

Determining the need for improvement of infant incubator design with quality function deployment

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Abstract. A Newborns need particular attention because it takes time to adapt to the outside world. In accordance with the standard post-neonatal procedures, newborns should be incorporated into the incubator within a specified period of time according to the infant's health level. Infant incubator as a medical device used to care for newborns, often get complaints from doctors and child nurses. The complaint indicates consumer dissatisfaction with incubator products in the hospital. Broadly speaking, objection against infant incubators lie in inappropriate designs. To overcome these complaints the researchers apply the method of Quality Function Deployment to determine the characteristics of priority techniques in accordance with the wishes of consumers with it. The primary focus of QFD is to engage customers in the product development process as early as possible, which their needs and desires serve as the starting point of the QFD process. Therefore, QFD is called the *voice of customer*. The underlying philosophy is that customers are not always satisfied with a product even though the product has been perfectly produced. The results show that the category used as a priority improvement is the additional function of the oxygen cylinder and the size of the door hole. QFD phase one produces technical characteristics of Ergonomy, Features and Cost as critical part determinants.

1. Introduction

Based on World Health Organization (WHO) data, the number of births in Indonesia in 2012 reached 4.7 million per year while neonatal mortality (newborn) reached 72 thousand babies per year. Prematurity, low birth weight, infection, asphyxia, and birth trauma cause many of newborn death (neonatal) [1]. Data obtained from the Medical Record Section Kabanjahe Hospital mentioned that the number of premature babies in April - September 2014 as we would see in Table 1.

Physicians and nurses of the children's section have complaints regarding the use of infant incubators in the hospital. By introducing a couple of preliminary questionnaires to doctors and child nurses, researcher collected the complaints from them which include price, design, and maintaining the infant incubator. The grievances obtained indicate the dissatisfaction of the doctor and child nurse to the available incubator. Such dissatisfaction will definitely affect the decrease in the performance of doctors and nurses as well as the quality of services offered by General Hospital of Kabanjahe.



Table 1. Number of Infants Births
(April – September 2014)

Bulan	Number of Premature Infants
April	9
May	8
June	8
July	6
August	10
September	10

Departing from these problems, Quality Function Deployment (QFD) is used to identify the most essential needs in an effort to improve infant incubator. QFD provides benefits in providing a better understanding of the interactions customers request and design. Early engagement of the production section during the design process will reduce iteration and focus the design while also fostering teamwork [2]. The use of the Quality Function Deployment method is expected to identify the technical characteristics of the infant incubator to produce an appropriate improvement of the target incubator design in improving customer satisfaction.

1.1 Literature

QFD is a way to improve the quality of goods or services by understanding the needs of consumers and then connect it with technical provisions to produce a good or service at every stage of manufacturing goods or services produced. Quality Function Deployment is a design tool used to help businesses stakeholder to focus on the needs of their customers when designing and its specifications [3].

The main benefits of QFD are as follows:

- a. Focuses the design of new products and services on customer needs.
- b. Prioritize design activities.
- c. Analyze the company's key product performance to meet the needs of key customers.
- d. Recent estimates show a saving of between one-third and a half compared to before the application of QFD.
- e. Reduce the number of design changes after issuing it by ensuring focused efforts at the planning stage.
- f. Encourage implementation of work teams and eliminate barriers between sections by involving marketing, engineering, and fabrication from the beginning of the project.
- g. Provide a way to make process documentation and provide a firm foundation for making design decisions

QFD consists of four phases that we can solve by using a series of matrices, i.e.:

1. Phase I Product Planning
2. Phase II Product Designing
3. Phase III Process Planning
4. Phase IV Process Control

Four phase of QFD as we would see in Figure 1.

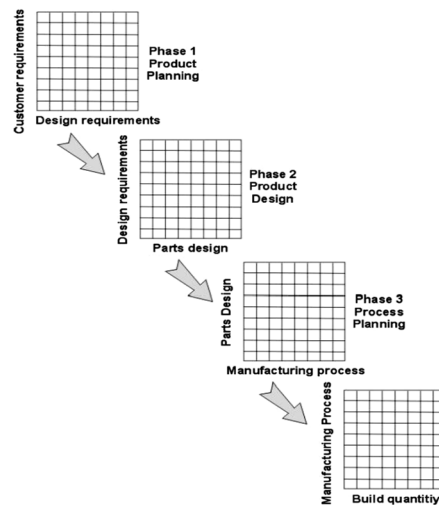


Fig 1. Four Phase of QFD [2]

1.2 Infant Incubator

The skin temperature and body of premature infants tend to decrease significantly due to conduction heat loss, convection, radiation and liquid evaporation. Cold temperatures experienced by babies for a long enough time will cause lack of oxygen, hypoglycemia and metabolic disorders. The baby incubator is a closed device with equipment to control the temperature that warms the baby by circulating warm air. Fatalities and injuries to infants in incubators have been associated with thermostat failure that causes overheating incubators and malfunctions that pose a fire and electric hazard [4].

2. Methods

2.1 Data Collection

We collected primary data by direct observation or measurement, including preliminary questionnaire data, open questionnaire data, closed questionnaire data, questionnaire data of technical characteristics, questionnaire data relationship between fellow technical characteristics and questionnaires data about the critical part and questionnaire data relationships among fellow critical part. Secondary data is obtained based on the one that obtained from interviews with suppliers of products, including product and cost components.

In this study data collection methods are as follows:

1. Observation technique, namely by made a direct observation of the process of using infant incubator.
2. Survey Technique, that is a technique to get primary data needed relating to consumer requirement to infant product incubator by spreading questionnaire.
3. Documentation techniques, namely by collecting data about the characteristics of infant incubator products in supplier companies.
4. The study of literature, namely as the initial foundation of the problem as well as the compilation of the questionnaire variables.

The variables that we questioned to the consumer are made based on the results of the preliminary questionnaire which asks about the complaints of doctors and nurses against infant incubator [5]. Then we adjusted the infant incubator variable for the complaint and the available literature [6].

The population taken is all doctors and nurses of the children who served in the hospital in Karo District. Research is conducted on all elements of the population because the subject is relatively little or called the population study. This choice applies to data collection using a preliminary questionnaire, an open questionnaire and a closed questionnaire. As for data collection using

Questionnaire Technical Characteristics, Questionnaires Level Relationships Between Technical Characteristics, Critical Part Questionnaire, and Level Critical Part is taken from the population of suppliers infant incubator. The sample population is the vendor who understands the product well [7]. The sampling method used is Purposive Sampling.

2.2 Data Processing

Stages of data processing begins by collecting data from the spread of open questionnaires to obtain the mode to be used for closed questionnaires. The result of the closed questionnaire is then poured into an assessment of the importance level that is tested for its validity and reliability. House of Quality is built on product attributes that have been obtained [7].

Development of HoQ matrix is done with the following stages:

1. Identify consumer desires into product attributes
2. Determine the relative importance of the attributes
3. Creating a resistance matrix between product attributes and characteristics.
4. Establish the relationship between technical characteristics and product attributes.
5. Identify the relevant interactions between technical characteristics
6. Determine the target image to be achieved for technical characteristics [7].

There should be an understanding that data processing in this paper is limited to only stage 1 QFD.

3. Results and Discussions

The following is the Customer's Requirement to infant incubator product as we would see in Table 2

Table 2. *Customer Requirement (CR) to Infant Incubator*

Atribut
Additional Functions of Infant Incubator is the Place of Oxygen Tube
The size of the door hole is 15 cm
Infant Incubator Price Rp 10.000.000
The Infant Incubator dimension is 70 cm x 50 cm x 40 cm
The floor distance from the base of the compartment is 100 cm
Compartment infant incubator materials are Acrylic
The controller's position on the infant incubator is on the top right side.

Table 3 contain the level of importance of the costumer requirement variable.

Table 3. *Customer Importance (CI)*

Costumer Requirement	The Result of Quest.					CI
	Measurement Scale					
	1	2	3	4	5	
Additional Functions of Infant Incubator is the Place of Oxygen Tube	0	2	6	16	11	4
The size of the door hole is 15 cm	3	9	11	10	2	3
Infant Incubator Price Rp 10.000.000	0	2	14	10	9	3
The Infant Incubator dimension is 70 cm x 50 cm x 40 cm	0	4	12	11	8	3
The floor distance from the base of the compartment is 100 cm	2	11	10	8	4	2
Compartment infant incubator materials are Acrylic	1	2	7	12	13	5
The controller's position is on the infant incubator is on the top right side.	0	2	11	9	13	5

The data has been obtained in the previous steps, then made into the HOQ matrix. The House of Quality of Infant incubator product as we would see in Figure 2.

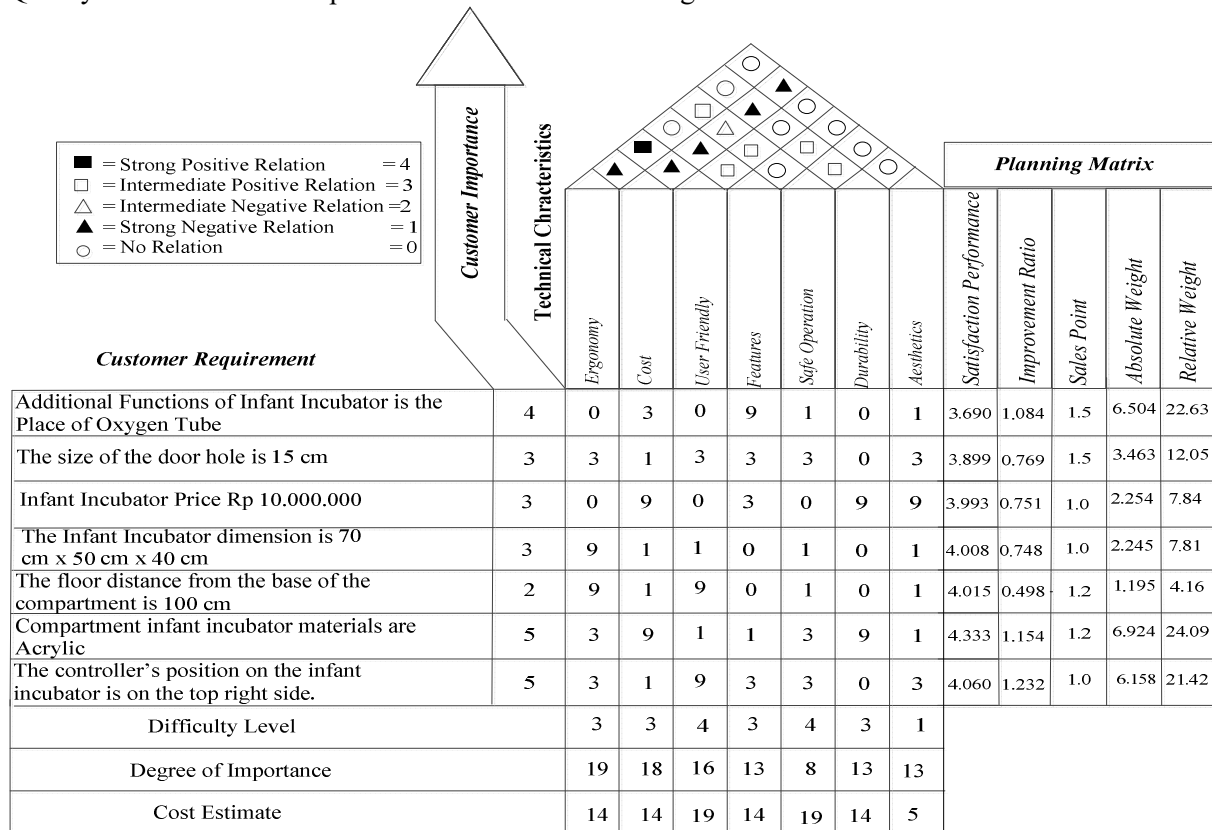


Fig 2. QFD Phase I of Infant Incubator

The Results of QFD Phase I of Infant Incubator products shows that the most important characteristics to be fixed immediately are Ergonomy, Cost and User-Friendly with the highest degree of importance, difficulty level, and cost estimate. From the planning matrix obtained the product attributes that become the priority of improvement because it has the greatest weight and high sales points, namely the compartment material and the additional function of the oxygen cylinder.

Technical characteristics with highest to the lowest degree of importance are ergonomy, cost, user-friendly, features, durability, aesthetics and safe operations. We can use the attributes as input in QFD Phase II for further research (8). By using QFD, we successfully analyzed product performance to meet the needs of customers. We also reduced the number of design changes by ensuring focused efforts at the planning stage.

4. Conclusion

Newborns need particular attention because it takes time to adapt to the outside world. Postnatal neonatal procedures suggest that newborns should be incorporated into the incubator within a certain period according to the infant's health level. Infant incubator is one of the medical equipment used to help babies adapt to the outside world especially regarding temperature differences [9].

The technical characteristics that are output in phase I are Ergonomy, Cost, User-Friendly, Features, Safe Operation, Durability and Aesthetics. The development of Quality Function Deployment Phase I produces performance measures of technical characteristics ie difficulty level, degree of importance and cost estimates. Technical characteristics Ergonomy, Cost and User-Friendly has the level of difficulty, degree of interest and the largest cost estimates so that a priority improvement. While product attributes that become priority improvement based on planning matrix

from QFD Phase I is Additional Function on Infant Incubator that is Place of Oxygen Tubes and Compartment infant incubator is Acrylic.

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