Quality Improvement of Shoes Manufacturing Process at SMEs using the Quality Function Deployment (QFD)

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Abstract

The approach taken in this research is to use the Quality Function Deployment (QFD). Involving customers in the product development process as early as possible is the main goal of QFD, where their needs and wants serve as a starting point. Through a survey, it was found that there are 7 consumer desires, such as the type of shoe is casual, the color of the shoe is black, the thickness of the shoe sole is 2 cm, the position of the logo/brand is on the right, the shoes use laces, the type of shoe body material is leather and the type of tread material is rubber. Meanwhile, five technical characteristics were obtained, namely; Mass of leather and rubber (kg), duration of drawing design (s), duration of gluing (s), duration of drying (s), and duration of sewing (s). The results show that of the five technical characteristics, it is known that the Drying Time is an aspect that needs attention. That is because the level of difficulty is considered high, namely with a value of 4. Improvements in these aspects can then be the main guideline in improving the quality of the process.

Keywords
Quality Function Deployment, UKM, Shoes and manufacturing process

1. Introduction
The relevance of QFD as a tool, in line with the instructions that have been provided in the form that has been submitted, is the fact that consumers and customers are obliged to try to plan the project in fulfillment. Institutional documents used for design improvement and subsequent detail analysis are representations of general reference points for the outcomes acquired.

The manufacturing process in shoe SMEs is generally still loyal to using conventional technology which is manual and simple. The new technology that is more modern, no longer manual, needs to be applied to increase the competitiveness of SME products. In the future, it is necessary to initiate adjustments in the overall production environment. Environmental adjustment is needed as a basis for success in the operation of new technological processes, as well as to ensure a match between consumer desires and producer capabilities.

QFD is an approach taken to determine consumer needs in a structured manner on leather shoe products from SMEs. By understanding consumer needs, the QFD methodology can help companies to determine the relevant technical needs, where each functional area within the company can understand and act and monitor the right operational processes to achieve the goal of creating products that can satisfy consumers.

QFD is used by first determining who the target consumer is. The target consumers are internal workers from SMEs. They were surveyed with questions about the production process to determine design considerations that would improve its quality in their eyes. This is done with the HOQ matrix. The HOQ matrix, which is known as a representation of QFD, not only provides information about what consumers need but also identifies how important those needs are to consumers. In addition, the HOQ matrix will guide designers to find out how much customer satisfaction is with the current performance of SME shoe production, so that information can be useful in determining the improvement ratio for product attributes and ranking weights that indicate what improvement

priorities should be prioritized by the company. Thus, these needs can be translated into quality characteristics (technical characteristics).

The original application of QFD was first developed for the shipbuilding area (Nishimura, 1972) and the electronics industry (Akao, 1972). Arcidiacono (2006) applies the use of QFD in the design of the suspension reliability improvement of the SAE formula racing car to increase customer satisfaction at the University of Florence, Italy. It was reported that this technique resulted in 10 critical attributes (critical to quality satisfied) desired by consumers and succeeded in reducing dimensions, weight, and machining costs from the initial design. The same research was also conducted on the development of bottled water products (Tutuhatunewa, 2010) which resulted in 7 important attributes for consumers in bottled water quality, namely packaging design and durability, water clarity, taste, ease of obtaining products, price, durability and packaging strength, and water resistance and strength.

1.1 Objectives

The research was conducted because the company wanted to find a solution to the problem of increasing the company's ability to meet customer demands due to the large amount of time needed to assemble the product. Therefore, an analysis is needed to reduce assembly time and reduce unit cost.

Problems in this study were identified using the quality function deployment (QFD) method. QFD is a well-known methodology for customer-oriented product design and development. The purpose of this study was to identify problems in the production process.

2. Literature Review

QFD is a planning process. QFD can help planning companies to support and combine other tools effectively to solve key problems. QFD can help focus consumer concerns with team involvement and the use of other appropriate tools. Companies can understand what is needed to increase customer satisfaction.

QFD will help companies plan the effective use of quality tools by directing these applications to the interests of consumers. Companies use QFD as the main planning tool in TQM. The term Quality Function Deployment is a translation of the Japanese Kanji characters used to describe the QFD process. This term can also be defined as a “customer-based planning process”. QFD helps companies to stop developing products and services based on company perceptions but based on consumer needs. The results obtained are very satisfactory.

The selection of priority items for increased customer satisfaction gives the company a clear focus on the product. Consumer characteristics related to customer satisfaction can be handled using available processes and procedures. QFD is viewed from a global perspective as a methodology that will connect companies with consumers and assist organizations in the planning process. Ordinary organizations understand QFD in terms of “how to build a matrix”. A common result is to build a matrix into a goal. Companies should avoid this. The main goal is not to build a matrix, but to communicate with consumers and use this knowledge to develop products that satisfy consumers. QFD will assist the organization in analyzing all important information related to the project. The priority items selected from the matrix will increase the level of customer satisfaction.

The items on which the company's actions are based are derived from the characteristics of consumers and there will be an increased focus on consumers and their needs. This focus will lead the process towards increasing customer satisfaction.

Successful companies always have data and information used in planning. Engineers should always check the performance and manufacturing data of existing products in planning new products. Engineers see laboratory results or conduct field tests, compare engineer products with competitors' products. Engineers check customer satisfaction information that may be available but the information is incomplete. Data is usually examined individually without comparing it with other data that supports or contradicts the data.

QFD uses a matrix format to record a number of important information in the planning process. The matrix depicts this information in an outline form which allows the company to examine this information multi-dimensionally. This information will lead to effective decisions based on team checks and the integration of critical data.

QFD can be used for a variety of planning challenges. QFD is usually used in the product planning process but QFD can also be used for business planning, project selection, and curriculum planning.

The QFD matrix has two main parts. The horizontal part of the matrix consists of information related to consumers. The vertical portion of the matrix consists of technical information that responds to consumer input. Consumers express their wants and needs through their own language. Consumers may state “want the control buttons to be easy to operate in describing the control buttons of the equipment”. The company must convert the consumer's language into a language that can be used to describe and measure the item and therefore, the company must translate this voice of the customer into "operational effort" or "style required for operation".

Voice of the customer is the basic input needed to start a QFD project. The level of consumer interest is a measure of the relative importance of each consumer's voice. A consumer's competitive evaluation of a product or service helps companies to observe how consumers rate their product on a numerical scale.

The data can be compared with competing products through the same scale value. Every complaint from consumers is interpreted by the company as an indication of dissatisfaction. This information explains the importance of each consumer's voice. This information will be checked by the team to determine which consumer voices are the company's priorities.

The next step after the consumer share of the matrix is determined is to build the technical information section of the matrix. The first step is to determine how the company will translate each consumer's voice. The technical characteristics that companies use to describe and measure each consumer's voice are placed at the top of the matrix. The voice of consumers is in the form of "wanting the control button to be easy to operate", technical characteristics become "operating effort". Other technical characteristics can be “hand clearance” and “tactile force”. These technical characteristics represent the company's way of translating consumer needs, the matrix. The center of the matrix where the consumer and technical characteristics meet records the strength of the relationship between these inputs. Symbols are used to indicate the strength of the relationship. Technical characteristics can be tested in the laboratory or in field trials to evaluate the performance of the company and its competitors. The results are then recorded in the matrix section.

The information on the matrix is checked and weighted by the QFD team. Goal or target values can be created for each technical characteristic. This value describes how much (how much) the target is needed to translate the needs and desires of consumers and to surpass the competitors' targets. In every phase of product development, QFD employs many Concurrent Engineering concepts. As shown in Figure 1, QFD includes four phases that employ a matrix to transform client demands into production control. Each element's connection with the other is assessed. In each step, just the most significant components will be evolved into the following matrix (Eshan S. Jaiswal 2012):

- Phase One: Product planning
- Phase Two: Product design
- Phase Three: Process Planning
- Phase Four: Process Control.

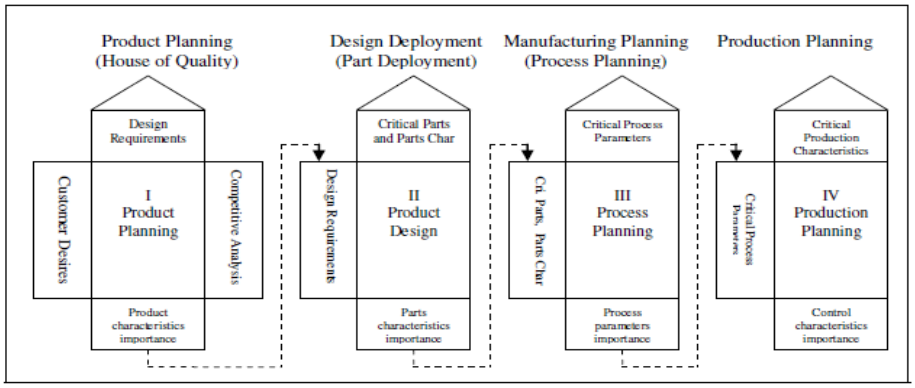

Figure 1. Four phases of QFD (Cohen, L, 1995)

3. Methods

The data for the study was retrieved through literature reviews, observations, interviews, and questionnaires. The questionnaire that was deployed was the technical characteristics questionnaire. The sampling strategy chosen is total sampling, which is a form of non-probability sampling.

The procedure for using the HOQ matrix is:

- Identify customer needs in the form of qualities that respondents will want.
- Identifying the relative significance of product features
- Assessing Customer Expectations
- Create a resistance matrix that includes product features and technical characteristics.
- Establishing a connection between product qualities and technological features.
- Identifying relevant interactions between engineering attributes.
- Determine the target's description
- Construct a High-Quality House

4. Results and Discussion

The goal of determining these characteristics is to figure out what consumers want and need from the shoe product that is being produced. The QFD (Quality Function Deployment) approach is used for this step. QFD is a methodical matrix that describes how quality products are designed, namely by translating consumer wants and needs into product qualities that are tailored to the product's technical characteristics. QFD uses the House of Quality, which is a matrix that translates consumer desires into design characteristics.

The procedure for using the House of Quality matrix is; Identifying consumer desires in the form of product attributes. At this stage will be tested to what extent the level of consumer satisfaction with the product. The method used in collecting data to determine consumer desires is by distributing questionnaires. The distribution of this questionnaire was carried out in two stages, namely Stage 1: Open Questionnaire. This questionnaire contains consumer desires for product attributes that have been determined. In this case, the questionnaire was distributed to 20 people. In this questionnaire, respondents were asked to provide answers freely regarding the attributes asked.

The next stage is the distribution of the Closed Questionnaire. This questionnaire contains a statement where the statement is taken based on the mode of data processing results from the open questionnaire. This questionnaire was distributed to 20 people, respondents were asked to fill in the provided columns regarding the performance of each shoe attribute which can be seen in Table 1.

Table 1. Product attributes

No	Criteria			Degree of Importance			
	Primary	Secondary	Tertier	Product of SME	Competitor 1	Competitor 2	Competitor 3
1	Design	type of shoe	Casual	5	4	3	5
		Color	Black	4	5	2	3
		the thickness of the shoe sole	2 cm	3	5	2	4
		Position of Logo/Brand	Right	2	4	1	2
		Slip on/Lace	Lace	5	1	3	3
2	Material	Material of Body Sepatu	Leather	5	2	3	1
		Material of Sole	Rubber	5	1	1	3

Determination of the relative importance of these attributes is done by assigning a percentage weight to each attribute using a priority scale. In this case, the modes obtained from a closed questionnaire are used according to the Likert scale which can be seen in Table 2.

Table 2. Modes of product attributes

No	Criteria			Degree of Importance
	Primary	Secondary	Tertier	
1	Design	type of shoe	Casual	5
		Color	Black	2
		the thickness of the shoe sole	2 cm	4
		Position of Logo/Brand	Right	2
		Slip on/Lace	Lace	5
2	Material	Material of Body Sepatu	Leather	4
		Material of Sole	Rubber	4

The attributes that have been translated into technical characteristics are placed in the vertical section on the left edge, while the technical characteristics are placed in the horizontal section on the top edge, which can be seen in Table 3.

Table 3. Matrix of resistance between product attributes and technical characteristics

	Product mass (kg)	Designing time (s)	Gluing Time (s)	Drying Time (s)	Sewing Time (s)
the type of shoe is casual					
the color of the shoe is black					
the thickness of the shoe sole is 2 cm					
the position of the logo/brand is on the right					
the shoes use laces					
the type of shoe body material is leather					
the type of tread material is rubber					

In the Quality House, the amount is placed on the roof. Using the roof matrix will make it easier to examine each pair of technical characteristics. This can be seen in Figure 2.

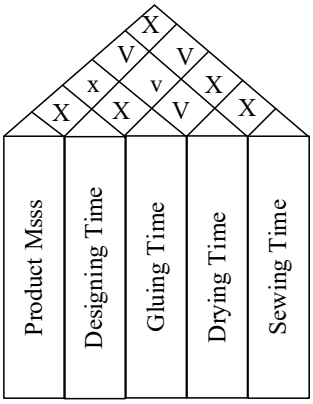

Figure 2. Relationship between each other technical characteristics

The aim to be accomplished for each technical attribute, namely the amount of difficulty in creating the product, the level of importance, and the expected cost, is decided in the next phase. The link between the technical characteristics determines the difficulty level. The weights of the relationship values are added together, and the weight of each technical characteristic is divided by the overall weight. The estimated cost is determined by the level of difficulty element; the more difficult it is to create a technical characteristic, the more expensive the cost allocation will be. Estimated costs are expressed in percent and are influenced by various considerations from the designer himself. In this target setting stage, the targets to be achieved are determined for measuring technical characteristics parameters so that they can produce products that can satisfy consumer desires and exceed competitors' products as shown in Table 4.

Table 4. Matrix of relationship between product attributes and technical characteristics

Unit	kg	s	s	s	s
difficulty level	3	3	2	4	3
level of importance	11	14	13	19	14
Estimated costs	14	14	14	19	14

Furthermore, the house of quality can be described which is a combination of all technical characteristics, attributes that consumers want, the position of the shoe-making process on the same attributes. Everything is made in a quality house using the QFD method. The House of QFD can be seen in Figure 3.

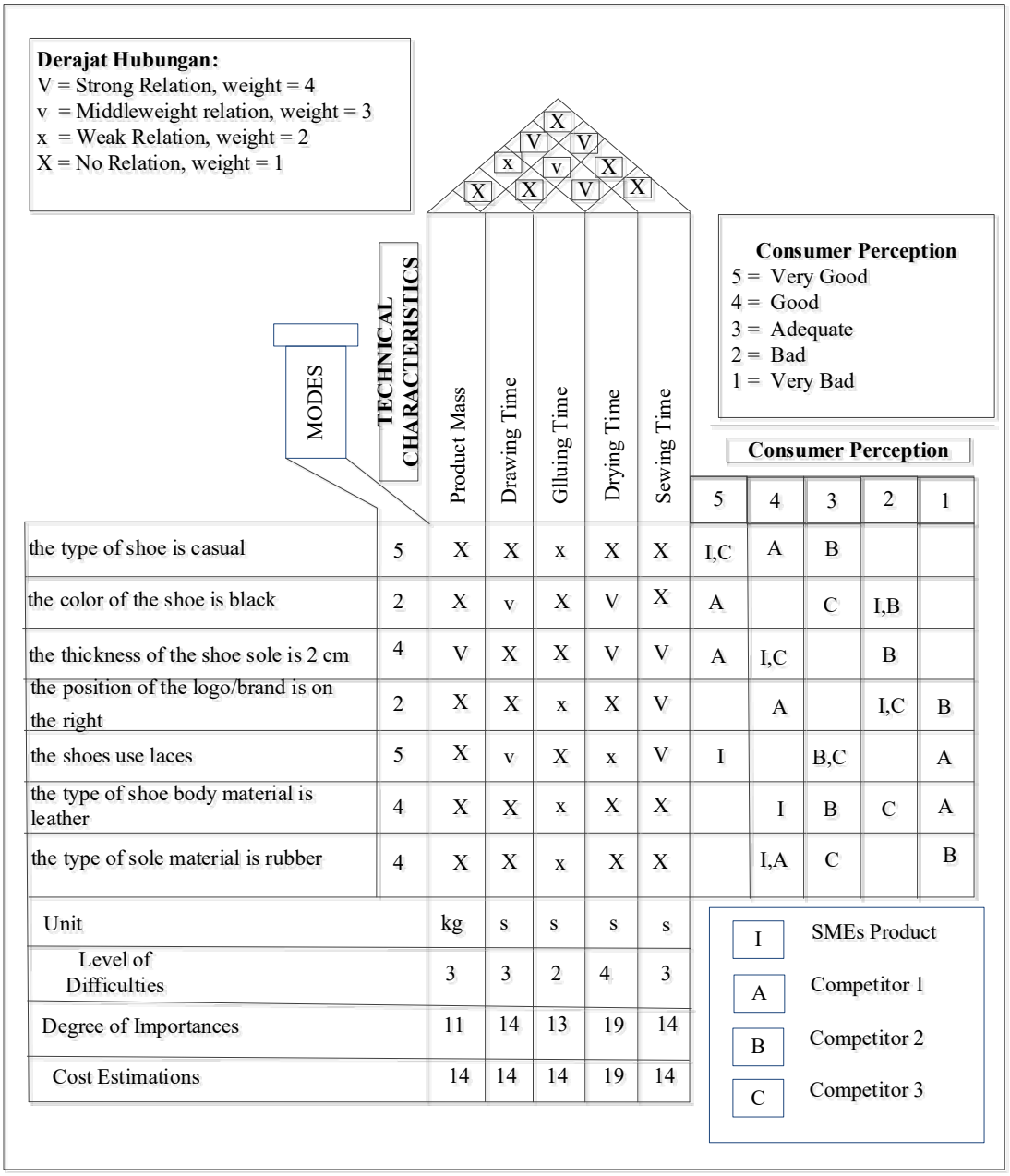

Figure 3. Quality Function Deployment (QFD)

5. Conclusions

Through the use of QFD, it is found that the main problem in the process of making SME leather shoes which are considered the most crucial is the technical characteristics of Drying Time. This is indicated by the high level of ignition, namely level 4, which is higher than other technical characteristics. In addition, when viewed from the Degree of Interest and Estimated Cost, the drying time activity is also the highest. The next step after knowing this is to make the Drying Time activity a starting point for process and product improvement. By reviewing the process again, it is possible to improve production activities that contribute to the drying time value. Meanwhile, when viewed from the product, the use of the right material and design can reduce the drying time of the product without reducing the quality of the product. The estuary of this activity is to increase the production capability and product of SMEs themselves.

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Biography

Rosnani Ginting received P.hD degree from Universiti Sains Malaysia. The areas of her specialization are Production System, Product Design and Planning, Machine Scheduling, Manufacturing System Plan, Decision Support System and Enterprise Resource Planning. She is active as a Head of Postgraduate Study Program Department of Industrial Engineering at Universitas Sumatera Utara. Her published books Production Systems, Machine Scheduling, Product Planning, Industrial Engineering Plan, Decision Support System, Questionnaire, and QFD. She has published numerous international papers. Her papers with title “TRIZ or DFMA Combined with QFD as Product Design Methodology: A Review”, and also title "Integration of quality function deployment and value engineering: A case study of designing a Texon cutting tool" indexed on SCOPUS. Her bookchapter has also published in Intechopen Publisher with title "Integrated Model of Product Design Methods".

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