Alternative Design of Ergonomic Walk Learning Tool for Toddlers using Quality Function Deployment (QFD)

by Hilma Raimona Zadry, Difana Meilani, Dina Rahmayanti

Submission date: 19-Mar-2019 01:10AM (UTC+0800)
Submission ID: 1095431107
File name: 2014_Alternative_Design_of_Ergonomic_Walk_Learning_Tool.pdf (141.84K)
Word count: 2070
Character count: 10586

Paper Code: CdE

Alternative Design of Ergonomic Walk Learning Tool for Toddlers Using Quality Function Deployment (QFD)

Hilma Raimona Zadry, Tri Yoza Mustafa, Dina Rahmayanti & Difana Meilani
Dept. of Industrial Engineering, Faculty of Engineering,
Universitas Andalas, Padang, West Sumatera

ABSTRACT: One of the tools for baby to learn to walk that is found in markets today is baby walker. However, the existence of baby walker now is still not guarantee the safety of toddlers when used. According to some previous study, among all products for babies, baby walker is the first cause of the baby accident with significant figures. In addition, in using this tool, parents should always keep an eye on the movement of their children. This study will make an alternative design of ergonomic walk learning tool for toddlers, in accordance with the wishes of the parents and may reduce the occurrence of accidents or injury to the children coupled with new innovations which are more attractive. Data were obtained from a preliminary survey using interviews, anthropometric data measurement and questionnaire with the method of Quality Function Deployment (QFD). The data obtained is used as a reference to design an alternative model of walk learning tool for toddlers. The design was created using AutoCAD software version 2008 and 3ds Max 2010 version. The design is expected to provide benefits to many parties, especially to reduce the rate of accidents due to the use of baby walkers in toddlers.

Keywords: walk learning tool, toddler, ergonomics, QFD

1 INTRODUCTION

The process of children growth and development consists of several stages. For newborns, the process takes a long time so the children can grow perfectly. The process starts from the child learn on his stomach, crawling, standing, walking, until talking up. Those processes require at least one year (Oning, 2013).

The process of children growth and development which is highly desirable and eagerly awaited by parents is when the child begins to learn to walk (toddler). Most parents use walking aids to help their toddlers learning to walk. There are many types of walking aids found in the market today, such as the Moonwalk, Push Baby Walker, Walker Stationary, Study Aids Walk, Traditional Baby Walker and Baby Walker. Among them, baby walker is the most familiar used by parents.

However, the presence of baby walkers in the market today, do not ensure the safety of children when used. American Academy of Pediatrics (APP) revealed that the use of baby walkers can bring in accident or injury to the baby. It also results in the late of baby in walking (Boudreault, 1995 as quoted by Rodgers & Leland, 2008). Tiafani et al. (2013) stated that due to the use of baby walker, children can experience poor physical growth such as bow-leggedness (Genu varum) and walk on their tiptoes because of the dimension mismatch of baby walker with children's body dimensions.

Preliminary survey was also conducted on the existence of walk learning tools for toddlers available today. The survey was conducted through interviews of 33 respondents in Padang and Pariaman who knew about the tools. Results of interviews found that there are still many weaknesses of the tools existing today. Then, respondents suggested that a good walk learning tool for toddlers should be safe, comfortable, well-built, no sharp surfaces, have toys and education, and does not cause bad effects to the children's physical growth.

Therefore, it is necessary to design an ergonomic walk learning tool for toddlers, as an alternative design to complement the existing product limitations. The alternative designs are expected to meet the

needs and desires of parents to ensure their children's safety.

2 METHODOLOGY

2.1 *Questionnaire Design of Quality Function Deployment (QFD)*

The design of QFD questionnaire refers to the results of preliminary survey through interviews. It also refers to the dimensions of quality according to David A. Garvin (1988). The criteria used are performance, features, strength and durability, conformance to standards, as well as aesthetics. Scale used for the design of the questionnaire is a Likert rating scale with a range of 1-5 for the assessment is not important (1) to very important (5).

2.2 *Anthropometric Data Collection*

Thirty four toddlers with the age between 9-18 months were recruited to participate in measurement of anthropometric data. The collected data are consisted of:

a. Shoulder height
b. Bust
c. Elbow height (from the base footing)
d. Shoulder width
e. Forearm length

2.3 *QFD Data Collection*

Questionnaire to build QFD collected from 50 respondents who were in Padang and surrounding areas. The questionnaire given to respondents who knew about the walk learning tools for children.

2.4 *Data Processing*

2.4.1 *Anthropometry*

Anthropometric data were analyzed using a Minitab v.14 software to find out the normality of data, the average value, the standard deviation, and percentiles.

2.4.2 *QFD Questionnaire*

The collected QFD questionnaires were tested for validation and reliability. Then, the collected data were processed using two-phase of QFD design. The first phase is called the product design phase (House of Quality) and the second phase to obtain the design characteristics of the alternative design of walk learning tool for toddlers.

The detail steps to make the design of QFD in this study are:

a. Determine the needs of the consumer and the consumer's interest rate
b. Determine the technical characteristics
c. Translating customer needs into measurable engineering requirements
d. Determine the relationship of each technical characteristics
e. Determine the priority of the technical characteristics
f. Determining the design characteristics
g. Determining the relationship between the technical characteristics and the design characteristics
h. Determine the priority of the design characteristics

2.5 *Product Design*

AutoCAD software 2009 version was used to design the alternative walk learning tool by implementing the features desired by the respondents using QFD method.

3 RESULTS

Table 1 presents the data summary for mean, standard deviation, 5^{th} and 95^{th} percentile of the measured anthropometric data.

Table 1. The summary of anthropometric data from 34 respondents with the age between 9-18 months.

Anthropometric Data	Mean (cm)	SD (cm)	5th Percentile (cm)	95th Percentile (cm)
Shoulder Height	50.53	2.60	46.26	54.80
Bust	45.74	2.42	41.76	49.71
Elbow Height	40.59	1.48	38.15	43.02
Shoulder Width	21.47	0.75	20.24	22.47
Forearm Length	18.82	1.03	17.13	20.52

The process of identification of customer needs (voice of customer) is the first step in designing a product. The desire of consumers who obtained from the initial interview survey are the product is safe, comfortable, sturdy, no sharp surfaces, has toys, has handrails, and using traditional tools mechanisms (rotates 360^0), not cause accidents due to falls from a height and do not adversely affect the physical growth of the child's body. In addition, the determination of consumer needs done also by distributing questionnaires to 50 respondents as the study sample. The results of the questionnaire were weighted in order to obtain the value of consumer's interest level (Table 2). Table 2 shows that the res-

pondents stated the criteria in the questionnaire are at the level of "very important", "important", and "quite important".

Table 2. The Level of Consumer Interests

Design Criteria	Consumer Interest Level
The side is not sharp	4.50
Not easily broken	4.30
Equipped with retaining body features	4.26
Safe materials (non-toxic)	4.22
Conformity with the body size	4.20
Material of safety features is soft and comfortable	4.18
Comfortable in use	4.16
Using anti-rust coating materials	4.10
Has grip availability	4.02
Ease of use	3.86
Durable material	3.84
Ease moved	3.72
Attractive design	3.50
Has color variations	3.50
Interesting toy design	3.50
Has toys	3.16

The technical characteristics represent the voice of the developers (technical response). It is the consumers' desire in the technical form. In this section, the process is validated to a technical expert. Based on the discussions, it was found the technical characteristics considered in the product design (House of Quality 1, HOQ 1). The percentages of the priority value for technical characteristics are shown in Table 3.

Table 3. Percentage of priority values for technical characteristics

Technical Characteristics	% Priority
Mechanism of use	15
The bottom tool equipped with wheels	9
Availability of seat belt	10
Type of seat belt material	10
Availability of supporting facilities	13
Frame is made from strong and sturdy material	10
Type of coating materials	6
Ergonomic design	10
Display design	18

The next step is to describe the technical characteristics in the form of design characteristics. Design characteristics were obtained from discussions with a technical expert. Then, in the House of Quality 2 (HOQ 2), it is shown the relationship between technical characteristics and design characteristics. Table 4 presents the percentages of priority value for the design characteristics.

Table 4. Percentage of priority values for technical characteristics

Design Characteristics	% Priority
Using a 360^0 rotating mechanism	8
Using the fiber wheels	8
Using the stopper on wheels	8
Using seat belts wrapped around the child's chest	13
Seat belt material made of soft foam	9
Seat belt material coated by soft cloth	9
Has various kinds of toys	7
Handrails in accordance with the dimensions of the average grip	9
Using stainless steel pipe	6
Using the *zincalume* coating materials	2
The dimensions appropriate children anthropometric data	5
Every corner is curved or given rubber	8
Variegated color seatbelts	7

Therefore, based on the results of data processing, it is obtained the features to design the ergonomics walk learning tool for toddlers. The features consist of:

a. Using a 360^0 rotating mechanism
b. Using seat belts
c. Equipped with toys
d. There is handrail
e. Using wheels with stopper

Figure 1 and 2 show the results of alternative design of ergonomics walk learning tool for toddlers.

Figure 1. The alternative design of ergonomics walk learning tool for toddlers

Figure 2. The seatbelt for alternative design of ergonomics walk learning tool for toddlers

The specifications of the products are:

a. Material for construction frame: Iron Stainless Steel
b. Material footing pedestal and table toys: Fiberglass
c. Seatbelt material: Foam Sponge and Cotton Fabrics
d. Dimensions:
   - Pole Body Buffer Height = Shoulder height (P_{95}) + allowance = 54.80 cm + 5 cm = 59.80 cm ≈ 60 cm
   - Seat Belt Hanger Width = Shoulder width (P_{95}) + allowance = 22.70 cm + 5 cm = 27.70 cm ≈ 28 cm.
   - Seat Belt = Bust (P_{95}) = 49.71 cm ≈ 50 cm.
   - Handrails height from the floor = Elbow height (P_{50}) = 40.59 cm ≈ 41 cm.
   - Reach distance to the toys = Forearm length (P_{95}) = 20.52 cm ≈ 21 cm.
   - Wheels = 2.5 cm (radius) and 4 cm (thick).

4 CONCLUSION

This study has succeeded in making an alternative design of ergonomics walk learning tool for toddlers. It is expected to reduce accidents in children and meet the wishes of the parents. Features contained in the draft is based on the needs of the consumer, such as using a 360^0 rotating mechanism, equipped with a comfortable seat, there is a handrail, there are toys that provide educational facilities, and equipped with wheels. The product has also met the ergonomic aspects which refer to the anthropometric data for toddlers. The selection of materials used is safe, comfortable, and not harmful to the child, stainless steel, fiberglass, foam sponge, and a soft cotton cloth. For the future research, will be conducted a study to evaluate the design, develop a draft design in accordance with the conditions and the latest technology, and build prototypes.

REFERENCES

Garvin, D.A. (1988). *Managing Quality: The Strategic and Competitive Edge*. Harvard Business School.

Oning, Deny. (2013). Cara Anak Biat Cepat Jalan. Diakses pada 17 desember 2013 dari http://tipscaramendidikanak.blogspot.com/2013/07/cara-anak-biar-cepat-jalan.html.

Tiafani, R., Desrianty, A., Caecilia (2013). Rancangan Perbaikan Alat Bantu Jalan Anak (Baby Walker) Menggunakan Metode Theory of Inventive Problem Solving (Triz). *Reka Integra*, Vol. 1(3): 67-76.

Rodgers, G.B & Leland, E.W. (2008). A retrospective benefit-cost analysis of the 1997 stair-fall requirements for baby walkers. *Accident Analysis and Prevention*, 40: 61–68.

Alternative Design of Ergonomic Walk Learning Tool for Toddlers using Quality Function Deployment (QFD)

ORIGINALITY REPORT

7%	0%	7%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

8%

★ "Industrial Engineering, Management Science and Applications 2015", Springer Nature America, Inc, 2015

Publication

Exclude quotes	On	Exclude matches	< 2%
Exclude bibliography	On		