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Development of a chopper machine design for raw chips using the Kano Method and quality function deployment

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Abstract

Chips are a food that is very popular with people in Indonesia. Chips also vary greatly in shape, size, smell, color, taste, crunch, thickness and nutritional value. UMKM Marga Utama Dampit Malang Regency is one of the small industries producing cassava chips where the process of making chips still uses simple equipment, especially in the chopping process, this is what causes the size of cassava and banana chips to be not uniform and not crispy.

The aim of this research is to design a chip raw material chopping machine using the Kano method and Quality Function Deployment (QFD). Integrating the Kano method and the QFD (Quality Function Deployment) matrix is able to create innovative machines more easily, cheaply and quickly[1]. The Kano model is an absolute requirement for identifying customer needs, hierarchies and priorities[2]Meanwhile, Quality Function Deployment (QFD) is a structured methodology used in the product planning and development process to determine specifications for consumer needs and desires and systematically evaluate the capabilities of a product or service in meeting consumer needs and desires.[3]. From the design results, a tuber chopping machine was obtained with machine dimensions of length 82 cm, width 69 cm and tool height 101 cm, and obtained a standard output of 44,38 kg/hour while the standard time was 1.2 minutes/kg.

Keywords: Design development; Chopper machine; Kano; QFD

1. Introduction

Chips are a type of snack that is very popular in Indonesia. Chips vary widely in shape, size, smell, color, taste, crunch, thickness and nutritional value. However, chips produced in home industries or MSMEs often ignore the process of chopping the chips so that the chips produced are not the same size, this causes the crispness of the chips to not last long. As is the case with the process of chopping the raw material for chips produced by UMKM Marga Utama, Malang Regency, which produces chips from cassava and bananas, where the process of chopping the raw material for chips has so far still used manual methods, so control over this stage is difficult and requires energy and time. longer work. Each time the worker produces, they have to be able to chop 20 kg of cassava and it takes 3 hours. The level of crispiness of the chip product is not yet optimal, due to the thickness of the chopping being not the same, so that the water content in the raw material used is still quite high and causes the frying results to be less crispy. The stage of chopping the raw material for chips is the main stage in the production process of various chip products, because it affects the quantity and quality of the chip products produced. The process of chopping the raw material for chips manually using a knife and cutting board as in the following picture:

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Figure 1 Chipping Process

The chopping carried out by the operator using a manual chopper often causes the operator to experience pain in the back and tingling in the legs so the operator has to rest first, this of course affects the processing time of the chopping.[4]. The process of manually chopping raw materials for chips certainly has a big impact on worker productivity because it will require a long chopping time in a working position that does not comply with ergonomic rules. In a business activity, productivity is generally always associated with production technology issues, work methods and economic issues. A technique is needed that is most relevant and has the greatest potential to increase productivity in the form of improving work systems[5]. The Kano model is used to determine the importance of individual product features for consumer satisfaction and to create optimal absolute conditions for process orientation in product development activities.[2]. The Kano method can be integrated with the QFD method, which is a method that is able to identify consumers' true desires and is the practice of designing processes in response to consumer needs.[6]. Quality Function Deployment (QFD) is a planning methodology that is often used to interpret consumer needs into technical specifications for the required product or machine design.[7]. The process of designing a chopping machine is carried out by collecting voice of the customer data which aims to capture the machine attributes that users really need, in this case the MSMEs that produce chips.[8]. By using the voice of the customer, customer requirement data will be obtained for the chopping machine product based on the level of importance of the specification criteria for the product

2. Research methods

The conceptual framework of this research can be seen in the following picture:

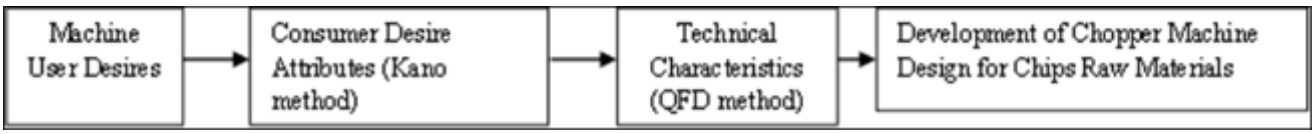

Figure 2 Research Conceptual Framework

2.1. Canoe Model

The Kano model is a model used to categorize the attributes of a product based on how well the product is able to have an effect on customer satisfaction. The Kano model provides a linear display of the results provided by the performance of a product or service on customer satisfaction which can be used to identify attributes that have the potential to cause satisfaction or dissatisfaction. customer[9]. The Kano method distinguishes 3 types of desired products, which can influence consumer satisfaction, namely[9]:

- Must-be requirements

This type is the basic criteria that must be present in a product or service. If these basic requirements are absent, not fulfilled or lacking, consumers will feel very dissatisfied. However, if satisfaction is more to the consumer.

- One-dimensional requirements

In this type, consumer satisfaction is proportional to the level of fulfillment of consumer needs, where the higher the level of fulfillment of consumer needs, the higher the degree of consumer satisfaction and vice versa.

- Attractive requirements

This requirement is the key to consumer satisfaction. These requirements are product criteria that have the greatest influence on consumer satisfaction if provided.

- Indifferent. Attributes in this category are seen as neutral need attributes for customers, so they will not have an influence on changes in increasing or decreasing customer satisfaction.
- Reverse Customers will feel dissatisfied if attributes in this category are provided, conversely customer satisfaction will appear if these attributes are not present.
- Questionable Attribute This category indicates that there is confusion and misunderstanding between the question asked and the answer given.

2.2. Quality Function Deployment

QFD is a structured method used in the product planning and development process to determine specifications for consumer needs and desires, as well as evaluate a product in meeting consumer needs and desires.[10].

In building an HOQ, there are several stages that must be passed, including:[5]:

- Identify consumer needs. At this stage, the variables for preparing the chopping machine are determined through questionnaires and interviews.
- Ranking of consumer needs. This is done to determine the priority scale of consumer needs.
- Competitive assessment. This assessment is carried out on competing products and companies to determine the ratio of improvements that must be made by the company.
- Development of technical characteristics. These characteristics are used as the basis for making chopping machines.
- Feature analysis of consumer needs which are managed into a relationship matrix. A relationship matrix is prepared to determine whether consumer needs have a strong, normal or weak correlation.
- Correlation analysis, on technical characteristics to determine the relationship between the two, whether it is strong, normal or weak.
- Setting operational targets to meet consumer needs.
- Calculate absolute and relative weights, to determine the priority technical characteristics of chopping machines based on consumers, competitors and internal companies.

3. Results and discussion

3.1. Analysis using Kano

The calculation of the customer satisfaction coefficient (CSC), which tries to identify or interpret the location of satisfaction with a feature in the form of an interpretation graph, is carried out after obtaining the Kano category value for each attribute for the respondent. The CSC calculation is a step in the requirements of Blauth's Formula used to determine the canoe category.

- If the total value (one dimensional + attractive + must be) = the total value (indifferent + reverse + questionable) then all canoe categories get the maximum grade, namely (one dimensional, attractive, must be and indifferent, reverse, questionable).
- If the total value (one dimensional + attractive + must be) > the total value (indifferent + reverse + questionable) then the grade obtained is the maximum value of (one dimensional, attractive, must be).
- If the total value (one dimensional + attractive + Must be) < the total value (indifferent + reverse + questionable) then the grade obtained is the maximum of (indifferent, reverse, questionable)[11].

3.2. Recapitulation of Kano questionnaire translation data

The results of the Kano questionnaire can be translated into Kano categories. For example, when on a functional question, the respondent answers "very much" and on a dysfunctional question they answer "don't like", then the translation results for this customer requirement are one-dimensional.

Table 1 Ranking User Needs

No	Customer Requirements	Score
1	The chopping machine is safe to use	5
2	Energy saving machine	4
3	Long lasting machine	5
4	The machine's speed can be adjusted	3
5	The chopper machine is easy to maintain	4
6	Affordable prices	4
7	Hygienic chopping machine	5
8	Uniform chip size	5

3.3. Results analysis using QFD

From the results of the analysis using Kano, sub-attributes were obtained which became the voice of the customer in creating the House of Quality in the next stage of using the QFD method. Where from the voice of the customer the technical requirements for the chip raw material chopping machine that will be designed can be determined. After knowing the customer's requirements for the chip raw material chopping machine product, then translate the customer's requirements into technical requirements. Engineering requirements are created by designers by connecting each attribute and sub-attribute to each other. Technical responses or commonly known as technical parameters are the translation of consumer desires into technical language that can be measured. The following are the results of the technical requirements shown in table 2 below:

Table 2 Technical Characteristics

No	*Technical Requirements*	Score
1	Ergonomic	5
2	Hygienic anti-corrosion machine material	4
3	½ PK electric motor	5
4	Blade rotation speed	3
5	Spare parts are easy to buy	4
6	Machine capacity 40kg/hour	4

The most important stage of House of Quality is to connect product attributes originating from the voice of the customer with the technical parameters of the chip chopping machine. In this matrix it will be possible to see whether the relationship between attributes and technical parameters is weak or strong. The matrix between attributes and technical parameters can be seen as follows.

Table 3 Relationship matrix atribute

	Electric motor½ HP (1400 rpm)equipped with gear box	The dimensions of the machine are according to the user's body size	Capacity 20 kg	Machine Components are easy to buy	The machine frame is sturdy, steel	Stainless steel material
Ergonomic machine design		●		△		
The cutting results are uniform		●	○			
Production capacity			●	●		
Fast cutting process	●		△			
Ease of maintenance				●		
Long lasting machine					●	●
Energy saving machine	●					
Affordable prices				●		

Symbol description: Product Specifications

- Capacity : 50 - 60 kg/hour
- Dimensions : 82 cm x 69 cm x 101 cm
- Electric Motor Power : ½ PK
- Overall Machine Weight: ± 50 Kg
- Cutting results : Thin and Smooth
- Knife : Stainless steel plate
- Frame : Rectangular iron 4 x 2 cm with a thickness of 3 mm
- Upper Pulley :Diameter: 17.5 cm, thickness: 5 mm
- Lower Pulley :Diameter: 5cm, 5 mm thick
- Knife system : rotate counterclockwise
- Number of knives : 3 pcs
- Dish : diameter 30cm

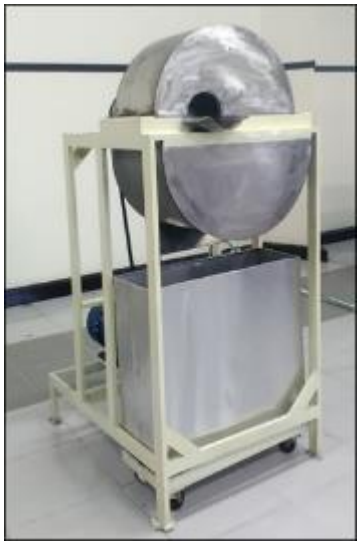

Figure 3 Chips Raw Material Chopper Machine

4. Conclusion

From the research results, the dimensions of the chip raw material chopping machine were obtained with a tool length of 82 cm x 69 cm x 101 cm. Working time testing using old equipment obtained a standard time of 9.97 minutes/kg and working time testing using a new chip raw material chopping machine obtained a standard time of 1.2 minutes/kg. Meanwhile, standard output using old equipment obtained an output standard of 6.018 kg/hour and testing using new equipment obtained a standard output of 50.4 kg/hour. Based on the results of machine testing, the difference in standard output is 44.382 kg/hour, resulting in an increase in standard output percentage of 737.49%.

Compliance with ethical standards

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