The Integration of Kano's Model and Quality Function Deployment : A Case Study for Design of An Alternative Energy Utilization

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Abstract

Alternative energy is a term that refers to all usable energy that aims to replace conventional fuels without undesirable consequences. In the context of this research, alternative energy is meant to be renewable energy, which is generated from natural sources, such as sunlight, wind, rain, tidal current, and geothermal, renewable or natural after use. Many methods, procedures, and techniques are adopted by some companies to improve the competitiveness of products through the fulfillment of customer satisfaction as much as possible by enhancement and improvement of an alternative energy utilization. This paper suggested combining Quality Function Deployment and Kano's model as design techniques in product design and by focusing on capturing dan translating consumer needs into product design. The result shows that the most important feature to be quickly corrected is technology sophistication and production cost with importance level, difficulty level, and highest cost estimation. From the planning matrix is obtained attributes which have the highest weight loss, namely container price and endurance. These attributes are the top priority.

Keywords: Quality Function Deployment, Kano, Product Design, Alternative Energy Utilizaton.

1. Introduction

Demand for the world's energy continues to increase throughout the history of human civilization. Expected demand for energy in 2050 is nearly threefold. It seems that energy issues will be a topic that must be resolved together. The use of energy has grown and increased in accordance with human development itself. The effort to obtain alternative energy has long been done to reduce dependence on petroleum resources. The use of petroleum is expected to be exhausted in the shortest time if current consumption patterns are rising with industry and transportation increases. Various studies have shown that air quality is increasingly anxious about petroleum burning.

Energy is one of the main requirements in human life. The increase in energy needs can be an indicator of prosperity, but it also creates problems in its preparation, because humans are only dependent on fossil fuels, of course, there is a very limited supply. Because of classified as irreversible and drained continuously, then the energy supply reduced and its existence cannot be re-established. Therefore, it is possible that in the future there will be problems related to the energy crisis. To anticipate that, over the last two decades, many experts energy from various countries try to seek new alternative sources of energy that are not only effective but also environmentally friendly. The option is solar cells, though its efficiency still needs to be considered (Sidopekso and Febtiwiyanti, 2010).

Meanwhile, the potential of water as a source of energy is mainly used as a supplier of electricity through the generator of hydropower and micro-hydro. The use of hydropower is essentially the use of potential energy gravity. The mechanical energy of the flow of water, which is a transformation of the potential energy of gravity is utilized to move the turbine or mill. In moving the mains, river water flows can be utilized when the flow speed is sufficient (Purnama et al, 2013). For the use of wind power, the potential of wind power in Indonesia generally speeds more than 5 meters per second (m/Sec). The mapping results of 120 locations from the National Aerospace and Aerospace Authority indicated that some regions have wind speeds above 5 m/s, respectively, East Nusa Tenggara, West Nusa Tenggara, South Sulawesi, and South Java Coast. Wind speed 4 m/s to 5 m/ medium, that is classified simple with potential capacity of 10-100 kW (Kompas GSA, 2012).

The region of Indonesia has the potential for high wind, sun and river velocity. This is a renewable energy source that can be used for electricity. This study aims to develop alternative energy-based mobile power generator products. The methods to be implemented are to carry out surveys, conduct interviews with users to fill out the questionnaire, and determine the expectation of users by integrating the Kano model and QFD method.

2. Literature

The Kano method was developed by a professor in Japan, named Kano in the early 1970s. This method is to determine the quality of service based on customer satisfaction. As shown in fig. 2.1, in Kano method, customer requirements (product/service quality) are categorized into three groups, namely the basic element, performance, and quality (Hashim et al, 2012). The Kano model provides an effective approach to classifying product attributes based on customer perceptions and understanding the relationship between product function and customer satisfaction. (Hsu, et al, 2007). Seyedi, et al (2012), argued that the Kano's model (interesting quality theory) is generally used to acquire knowledge about the needs of customers (attractive quality theory) (Chen and Su, 2006; Gerson, 2003).

There are several basic elements of Kano model for product development and customer satisfaction, and Kano classifies customer preferences into five categories such as attractiveness, one-dimensional, must-be, indifferent and reverse. This category is stated as follows. (Kano, 2001).

1. Attractive: characteristics of certain qualities to be gained on customer satisfaction. However, the absence of the same quality attributes is not discontent. The level of customer satisfaction will increase significantly by improving performance characteristics. However, the decline in performance characteristics will result in a decline in satisfaction.
2. Must be: the customer will not be satisfied when meet the current quality attributes. However, if the product or service does not meet the customer requirements, customers will be very satisfied. But customer satisfaction will not increase above neutral despite high performance characteristics.
3. One-dimensional: the level of customer satisfaction is directly proportional to the quality attributes. The higher the quality of one-dimensional elements, then customer satisfaction will be higher and vice versa. Therefore, customers are clear and usually demand a one-dimensional requirement.
4. Indifferent: A certain quality that has an impact on customer satisfaction.
5. Reverse: when the level of customer satisfaction is inversely proportional to the performance characteristics.
6. Questionable: when the customer's satisfaction level be undefined.

In the Kano's model, the intent of the quality is attributed to the goal that is actually achieved and these attributes are usually expected. One-dimensional quality features are attributed to quality features that satisfy customers when their expectations are met, and vice versa. Characteristics of quality must be attributed to the attributes that must be met, but may result in discomfort if not fulfilled (Raharjo, et al, 2009).

Quality function deployment (QFD) has been recognized as an effective method for integrated products and process development. QFD is a structured approach to integrate customer voices into design/develop products (N. Mendoza et al, 2003). The introduction of QFD to American and European Regions began in 1983 and today, QFD continues to inspire strong interest worldwide throughout the academic and industrial world. It is applied in many industries such as automotive, electronics, construction and service sectors. QFD is implemented as a multi-process process, offering the greatest potential to realize significant benefits (N.K. Naseri, 2014).

The QFD method is known by several names, the most common is Quality house. The information in the QFD chart is organized so that it highlights the relationship between customer demands and product quality features. House of quality (HoQ) introduces cross-linking between customer needs and design changes and between the design variables themselves. Using HoQ, the customer's needs are converted into one or more technical requirements at all levels of structured projects with interrelated matrices (Chien-Jung Lai, et al, 2012; And Kao., Et al, 2002; IQFD Hsing-Pei Kao., Et al 2010; and Hsu-Fang Hung, Et al 2008)..

3. Research Method

The data were obtained from interviews with expert teams and user of generator in Langkat District. Key data were collected through direct observation or measurement, including initial questionnaire data, open questionnaire, interest questionnaire and satisfaction, technical questionnaire, and Kano's questionnaire. Secondary data was obtained based on data obtained from interviews with product suppliers.

In this study the data collection methods are as follows:

1. Observation
2. Survey
3. Documentation
4. Literature

The variables to be questioned are based on the results of the initial questionnaire which asked the customer needs for alternative energy use. Variables are adapted with the result of recapitulation of customer needs and literature.

4. Data Processing

The data processing stage started by collecting data from the spread of open questionnaire to get mods to be used for closed questionnaire and KANO questionnaires. Closed questionnaires and KANO were then poured into the Kano Model. House of Quality is then constructed based on the characteristics of the product that has been obtained. HoQ matrix development is done at the following levels:

1. Identify the customer needs into product attributes
2. Determine the relative importance of its properties
3. Create a resistance matrix between attributes and product features.
4. Identify the relationship between technical characteristics and product attributes.
5. Identify relevant interactions between technical characteristics
6. Define target images to be achieved for technical features.

The processing of data in this study is limited to the QFD phase 1.

5. Result and Discussion

The Calculation and classification of Kano can be used to map the Kano properties of customer needs (CR) to all respondents as seen in Table 1.

Table 1. Kano's Category of Customer Needs

No	Attributes	Category					
		A	O	M	I	R	Q
1	Price of Generator	**5**	4	4	4	0	0
2	Operation cost	0	3	**8**	6	0	0
3	Safety factor	5	**6**	2	4	0	0
4	Operation Ease	2	**6**	5	4	0	0
5	Durability	0	5	**8**	4	0	0
6	Environmental Impact	0	4	**9**	4	0	0
7	Output Energy	1	4	**8**	4	0	0
8	Aesthetics	1	2	5	**9**	0	0

It is done after obtaining the Kano category number/value of each attribute to all respondents, and then determining the Kano category by using Blauth's formula. The Kano category recapitulation can be seen in Table 2.

Table 2. Kano's Category of *Blauth's formula*

No	Attributes	Category
1	Price of Generator	A
2	Operation cost	M
3	Safety factor	O
4	Operation Ease	O
5	Durability	M
6	Environmental Impact	M
7	Output Energy	M
8	Aesthetics	I

From the results of the Kano recapitulation, it is known that there is one attribute in the indifferent category of Esthetics. Then, for the next calculation, this attribute is elliminated. The importance level of the customer needs variable is shown in Table 3.

Table 3. *Customer Importance* (CI) to the Kano's Category

Customer Needs	The Results Scale					CI
	1	2	3	4	5	
Price of Generator	0	0	1	3	13	5
Operation cost	0	0	2	10	5	4
Safety factor	0	0	5	4	8	5
Operation Ease	0	0	3	5	9	5
Durability	0	1	2	5	9	5
Environmental Impact	0	0	3	4	10	5
Output Energy	0	1	0	11	5	4

The data that obtained in previous steps is applied the HOQ matrix. The QFD of power generator can be seen in Figure 1.

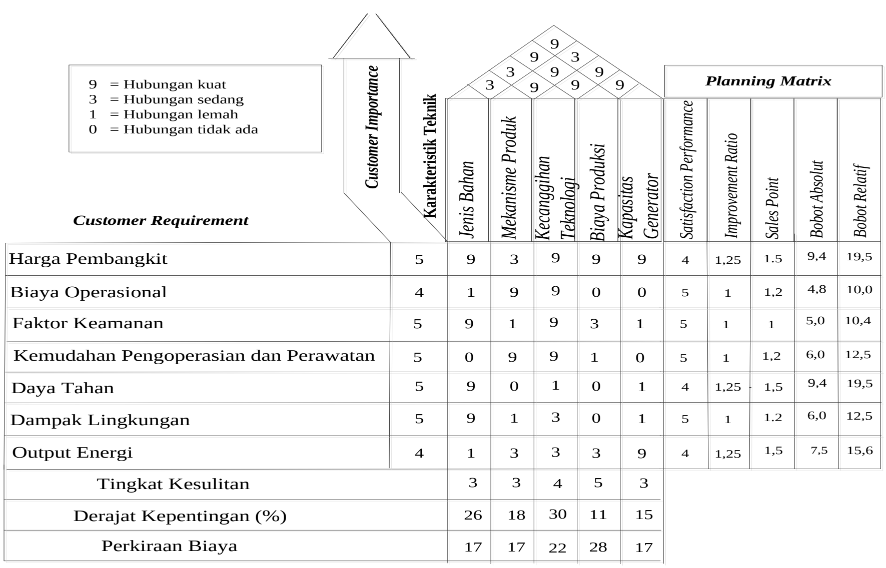

Figure 1. QFD Phase 1 of Power Generator

The result of QFD phase 1 for power generator shows that the most important features to be prompt improved are technology sophistication and production costs with significant importance levels, difficulty levels, and cost estimates. From the planning matrix obtained by the product attributes in the form of container price and endurance is the top priority as it has the highest weight. The technical characteristics of the highest priority are technology sophistication, material type, product mechanism, generator capacity and production cost. These attributes will then be used as inputs in QFD phase 2 for further investigation.

6. Conclusion

From Kano questionnaire, it is obtained that attractiveness is an interesting category. Although the safety and operational are included in one dimensional category. Although aesthetic is the attributes that fall into the indifferent category. Through the use of the Kano's model, researchers can eliminate the attributes for subsequent processing. The technical characteristics in QFD phase 1 are technology sophistication, material type, product mechanism, generator capacity and production cost. It produces technical performance measures namely level of difficulty, importance level, and cost estimation. The use of QFD can help manufacture produce better products based on customer needs.

Biographies

Rosnani Ginting is a P.hD 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 Production System Laboratory. 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 paper with title "TRIZ or DFMA Combined With QFD as Product Design Methodology: A Review" indexed on SCOPUS.

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