

## DESIGN OF BABY SWINGS BY RATTAN CRAFT SMES USING THE QUALITY FUNCTION DEPLOYMENT METHOD

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### Abstrak

Saat ini, Industri Kecil dan Menengah (IKM) dituntut mampu memenuhi kebutuhan konsumen melalui pengembangan produk yang inovatif agar dapat bersaing di pasar. Berdasarkan hasil wawancara dengan pelanggan produk kerajinan rotan, ayunan bayi menjadi produk yang paling banyak memperoleh keluhan, khususnya pada aspek keamanan, kenyamanan, dan ketahanan. Oleh karena itu, penelitian ini berfokus pada perancangan ulang produk ayunan bayi berbahan rotan agar sesuai dengan kebutuhan pelanggan dan mampu bersaing dengan produk rumah tangga modern. Penelitian ini bertujuan untuk menentukan kebutuhan desain dan karakteristik teknis yang diinginkan pelanggan. Metode penelitian meliputi pengumpulan data, penyusunan *Quality Function Deployment* (QFD) Fase 1 dan Fase 2, serta pengembangan desain produk. Hasil QFD Fase 1 menunjukkan bahwa kebutuhan desain pelanggan mencakup aspek ekonomis, ergonomis, ketahanan, estetika, dan fitur. Sementara itu, hasil QFD Fase 2 menunjukkan bahwa karakteristik teknis yang perlu dipenuhi produsen meliputi penggunaan data antropometri, modifikasi desain, pemilihan bahan baku berkualitas, warna yang menarik, matras yang nyaman, serta material yang bebas dari zat kimia berbahaya. Dimensi ayunan ditentukan berdasarkan data antropometri orang dewasa dan bayi dengan mengacu pada persentil ke-50 tinggi pinggul orang dewasa serta persentil ke-95 jangkauan dan rentang lengan bayi.

**Kata Kunci:** Ayunan Bayi, Ergonomi Antropometri, Perancangan Produk, *Quality Function Deployment*,

### Abstract

Currently, *Small and Medium Enterprises (SMEs)* are required to meet consumer needs by developing innovative products to compete in the market. Based on interviews with customers of rattan handicraft products, baby swings receive the most complaints, particularly regarding safety, comfort, and durability. Therefore, this study focuses on redesigning rattan baby swings to align with customer needs and compete with modern household products. To achieve this, the study identifies the design requirements and technical characteristics desired by customers through data collection, *Quality Function Deployment (QFD) Phases 1 and 2*, and product design development. The results of Phase 1 QFD indicate that customer design needs encompass economic, ergonomic, durability, aesthetic, and feature aspects. Meanwhile, the results of Phase 2 QFD indicate that the technical characteristics manufacturers must meet include the use of anthropometric data, design modifications, selection of high-quality raw materials, attractive colors, comfortable padding, and materials free from hazardous chemicals. The swing dimensions were determined based on anthropometric data for adults and infants, referencing the 50th percentile of adult hip height and the 95th percentile of infant arm reach and span.

**Keywords:** Baby Swing, Ergonomic Anthropometry, Product Design, *Quality Function Deployment*

## 1.0 INTRODUCTION

Small and Medium-sized Enterprises (SMEs) encompass everything from home-based businesses to small and medium-sized industries, which are easily established by people from lower-middle-income groups. They are often labour-intensive and drive the local economy. In terms of workforce size, small enterprises employ between 5 and 19 people, whilst medium-sized enterprises employ between 20 and 99 people [1]. SMEs must enhance their competitiveness and quality, and continue developing new innovations to remain competitive and survive in the market.

Anil Rotan, a small and medium-sized enterprise (SME) located in Padang, Indonesia, manufactures various rattan crafts, including guest chairs, swings, trestles, elephant chairs, room dividers, oshin tables, patio chairs, rocking chairs, and lounge chairs. The company has an average production capacity of 10 items per week and employs 10 workers. To remain competitive with modern household product manufacturers, the SME must deliver high-quality rattan crafts that align with customer expectations. Currently, its products do not meet national or international standards. Customer interviews indicate that rattan swings receive the most complaints, particularly regarding product safety, comfort, and durability. Consequently, research is required to redesign a household rattan craft product, specifically the baby swing, to better satisfy consumer expectations and enhance competitiveness with modern household products. Figure 1 presents an image of the rattan swing produced by Anil Rotan.



Figure 1: Rattan Swing Product

Various studies have been conducted on product design, including the identification of design requirements for lubricants [2], wall shelves [3] and book shelves [4], shoes [5], whiteboard erasers [6], file organizer [7], sunscreen packaging [8], and SMEs products such as amplang crackers [9] and madura corn rice [10] using the QFD method. In these studies, researchers distributed questionnaires to consumers to identify customer needs. These needs were then used to produce the Phase 1 House of Quality (HOQ) design.

Another study analysed whether consumer purchasing decisions align with the relevant technical characteristics of health products using the QFD method [11]. A subsequent study integrated multi-criteria decision-

making and QFD methods to improve decision-making processes in the renewable energy sector [12]. Research combining the QFD, TRIZ, and Kano methods has also been conducted on the design of a grain threshing machine, a product of the small and medium-sized industry [13]. This study was motivated by the fact that the grain threshing machine is a product of small and medium-sized enterprises and does not yet have an Indonesian National Standard. Another study aimed at improving customer satisfaction identified cabin interior requirements for high-speed trains in China using the QFD method [14].

The novelty of this study lies in integrating QFD and contextual ergonomics into traditional rattan production systems. In this study, QFD was used as a systematic framework to translate user input, workers' physical limitations, rattan characteristics, and occupational comfort and safety requirements into technical product design specifications. The main contribution of this study is to demonstrate how ergonomic principles can be adapted to traditional craft production systems that still rely on manual skills, simple tools, and work patterns based on local experience. Thus, this study provides an applied contribution to the development of more ergonomic rattan designs without losing the traditional values and characteristics of the production process, while also expanding the application of QFD in the context of manual labour-based craft industries.

## 2.0 METHOD

The stages of the research methodology employed in this study are shown in Figure 2.

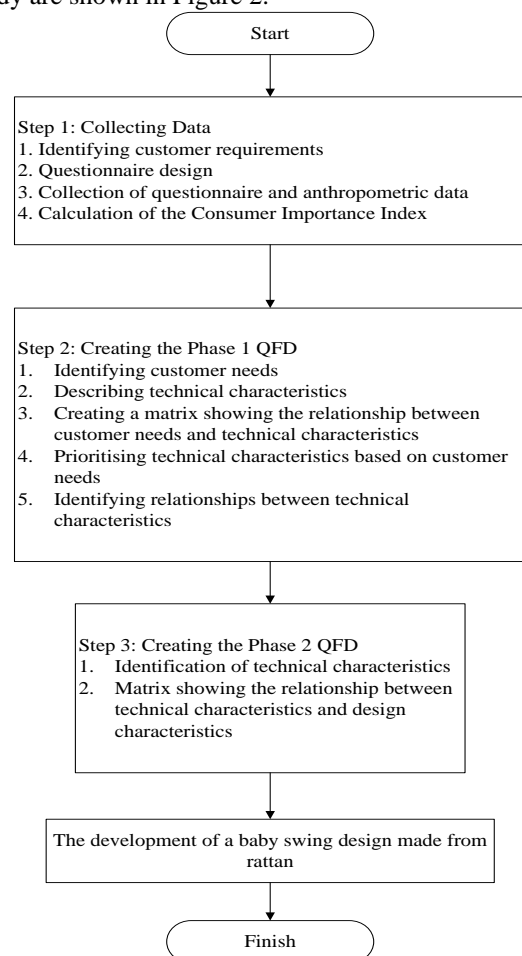


Figure 2: Research Methodology

### 3.0 RESULTS AND DISCUSSION

#### 3.1 Identification of Customer Requirements

Determining customer needs in product design using the Quality Function Deployment (QFD) method begins by defining QFD: a structured approach for translating customer requirements into specific product attributes. The process starts by identifying the product's target users, or primary customers. This stage aims to ensure that the required information is obtained from individuals who truly understand, use, or experience the product's benefits. After the target customers are identified, the researcher collects the voice of the customer through observation, preliminary interviews, customer complaint analysis, review of similar products, or discussions with users. The data obtained at this stage are usually still in the form of open statements, such as customer expectations, complaints, preferences, and experiences related to the product.

Following the identification and collection of customer input, the next stage is processing the *voice of the customer* into more systematic customer need attributes. Customer statements with similar meanings are grouped to avoid repetition. Each statement is then reformulated into clearer, concise, and measurable need indicators. These attributes serve as the basis for defining customer needs, which will later be included in the *House of Quality* matrix.

Customer needs were identified based on data from SMEs, online research, and preliminary interviews with customers of rattan swings. The results revealed several characteristics that customers seek in rattan swing products: portability, affordable pricing, durability, comfort and ergonomics, rattan that is safe for the skin, attractive weaving patterns and colors, high-quality materials, easy cleaning, absence of hazardous chemicals, easy storage, and strength.

#### 3.2 Questionnaire Design

The questionnaire is designed to measure the importance of each attribute from the customer's perspective. Each customer need attribute is converted into a questionnaire item and assessed using a specific scale, such as a 1–5 Likert scale, ranging from very unimportant to very important. The questionnaire results are then analyzed to determine the priority of customer needs. These priorities serve as the basis for translating customer needs into technical product characteristics, ensuring the final design is better aligned with user expectations and supported by a systematic decision-making process.

The questionnaire was designed based on customer needs. Based on the identified customer needs, these were grouped into five dimensions of product quality: economic, ergonomic, durability, aesthetic, and feature. Questions were then designed to assess each of these quality dimensions. The questionnaire consists of three sections: respondent data, the importance rating questionnaire, and the satisfaction rating questionnaire. The 30 respondents who completed the questionnaire for the design of a rattan baby swing were all female and had previously used a rattan baby swing. The sample size of 30 respondents was determined based on the central limit theorem, which states that the sampling distribution (for sample sizes of 30 or more) will be centred on the


population parameter and will have all the properties of a normal distribution [15].

#### 3.3 Ergonomics Data

Product design using ergonomic data in the QFD method is carried out to ensure that the product design not only meets customer needs but also aligns with the users' abilities, limitations, and comfort. Ergonomic data may include anthropometric data, working posture, hand reach, physical strength, user comfort, and safety aspects. In the QFD process, ergonomic data serve as a basis for translating customer needs into technical product characteristics. Therefore, using ergonomic data in product design through QFD can yield a design that is more functional, safer, more comfortable, and better suited to the characteristics of the target users.

The redesign of a rattan baby swing considers ergonomic factors. The anthropometric data used consist of two types: infant and adult women anthropometric data, as shown in Tables 1 and 2. This anthropometric data is supplemented with percentile measurements, which indicate the percentage of people whose measurements are at or below a given value. For example, the 5th percentile indicates that 5% of the population will have measurements at or below that value.

Table 1: Anthropometric Data for Adult Women

Dimension	5 <sup>th</sup>	50 <sup>th</sup>	95 <sup>th</sup>	SD	Illustration
D5/Hip height	90.92	92.56	94.21	5.8	

Source : [16]

Table 2: Infant Anthropometric Data

Dimension	5 <sup>th</sup>	95 <sup>th</sup>
Arm Span	61.069	77.65
Standing Arm Reach	70.572	101.827
Arm's Reach	19.175	28.024

Source : [16]

#### 3.4 Calculation of the Consumer Importance Index

Customer needs regarding rattan baby swings were identified through direct interviews with users. This primary data informed the purposive selection of respondents for the initial exploratory phase, based on experience with rattan baby swings. Subsequently, Consumer Importance Index (CII) data were collected after validity and reliability tests on 30 respondents.

The Consumer Importance Index is calculated to determine the priority level of each customer need related to the product being designed. This calculation is generally obtained from the customer needs questionnaire, in which respondents are asked to assess each need attribute using a specific scale, such as a 1–5 Likert scale. Before calculating the Consumer Importance Index (CII), the questionnaire data must be assessed for validity and reliability. These tests ensure that each item

accurately captures customer needs and delivers consistent results. If the data lacks validity or reliability, the resulting CII may be inaccurate because it would be based on an unsuitable instrument.

Validity testing can be conducted using Pearson's product-moment correlation. Specifically, this test is performed by correlating each item's score with the total score. If an item's correlation value is high, then that item has a strong relationship with the total construct being measured, indicating suitability for further analyses. At a 5% significance level, the critical r value for  $df = 28$  is approximately 0.361. Accordingly, an item is considered valid if the calculated r value is greater than the critical r value and the significance level is less than 0.05. The formula for Pearson's correlation is as follows.

$$r_{xy} = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}} \quad (2)$$

Where X is the score for each item, Y is the respondent's total score, n is the number of respondents, and r is the correlation coefficient between the item and the total score. Based on Table 3, all items have a calculated r value > 0.361 and a p-value < 0.05. Therefore, all items are deemed valid.

Table 3: Validity Test

Item	r-value	p-value	r-table	Decision
X1	0.972	<0.001	0.361	Valid
X2	0.815	<0.001	0.361	Valid
X3	0.970	<0.001	0.361	Valid
X4	0.417	0.022	0.361	Valid
X5	0.965	<0.001	0.361	Valid
X6	0.883	<0.001	0.361	Valid
X7	0.674	<0.001	0.361	Valid
X8	0.739	<0.001	0.361	Valid
X9	0.891	<0.001	0.361	Valid
X10	0.834	<0.001	0.361	Valid
X11	0.954	<0.001	0.361	Valid
X12	0.819	<0.001	0.361	Valid
X13	0.883	<0.001	0.361	Valid

Reliability testing is generally conducted using Cronbach's Alpha. The Cronbach's Alpha value indicates the level of internal consistency among the items in a single instrument. The formula for Cronbach's Alpha is as follows.

$$\alpha = \frac{k}{k-1} \left( 1 - \frac{\sum S_i^2}{S_t^2} \right) \quad (3)$$

Where:  $\alpha$  is the Cronbach's Alpha value, k is the number of items, and  $S_i^2$  is the variance of each item.  $S_t^2$  is the variance of the total score. The instrument is considered reliable if the Cronbach's Alpha value is  $\geq 0.70$ . If the Alpha value is less than 0.70, the instrument needs to be revised because the items do not yet demonstrate adequate internal consistency. Based on Table 4, a Cronbach's Alpha value of 0.967 indicates that the instrument has very high reliability.

Table 4: Reliability Test

Number of Items	Cronbach's Alpha	Criteria	Decision
13	0.967	$\geq 0.70$	Reliable

The scores for each attribute are then summed and averaged to identify how important the attribute is from the customer's perspective. Furthermore, the average score for each attribute can be compared with the overall average to obtain the attribute's weight or consumer importance index. The result of this calculation serves as the basis for identifying which customer needs should be prioritized in the house of quality matrix. Therefore, the product design developed is not based solely on the designer's assumptions, but is supported by a measurable, systematic assessment of customer priorities.

To determine the level of importance of the variables related to rattan baby swings for customers, a CII calculation was performed, as shown in Table 5. The CII for attribute 1 was the weighted average of 30 responses: 22 rated it "very important," 6 "important," and 2 "moderately important." No one chose "less important" or "unimportant." The resulting CII value was 4.667, indicating that customer need (1) is considered very important.

Table 5: Calculation of Consumer Importance Level

Row	Aspect	Customer Needs/ Attribute	Respondents' Answers					Total	CII
			Very Important	Important	Moderately Important	Less Important	Not Important		
1	Economic Aspects	Handcrafted rattan baby swings are sold at affordable prices	22	6	2	0	0	30	4.667
2		The price of rattan baby swings reflects their quality	12	17	1	0	0	30	4.367
3		The price of rattan baby swings is commensurate with their benefits and functions	18	10	2	0	0	30	4.533
4	Ergonomic Aspects	This rattan baby swing is comfortable to use	20	9	1	0	0	30	4.633
5		The size of the rattan baby swing is tailored to the user's body size	5	15	6	4	0	30	3.700
6		Rattan baby swings do not pose a risk of injury when used	16	11	3	0	0	30	4.433

Row	Aspect	Customer Needs/ Attribute	Respondents' Answers					Total	CII
			Very Important	Important	Moderately Important	Less Important	Not Important		
7	Durability Aspects	A durable rattan baby swing	16	7	6	0	1	30	4.233
8		Baby swing made from durable rattan craftwork	12	14	3	0	1	30	4.200
9	Aesthetic Aspects	This rattan baby swing features an attractive woven pattern	1	12	12	5	0	30	3.300
10		The rattan baby swing has attractive colors	2	13	10	2	3	30	3.300
11		This rattan baby swing is easy to clean	2	18	10	0	0	30	3.733
12	Feature Aspects	Easy to carry around	1	1	3	12	13	30	1.833
13		Easy to store	1	9	8	5	7	30	2.733

### 3.5 QFD Stage 1

The first stage of the Quality Function Deployment (QFD) method focuses on gathering customer needs, which are then translated into technical product specifications. The steps in QFD Phase 1 are as follows. First, customer needs were identified through the collection of QFD questionnaire data, resulting in a ranking of importance from highest to lowest. Customer needs with the highest importance scores indicate the highest priority for fulfilment in product design. Table 6 below shows the ranking of customer needs.

Table 6: Customer Needs

Row	Customer Needs	CII	CII Rankings
1	Handcrafted rattan baby swings are sold at affordable prices	4.667	1
2	This rattan baby swing is comfortable to use	4.633	2
3	The price of rattan baby swings is commensurate with their benefits and functions	4.533	3
4	Rattan baby swings do not pose a risk of injury when used	4.433	4
5	The price of rattan baby swings reflects their quality	4.367	5
6	A durable rattan baby swing	4.233	6
7	Baby swing made from durable rattan craftwork	4.200	7
8	This rattan baby swing is easy to clean	3.733	8
9	The size of the rattan baby swing is tailored to the user's body size	3.700	9
10	This rattan baby swing features an attractive woven pattern	3.300	10
11	The rattan baby swing has attractive colors	3.300	11
12	Easy to store	2.733	12
13	Easy to carry around	1.833	13

Next, the product's technical characteristics were obtained through direct interviews with rattan craftsmen. The data collected consisted of primary data obtained through a qualitative approach, gathered directly from

individuals with firsthand experience in the production process. Respondents were selected using purposive sampling, which involves choosing informants who understand the materials, design, dimensions, strength, safety, and manufacturing process of rattan baby swings. Table 7 below shows the technical characteristics of rattan baby swings.

Table 7: Technical Characteristics

Row	Technical Characteristics
1	Ergonomic Product Design
2	Product Dimensions
3	Baby Swing Stand Design
4	A variety of woven designs
5	Providing a comfortable mattress pad for babies
6	Paint products available in a variety of colors
7	The paint products used are safe for babies
8	The materials used are high-quality

Furthermore, the matrix of the Relationship Between Customer Needs and Technical Characteristics was developed. The relationship matrix is used to assess the relationship between customer needs and technical characteristics. The matrix contains values and symbols used to indicate these relationships, as shown in Table 8.

Table 8: Symbols and Values in Relationships

Row	Symbols	Description	Value
1	Empty	No Connection	0
2	Δ	Weak Correlation	1
3	○	Moderate Relationship	3
4	⊙	Strong Relationship	9

Source : [13]

The technical characteristics to be used in Phase 2 of QFD are determined at this stage. A summary of the priority values for the technical characteristics is presented in Table 9. The priority values for the technical characteristics are calculated by multiplying the customer

need level by the correlation coefficient in the correlation matrix between customer needs and technical characteristics, using the following equation [13].

$$NP_j = (TK_j \times NH_{ij}) \tag{3}$$

Where,  $NP_j$  = Priority values of technical characteristics,  $TK_j$  = Level of customer importance,  $NH_{ij}$  = The relationship between technical characteristics and customers.

Table 9. Priority Values of Technical Characteristics

Row	Technical Characteristic	Absolute Priority Value	Priority Percentage	Order of Priority
1	Ergonomic Product Design	128.000	18.0%	3
2	Product Dimensions	87.633	12.3%	4
3	Baby Swing Stand Design	136.400	19.2%	2
4	A variety of woven designs	47.467	6.7%	6
5	Providing a comfortable mattress pad for babies	44.967	6.3%	8
6	Paint products available in a variety of colors	47.467	6.7%	7
7	The paint products used are safe for babies	51.900	7.3%	5
8	The materials used are high-quality	167.300	23.5%	1

Subsequently, the relationships among technical characteristics are identified. This step aims to examine the relationships among each technical characteristic. The relationship scores for QFD Phases 1 and 2 were determined through expert judgment, specifically by rattan craft business owners and researchers serving as facilitators. Consumers were only involved in the stages of identifying needs and assessing levels of importance, not in determining the technical relationships. The degree of correlation is expressed using symbols, as shown in Table 10.

Table 10: Description of the Correlation Level Symbol

Row	Symbols	Description
1	√√	Strong Positive Correlation
2	√	Weak Positive Correlation
3	Empty	No Correlation
4	××	Strong Negative Correlation
5	×	Weak Negative Correlation

Source : [13]

Figure 3 shows the results of stage 1 of the Quality Function Deployment (QFD) process, illustrating the relationship between customer needs and product technical specifications. At this stage, previously identified customer needs are translated into technical characteristics that are measurable and controllable by the manufacturer. The results provide an overview of the technical attributes prioritised for development based on their importance to customers. Thus, Figure 3 not only maps customer needs but also serves as the basis for more systematic product improvement and development.

		Technical Characteristics	Ergonomic Product Design	Product Dimensions	Baby Swing Stand Design	A variety of woven designs	Providing a comfortable mattress pad for babies	Paint products available in a variety of colors	The paint products used are safe for babies	The materials used are high-quality								
											Importance Level	Design			Material			
											Consumer Requirement	Handcrafted rattan baby swings are sold at affordable prices	4.714				Δ	Δ
This rattan baby swing is comfortable to use	4.667	●	●	●		○												
The price of rattan baby swings is commensurate with their benefits and functions	4.571			Δ					Δ									
Rattan baby swings do not pose a risk of injury when used	4.429	●	Δ	●		○		Δ										
The price of rattan baby swings reflects their quality	4.381	○		Δ	○	○	○	○	●									
A durable rattan baby swing	4.333								●									
Baby swing made from durable rattan craftwork	4.381			○					●									
This rattan baby swing is easy to clean	3.762								Δ									
The size of the rattan baby swing is tailored to the user's body size	3.762	●	●	●														
This rattan baby swing features an attractive woven pattern	3.381				●													
The rattan baby swing has attractive colors	3.286						●	●										
Easy to store	2.571		○															
Easy to carry around	1.714		○						Δ									
<b>Importance Rating</b>			128.857	88.000	137.810	48.286	45.143	47.429	51.857	170.333								
<b>Relative (%)</b>			18.0%	12.3%	19.2%	6.7%	6.3%	6.6%	7.2%	23.7%								

Figure 3: QFD Phase 1

### 3.6 QFD Stage 2

At this stage, the rattan baby swing is redesigned based on technical characteristics. The technical characteristics used are those that do not contradict one another in their interrelationships. In Phase 2 of QFD, the technical characteristics of the rattan swing product were determined by translating the technical priorities identified in Phase 1 of QFD into more specific component characteristics. This stage involved identifying the design elements that most significantly influence the fulfilment of customer needs, such as the rattan raw material, seat dimensions, weaving patterns, joint systems, frame strength, and finish types. For example, the customer's need for a portable product is

translated into product weight, the assembly and disassembly system, and frame dimensions, while the need for comfort and safety is translated into ergonomic aspects, surface smoothness, and the selection of skin-safe materials. Thus, QFD Phase 2 plays a crucial role in guiding the development of the rattan swing's design to be more measurable, systematic, and aligned with customer needs.

This study focuses on the redesign of a rattan baby swing using anthropometric data from two user groups: infants aged 0–12 months and adult women. The design process utilises specific anthropometric measurements and relevant percentiles. First, the distance from the

swing to the floor was determined using the 50<sup>th</sup> percentile of adult hip height, which is 92.56 cm.

Next, the length of the swing was established based on the anthropometric data for the upward arm reach of an infant standing upright at the 95<sup>th</sup> percentile, which is 101.828 cm. Following this, the width of the swing was determined using the arm span of an infant at the 95<sup>th</sup> percentile, measuring 77.650 cm. Lastly, the swing height from the mattress was set using the infant’s arm reach length at the 95<sup>th</sup> percentile, which is 28.024 cm.

Based on interviews with rattan craft producers, there should be no wooden support at the top of the swing. This is to ensure that the baby’s head does not hit the top support when the mother places the baby in the swing.

Varied weaving designs is used, with more varied, modern designs so traditional rattan crafts can compete with modern furniture. In addition, providing a comfortable mattress for babies is important, as rattan baby swings require a comfortable, soft mattress since babies' bodies are delicate.

Furthermore, using paint with a wider variety of colors is necessary. These SMEs, when producing rattan crafts—particularly baby swings—currently use only wood varnish. Therefore, innovation is needed to give these rattan crafts attractive colors and to customize them to meet customer preferences. This will make rattan crafts more competitive with modern furniture today and increase customer demand. The various wood paint color options available include natural, fancy, and dark colors.

Paint products safe for babies should be prioritized. Manufacturers can choose paints labelled lead-free, mercury-free, and low in solvents. This is done to ensure babies are safe from harmful substances. Furthermore, standard wood varnish products commonly available on the market may contain harmful substances because they lack labels indicating they are lead-free, mercury-free, and low in solvents.

In addition, using high-quality materials is important. The quality of rattan is determined by its age; younger rattan is of inferior quality. Therefore, manufacturers must be selective in choosing rattan that is at least 10 years old.

The matrix of relationships between technical and design characteristics in QFD is a tool for linking customer needs to more detailed, measurable design elements. In this matrix, the technical characteristics derived from the customer needs analysis serve as the basis for determining the design characteristics to be embodied in the product. This matrix helps the development team prioritise the most important design elements, avoid duplication of effort, and improve communication across teams. The benefits include translating customer needs into concrete design specifications, facilitating more accurate decision-making, and ensuring the final product better aligns with customer expectations. The results of QFD Phase 2, which illustrate the relationship between technical and design characteristics, are shown in Figure 4.

	Technical Characteristics	Using anthropometric data	Dimensions based on anthropometric data	The top support feature has been removed	A wider variety of swing designs	Made from well-aged rattan	Natural, fancy, and dark paint colors	A soft mattress pad	Paint products free of mercury, lead, and solvent compounds
	CII								
Ergonomic Product Design	18.0%	●	●						
Product Dimensions	12.3%		●	Δ					
Baby Swing Stand Design	19.2%		○	●					
A variety of woven designs	6.7%				●				
Providing a comfortable mattress pad for babies	6.3%							●	
Paint products available in a variety of colors	6.6%						●		
The paint products used are safe for babies	7.2%								●
The materials used are high-quality	23.7%					●			
Absolute Priority Value		1.616	3.295	1.851	0.605	2.136	0.595	0.566	0.650
Priority Percentage		14.3%	29.1%	16.4%	5.4%	18.9%	5.3%	5.0%	5.7%

Figure 4: QFD Phase 2

### 3.7 Product Design

A comparative analysis between the initial product and the QFD-designed product for a rattan swing can be conducted by comparing two main aspects: anthropometric dimensions and modifications to the product’s features.

Anthropometric dimensions refer to human body measurements used as a reference in designing products to meet user needs—in this case, the needs of infants using the swing. The initial product may not fully

accommodate an infant’s body dimensions, such as a suboptimal seat size or a backrest height that does not adequately support the infant’s comfort. However, in the QFD-based design, anthropometric dimensions have been analyzed in greater depth based on customer needs identified in Phase 1 of QFD, such as seat size, backrest angle, and swing height. This new design will be tailored to the baby’s body dimensions more precisely, thereby providing greater comfort and supporting the baby’s posture during swing use.

The next aspect is features modifications. In the initial product, features such as ease of storage, material safety, and comfort may not yet be fully optimized. These features can be further modified in the QFD-based design product based on input from the mapped customer needs. For example, to improve material safety, the design can incorporate smoother rattan that is gentle on a baby's skin, along with a finish free of harmful chemicals. Additionally, portability can be enhanced by adding a folding mechanism to the frame or making the product lighter, allowing it to be easily moved or stored without compromising the swing's stability.

Overall, products developed with QFD emphasise infants' comfort and needs, informed by customer feedback, unlike initial products that follow general design standards. In-depth anthropometric analysis also allows for advanced, user-focused modifications, such as adjustable backrests or added safety features. As a result, QFD products are more likely to satisfy customers and improve functionality than those designed without this approach.

The proposed design adheres to infant product safety principles across three areas: structural strength, material safety, and injury prevention, as outlined by the Consumer Product Safety Commission (CPSC) [17]. The structural strength aspect focuses on the frame's and joints' ability to safely support the baby's weight. The material safety aspect focuses on using non-toxic, easy-to-clean materials free of hazardous substances. The injury prevention aspect focuses on eliminating sharp edges and corners, pinching gaps, small parts that can easily come loose, and potential product instability. However, full compliance with safety standards cannot be declared until user testing and certification based on standards appropriate for the product category have been conducted. In summary, QFD-designed products shown in Figure 5 offer advantages in design customisation and feature enhancements aligned with user needs, thereby better meeting customer expectations and providing a superior experience.

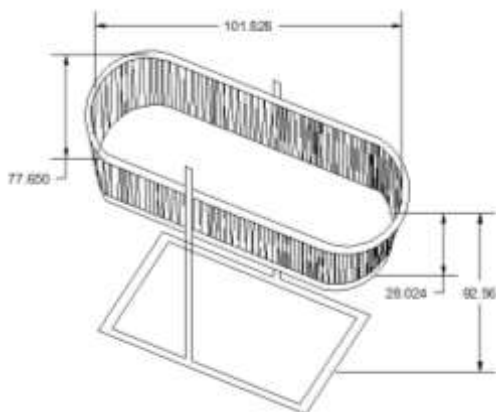


Figure 5: Baby Swing Products Using the QFD Method

Product design validation ensures the final design aligns with customer requirements and is technically viable. This process generally engages both MSME owners and customers. Common validation methods include developing prototypes and conducting in-person interviews to demonstrate measurable improvements in cost-efficiency, usability, durability, appearance, and distinct product features.

Several previous studies on product design using the QFD method were limited to QFD Phase 1, such as in the design of sunscreen packaging [8], Jogja gudeg

packaging [18], pouch bags [19] and turmeric-and-tamarind drink products [20]. Some studies have combined the QFD method with the Kano model for roasted melinjo nut products [21] and with anthropometry for ironing cabinet products [22]. In contrast, this study applies both QFD Phases 1 and 2, integrating anthropometric ergonomics, to enhance non-standardized rattan swing products from MSMEs to better meet customer expectations.

#### 4.0 CONCLUSION

Based on the study's results, the QFD method significantly improves the quality of rattan baby swings. This method helps small and medium-sized enterprises (SMEs) identify customer needs, tailor designs to market expectations, and boost competitiveness. Customers seek five main design aspects: affordability, ergonomics, durability, aesthetics, and user-friendly features. Accordingly, design characteristics include infant-sized dimensions, a removed upper support structure for practicality, attractive weaving, durable rattan, and safe, market-preferred paint colors. A soft mattress pad and paints that are mercury- and lead-free and low in solvents demonstrate a commitment to safety and health. This study guided the creation of swings that are more functional, attractive, and safe for infants, increasing customer satisfaction and competitiveness.

Theoretically, this study reinforces the concept that Quality Function Deployment (QFD) is an effective approach in customer-driven product development. The research findings support the view that the success of product design is determined not only by technical and production aspects but also by a company's ability to integrate customer needs into design specifications in a structured manner through the House of Quality (HOQ). Furthermore, this study expands the application of QFD to the rattan craft and baby product industries, which have been relatively underrepresented in the national literature to date. Findings on the importance of ergonomics, safety, aesthetics, and ease of use indicate that developing baby products requires a multidimensional approach that integrates principles of ergonomics, product safety, and design quality. Thus, this study provides a conceptual contribution to the development of a consumer-needs-based product design model that prioritises the safety and health of end-users. Additionally, the research results support previous studies indicating that a customer-needs orientation contributes to improved product quality, customer satisfaction, and the competitive advantage of SMEs [23].

In practical terms, this study provides guidance for SMEs in the rattan industry on designing products that better align with market needs. By identifying customers' priority attributes, SMEs can focus their resources on developing product characteristics that offer the greatest value to consumers, such as improvements in ergonomics, safety, aesthetics, and product durability. This approach enables the product development process to be conducted more effectively and in a more data-driven manner, rather than relying solely on the manufacturer's intuition [24].

Additionally, the research findings can serve as a foundation for manufacturers to implement baby product safety principles by selecting safe, health-friendly materials. The use of high-quality rattan, comfortable mattress pads, and mercury- and lead-free paint not only improves product quality but can also serve as a unique selling point that distinguishes the product from

competitors. Implementing the resulting design recommendations has the potential to increase customer satisfaction, strengthen brand image, and enhance the competitiveness of rattan SMEs in both domestic and export markets [25].

A limitation of this study is that prototype testing and user validation have not yet been conducted; therefore, claims regarding improvements in safety, comfort, and usability cannot yet be considered empirical findings. Consequently, the research results are presented as conceptual design proposals based on needs analysis, ergonomic principles, and an assessment of infant product safety. Physical prototype validation and user testing will be the focus of future research.

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