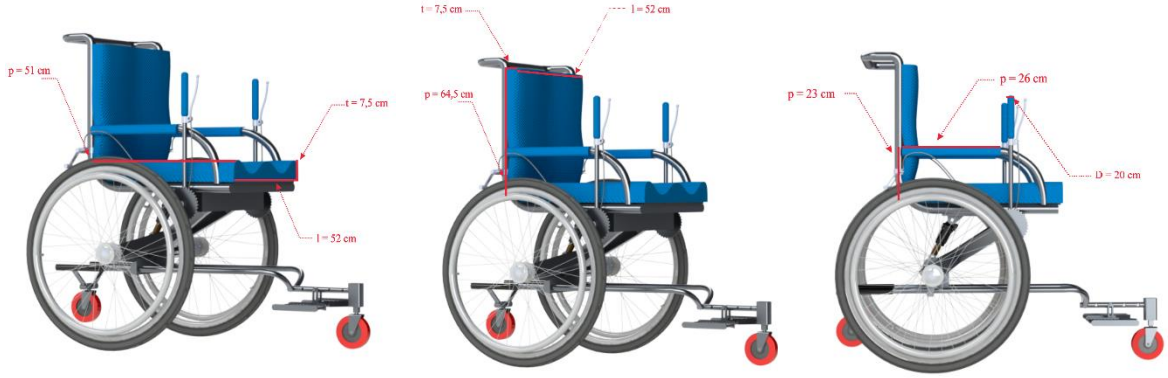

Figure 4 Design of wheelchair

4.3. Result of Validation

4.3.1. Marginal Homogenity Test

Marginal homogeneity test used implemented to validate wheelchair. Here is a hypothesis developed.

H_0: There is no significant difference between the criteria of consumers and wheelchair design.

H_1: There are significant differences between the criteria of consumers and wheelchair design.

Table 2 Result of Marginal Homogenity Test

Attribute	*Asymp. Sig. (2-tailed)*
Comfortable	0,782
Strong	0,763
Economic	0,715
Easy to use	0,131
Easy to repair	0,123
Easy to user move	0,683

In Table 2, it shows that Asymp column. Sig. (2-tailed) the existing number, all were z > 0.05, which means that the proposed design is suitable to the customer requirements of wheelchair.

4.3.2. Wilcoxon Test

The Wilcoxon test aims to compare existing wheelchair products with the product being developed. Here is hypotheses developled.

H_0: There is no significant difference between existing products and proposed product.

H_1: There are significant difference between existing products and proposed product.

Table 3 Result of Wilcoxon Test

Attribute	*Asymp. Sig. (2-tailed)*
Comfortable	0,000
Strong	0,003
Economic	0,000
Easy to use	0,002
Easy to repair	0,006
Easy to user move	0,004

In Table 3 it shows that Asymp column. Sig. (2-tailed) the existing number, all were z < 0.05, which means that there is a difference between the existing wheelchair and the proposed wheelchair, so that consumers prefer to use the proposed wheelchair.

5. CONCLUTION

Based on result of this research, concluded as follows :

1. Design of wheelchair which is developed based on customer attribute needs are comfortable, strong, economic, easy to use, easy to repair and easy to user move.
2. Parameters Design for wheelchair is framework of using stainless steel material with a seating size is 64,5 cm x 52 cm x 7,5 cm and backrest size is 64,5 cm x 52 cm x 7,5 cm. Using a type foam platinum D-26 as the sit and backrest. Futhermore, using composite as support material. Then the lever system as steering wheel with diameters grip is 20 cm then size of 26 cm x 23 cm as arm rest place and footrest that can adjusted to user requirements beetwen a maximum 49 cm and a minimum 40 cm.
3. According to validation test, a design of wheelchair valid to satisfy customer requirements at 5% level that is more comfortable, more strong, more economic, more easy to use, more easy to repair and more easy to user's move.

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