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Product Design Of Clothes Drying Cabinet Using Quality Function Deployment (QFD) Method

Larisang[1] and Meylia Vivi Putri[2]

[1]Industrial Engineering Study Program
Ibnu Sina University
Indonesia
larisang@uis.ac.id

[2]Industrial Engineering Study Program
Ibnu Sina University
Indonesia
meyliaviviputri@gmail.com

Abstract— The problem that often occurs in the laundry business during the rainy season is the difficulty of drying cloth/clothes. Erratic weather changes make it difficult for wet clothes to dry. Ideally, drying clothes in the summer takes 6-7 hours and in the rainy season it can take up to 2 days. Drying clothes outside the home is susceptible to bacteria and germs. Clean clothes that are not maintained will cause bacteria to stick to the clothes and can certainly cause irritation to the skin. This study aims to design a clothes drying cabinet. To find out the specifications of the needs and desires of users, this research uses the Quality Function Deployment method. Closed interviews were used to obtain more detailed attributes and produce the HOQ (House Of Quality). The results of the HOQ are the level of difficulty of the design, the level of importance for each technical character and estimated costs so that it is feasible to design and implement. In designing a clothes drying cabinet, it requires a heater to function as a heater, a 12V fan functions to spread the temperature released by the heater, a temperature sensor functions to determine the temperature and humidity levels in the clothes drying cabinet, the control panel box functions to control the clothes drying cabinet like a button. on/off, temperature and humidity settings.

Keywords— Heater, House Of Quality, Closet, Clothes Dryer, Quality Function Deployment

I. INTRODUCTION

The problem that often occurs in the laundry business is the difficulty of drying cloth/clothes during the rainy season. Erratic weather changes make it difficult for wet clothes to dry. Ideally, drying clothes in the summer takes 6-7 hours and in the rainy season it can take up to 2 days[1]. Drying clothes outside the home is susceptible to bacteria and germs. Clean clothes that are not maintained will cause bacteria to stick to the clothes and can certainly cause irritation to the skin.The case study in this research was carried out at a laundry shop in Tanjung Sengkuang Village, Batu Ampar. This research was made because laundry entrepreneurs wanted to improve the quality of service to consumers. Good drying results will increase customer satisfaction because their clothes will dry faster, be softer, and be comfortable to wear. The problem that occurs in laundry shops is the long process of drying consumer clothes both in hot and rainy weather. Respondents' desire for the product is related to the technical characteristics of the product. The technical characteristics of the product with the highest score indicate that these technical characteristics are the focus of the problems faced by laundry entrepreneurs, while the attributes of consumer needs with the highest value are things that must be fixed to overcome existing problems.In general, clothes can only dry up to 75% -90% after

Corresponding Author: Larisang

being dried using the dryer in the washing machine, which after that you may need to continue drying them in the sun.[2]. Meanwhile, types of clothing made from thick fabrics such as jeans require a longer drying time than other types of fabrics, namely drying for one day to dry completely. According to Efendi, QFD is a quality tool that helps to translate voice of customers into new products that truly meet their needs.[3]. From the definition above, Quality Function Deployment can be concluded as a product or service design system based on consumer desires, which in the process involves the participation of members of all organizational functions. The purpose of this research is to obtain an efficient and effective design of a clothes drying cabinet according to the needs of consumers using the Quality Function Deployment (QFD) method. This study aims to design a clothes drying cupboard according to consumer needs using the Quality Function Deployment (QFD) method.

II. RESEARCH METHOD

The research method used in this study is the QFD (Quality Function Deployment) method. QFD originated in Japan in the 1960's. QFD is not only to control quality in the manufacturing process, but QFD defines quality measurement as improvement and design[4], [5]. With the QFD method researchers can take an approach to find out something that consumers want and can translate consumer desires into technical design, manufacturing, and production planning that are appropriate[6]. With QFD researchers can carry out their duties systematically in order to determine the best way to meet consumer desires[7]–[10]. The use of QFD can reduce design time by 40% and save design costs by 60% at the same time as maintaining and improving design quality[11]. The stages in this research are as follows: first, identify consumer needs to identify what are the needs in designing this clothes drying cabinet. Identification was carried out to laundry entrepreneurs in the Tanjug Sengkuang sub-district, Batam city. The interview was conducted through 2 stages. In the first stage, respondents were asked to give answers freely about what attributes should be in a clothes dryer. The second stage is in the form of a closed questionnaire. The characteristics of the sample taken are that the laundry business has been established for at least 1 year and has regular customers. After obtaining the customer attributes and their level of importance, then testing the validity and reliability of the questionnaire was carried out. This was done to ensure that the questionnaire used in the study was able to measure research properly. Next is to determine the hierarchy of needs. The hierarchy of needs functions for what is the need for a product design that will be carried out on existing problems, so that by making this hierarchy it can be known the needs of consumers or the design of the product itself. After that a product concept classification tree is made, to consider several combination or alternative concepts of product development which will later be used as product considerations. The preparation using QFD involves the preparation of the House of Quality. The House of Quality is prepared based on the voice of the customer, then an assessment of the level of importance is carried out by the customer. After that, customer rating competition was carried out. The next step is to create a voice of engineering, relationship matrix, correlation matrix, to form the HOQ matrix. The HOQ matrix model can be seen in Figure 1.

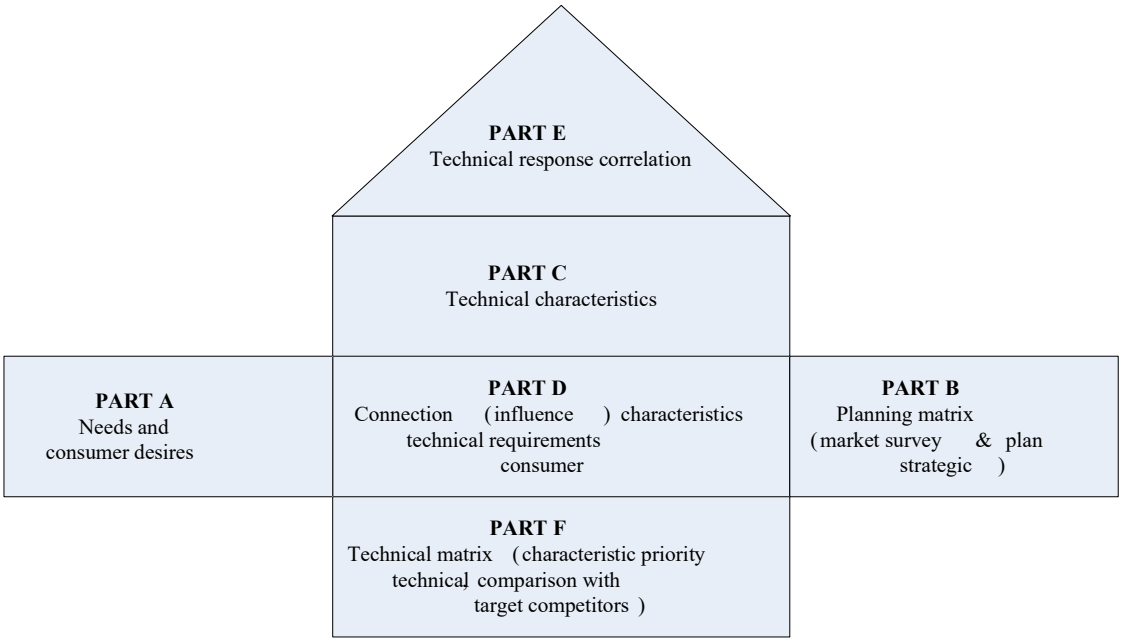


Fig 1.HOQ Matrix Model[12]–[14]

Part A: consists of a number of consumer needs and wants obtained from market surveys Part B: consists of (1) the importance weight of consumer needs (2) the level of customer satisfaction with products and services (3) the level of customer satisfaction with products or services from competing companies Part C: contains the technical requirements for new products or services to be developed. This data is an information derived from matrix A (consumer needs and wants). Part D: consists of management research regarding the relationship between the elements contained in matrix C (technical characteristics) to matrix A (consumer needs and wants) which are affected. Strong and weak relationships are marked with symbols. Section E: describes the relationship between one technical requirement and the other contained in matrix C. The relationship is explained by symbols. Part F: describes information to compare the technical performance of products or services produced by the company with products or services produced by competing companies.

III. RESULT AND DISCUSSION

The results of this study seek to be as close as possible to the wishes of the user so that user satisfaction is achieved. The first stage conducted interviews with 10 respondents. In this interview, respondents were asked to provide answers freely regarding the attributes in question. Then proceed to the second stage, where the respondent is asked to fill in the column provided regarding the level of importance of each attribute. The level of importance of the clothes dryer cupboard product attributes can be seen in Table 1.

Table 1.Level of Importance of Drying Cabinet Product Attributes

Criteria			**Interest Level**	
Primary	**Secondary**	**Tertiary**	***Our Product***	**Competitor**
Design	Easy to get spare parts	Component	5	4
	Easy Machine Maintenance	Easy to Clean	5	4
	Strong And Durable	Quality	5	4
	Easy to use	*Simple*	5	4
	Safe to Use	*Safety*	5	3
	Anti-rust	painted	4	3
	Easy to Move	*Portable*	4	3
Effective	Time	Fast	5	4
	Capacity	Lots	5	3
efficient	Cost	Affordable	5	3

After that, validity and reliability tests were carried out. Testing the validity and reliability of the questionnaire is needed to ensure that the questionnaire used in research is able to measure research properly. The validity and reliability tests in this study will test the design questionnaire for clothes drying cabinets that have been prepared by researchers where the questionnaire will be tested using 10 statements. The results of the validation test can be seen in Table 2. Based on the Output Item-Total Statistics, it can be seen that all variables have a calculated r value (1,000) (Column Corrected Item-Total Correlation) greater than the r table value (0.6581), so it can be concluded that the instrument the questionnaire used in the study was declared valid.

Table 2.Output Item-Total Statistics

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
P_1	43.20	14.400	1.000	1.000
P_2	43.20	14.400	1.000	1.000
P_3	43.20	14.400	1.000	1.000
P_4	43.20	14.400	1.000	1.000
P_5	43.20	14.400	1.000	1.000
P_6	43.20	14.400	1.000	1.000
P_7	43.20	14.400	1.000	1.000
P_8	43.20	14.400	1.000	1.000
P_9	43.20	14.400	1.000	1.000
P_10	43.20	14.400	1.000	1.000

After that, reliability testing was also carried out. Based on the Output Reliability Statistics shown in Fig. 2. it can also be seen that all variables have an alpha coefficient (Cronbach Alpha) which is greater than 0.6 so it can be concluded that the questionnaire instrument used in the study is stated to be reliable.

Reliability Statistics

Cronbach's Alpha	N of Items
1.000	10

Fig 2.Output Reliability Statistics

Then do the analysis of the hierarchy of needs. This hierarchy of needs functions to find out what is the need for a product design that will be carried out on existing problems, so that by making this hierarchy it can be known the needs of consumers or the design of the product itself. Based on the results of interviews and questionnaires, it can then be interpreted into the needs of shop owners, which can be seen in Table 3. After that, an analysis was also carried out using a conceptual classification tree. This is done to consider several combinations or alternative concepts from product development, which will later be used as product considerations. The combination of concepts can be seen in Table 4.

Table 3.Interpretation Need

need	***Interpretation Need***	**Classification**
Spare Parts Components Easily Obtained	Spare Parts Available	Material
Easy Machine Maintenance	Machine Easy To Clean	Design
Strong and Durable (Lifespan)	Made from heat and moisture	Material
Easy to use	Has Navigation On/Off	Design
Safe to Use (Safety)	Has a Heat Resistant Coating	Material
Anti-rust	Anti Rust Painted	Material
Easy to Move (Fortable)	Have Wheels	Feature

Time	Time is fast	Component
Capacity	Accommodates Multiple Capacity	Design
Cost	Affordable Cost	Material

Table 4.Concept Combination

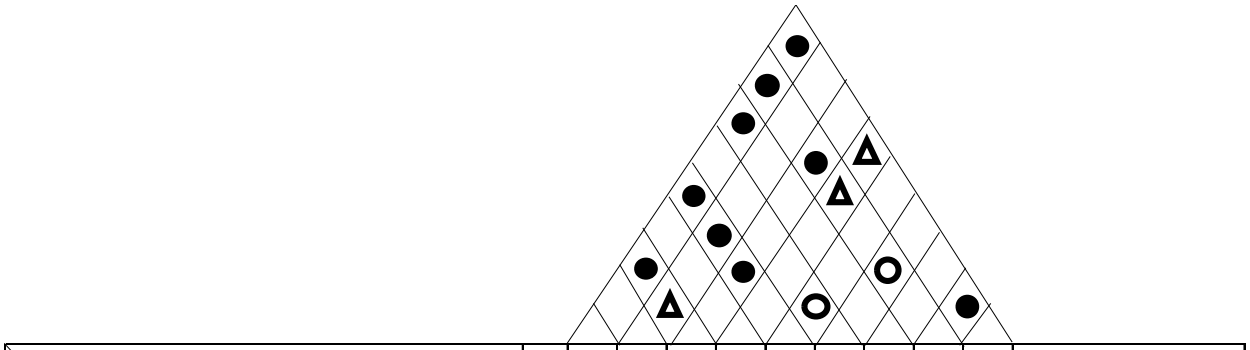
1. A concept

Material Type Material	**Design Product**	**Material Type Player**	**Type Material lock**	**Layer Outsid**
Stainless Steel	Rectangle	LPG	Padlock	Unpainted
Carbons, GRC, *Polywood*	Rectangle	Element Heating	Padlock	painted

2. B concept

Material Type Material	**Design Product**	**Material Type Player**	**Material Type lock**	**Layer Outsid**
Stainless Steel	Rectangle	LPG	Padlock	Unpainted
Carbons, GRC, *Polywood*	Rectangle	Element Heating	Padlock	painted

The most important thing in analyzing consumer needs is building a House of Quality (HOQ). Consumer needs (what) and technical realization of consumer needs (how) are important in developing the HOQ. Consumer desires (what) must be sought out how (how) efforts to overcome these consumer desires. It is known that consumer desires are easy to obtain spare parts, easy machine maintenance, strong and durable, easy to use, etc. The HOQ matrix can be seen in Fig 3.



Needs "What" \ Technical "HOW"	Customer Importance	Spare Parts Available	Easy to clean	Heat and water resistant	Has Navigation On and Off	Has a Heat Resistant Outer Layer	Using Stainless Steel ad Painted	Using the wheel	Able to dry clothes within 30 minutes	Able to dry lothes as much as 40 pcs	Customer Rating: ● Our Product, □ Other Product — 1	2	3	4	5
Spare Parts Components Easily Obtained	5	●						●						□	●
Easy Machine Maintenance	5		●	○		○	●		●	●				□	●
Strong and Durable (Lifespan)	5	●		●	●	●	●		●	●				□	●
Easy to Use	5	○			●	○		●	●	●				□	●
Safe to use (Safety)	5			●	●	●							□		●
Anti rust	4	●	●				●						□	●	
Easy to Move (Fortable)	4							●					□	●	
Time	5								●					□	●
Capacity	5									●			□		●
Cost	5	●			●				●	●			□		●
Degree of difficulty		45	10	18	2	3	3	0	9	9					
Degress of Importance		14	6	7	13	8	9	9	16	16					
Cost Estimates		20	10	20	0	10	10	0	20	20					

Degree of difficulty	
1 = Easy	= 1-20%
3 = Fairly Easy	= 21-40%
5 = Difficult	= 41-60%
7 = Fairly Difficult	= 61-80%
9 = Absolute Difficult	= 81-90%

Degree of Interest
1-15 = Fairly Important
16-30 = Important
31-45 = Very Important

Cost of Estimation
1-15 = Cheap
16-30 = Expensive
31-45 = Very Expensive

Fig 3.HOQ Matrix

Based on the design criteria that have been obtained from the results of the HOQ and conceptual matrices that have been selected, the authors then begin to design a system scheme that will be used in designing drying cabinets. The system schematic

can be seen in Fig. 4. After that, a visual design is carried out using Autocad software. The design results can be seen in Fig. 5.

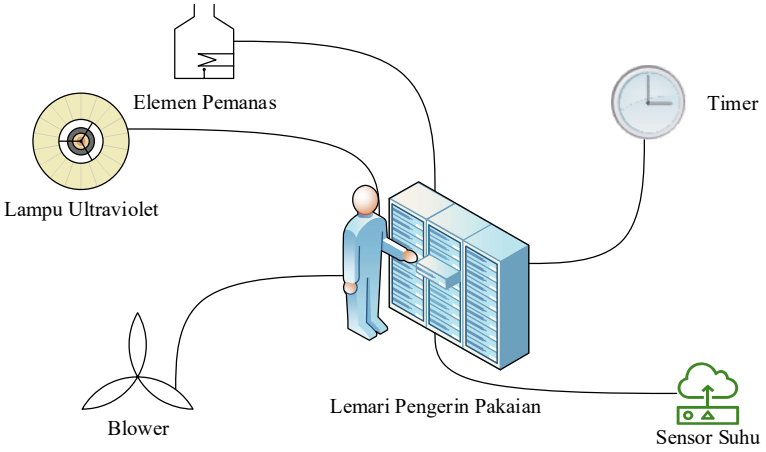


Fig 4.System Schematic

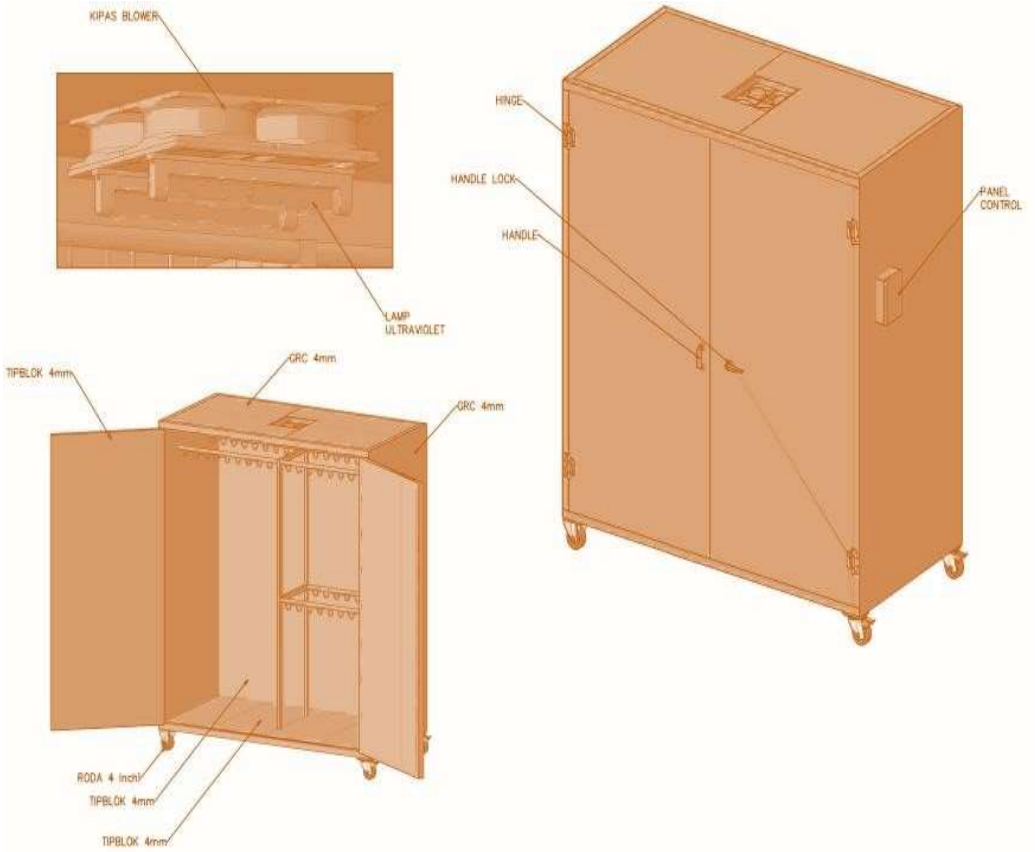


Fig 5.Clothes Drying Cabinet Product Design

After being designed, it is continued with making a prototype tool and testing. The prototype can be seen in Fig. 6. This test is carried out by operating a clothes dryer cupboard by putting wet or semi-wet clothes to be dried into the cupboard so that the clothes can dry within 30 minutes. It was noted that the comparison of the time and capacity required in the work system of the existing and those to be designed is to dry clothes in the drying cabinet in accordance with the capacity of the wardrobe. Existing products take approximately 60 minutes to dry 20 pcs of clothes and products that will be designed take approximately 30 minutes to dry 40 pcs of clothes.

Fig 6.Prototype Products

IV. CONCLUSIONS

Based on the results of the research that has been done, several conclusions can be drawn, including: 1. Product development which was carried out using the Quality Function Deployment method resulted in a wardrobe drying product that has the function of drying clothes quickly with a large capacity and can eliminate bacteria and odors by using ultraviolet light. 2. The target results for achieving technical characteristics for the level of difficulty are classified as easy except for the characteristics of available spare parts which are classified as difficult. Technical characteristics for the level of importance are quite important except being able to dry clothes in 30 minutes as many as 40 pcs which are classified as important. As for the cost estimate, all technical characteristics are relatively cheap except for available spare parts.

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