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DESIGNING THE ATTRIBUTES OF FOOD PRODUCTS USING QUALITY FUNCTION DEPLOYMENT (QFD) PHASE II

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ABSTRACT

The first step in designing a new product is developing technical requirements for the product. It has been done in QFD phase I and result in technical attributes as the basis for developing the QFD phase II. The QFD phase II, which is product design or part deployment, is discussed in this research. The QFD phase II identified critical parts required from the technical requirements provided in the QFD phase I. This research has found critical parts for the products and their packages.
Keywords: *QFD, product design, food products*

1. INTRODUCTION

Indonesia is an agricultural country. One of the agricultural products harvested in Indonesia is carrot. Carrot has a unique characteristic making it easy to grow in entire part of the country. This condition makes Indonesia one of the largest carrot producers in the world. In 2009, the total number of carrot produced in Indonesia was 358.014 ton which means that the productivity rate was 14,86 ton/hectare. In 2013, it increased to 479.376 ton which means that the productivity rate was 15,42 ton/hectare (Badan Pusat Statistik, 2013).

However, the increasing number of carrot produced in Indonesia is not corresponding with the economic condition of its farmers. Carrot has a short lifetime (Pardede, 2009) causing its farmers to sell it quickly before decomposing. Moreover carrot farmers in Indonesia tend to avoid risk saving unsold carrot by not increasing its price. One only thing in farmers mind is how to sell harvested carrot as soon as possible even when the market price is low. The aim of this research is to help farmers to add value to the crop by developing a carrot based product. When value is added, the farmers can sell their carrot with a higher price.

This research used Quality Function Deployment (QFD) to help developing carrot based products that meet customer requirements. QFD is a method to develop and design product by transforming voice of customers into product’s attributes. By listening to customer’s voice, it expects that the product developed from the method can generate customer satisfaction (Cohen, 2006). There are four steps in QFD including (1) Product Planning, (2) Product Design, (3) Process Planning, and (4) Process Control.

In designing a product, including the carrot based product and its packaging, there are two phases in QFD that need to be conducted. The first phase, the product planning had been done (Halim, 2014). The preliminary research for the QFD phase I was carried out to determine the carrot based product to be designed. The most favorite carrot based products are syrup and candy. The QFD phase I carried out to find the customer requirements of those products and their packaging. The house of quality matrix then found the products’ technical attributes. There are six carrot syrup attributes, four packaging of carrot syrup attributes, twelve carrot candy attributes and four packaging of carrot candy attributes. Based on the products’ technical attributes the QFD phase II was conducted.

2. THEORITICAL BACKGROUND

2.1 Quality Function Deployment

The most used method in designing a new product is Quality Function Deployment (QFD) (Cohen, 2006). QFD was first developed by Yoji Akao in 1966 in Japan. The method then was adopted by Mitsubishi

Heavy Industries Kobe Shipyard in 1972 and by Toyota in 1986 (Shenly, 2008, Creative Industries Research Institute, 2010). QFD was used to translate the voice of customers into technical requirements and targets in production phase. All the process aims to achieve high quality standard and customers satisfaction.

QFD is not used in developing an existing product only. It is commonly used in to develop a completely new product, design attributes of a new product, determine characteristics of a process, oversee manufacturing process, and review specification of a product (Creative Industries Research Institute, 2010).

2.2 The Development of QFD Phase II

The second step of QFD obliges technical requirements and its weight from the first QFD (Linnemann dan Van Boekel, 2007). The second step is the step which requires brainstorming process, benchmarking, and more intensive research to generate a new product. Constructing the second QFD is similar with the formulation of HOQ matrix. Technical requirements from HOQ matrix is converted to the left part of the product design matrix whereas the upper part consists of critical part attributes.

The principles of the second QFD are providing significance value to technical requirement, identifying critical parts, and constructing weight of each critical part (Tsai et al., 2008). To construct the second QFD, steps to be taken are defining part specification, determining critical part, specifying significant value, finding connection between part specification and critical part, and identifying importance weight (Sriwahyuni, 2006). The difference between the second QFD and HOQ matrix is lying on the definition of its attributes. The second QFD is explained as follows:

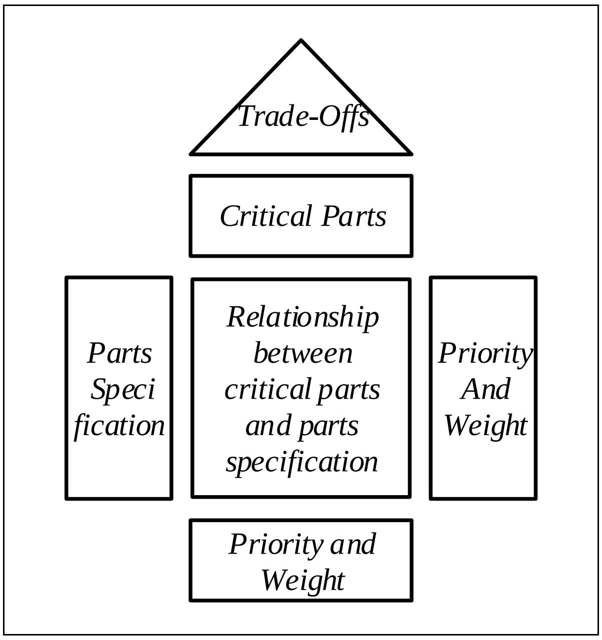

Figure 1 The second QFD (product design) Matrix

3. RESEARCH METHOD

From previous research, it has been found that products that meet customer need were carrot syrup with its packaging and carrot candy with its packaging. The result was on the construction of the first QFD. The data was collected by interviewing experts in the field of agriculture and food technology.

The first step in constructing the second QFD starts with defining part specification. This part is done by identifying technical requirements from the first QFD. Because this research aims to develop a new product, all the attributes in the first QFD are used as part specification in the second QFD. These part specifications are then classified to four parts. These parts are part specification of carrot syrup, part specification of the packaging of carrot syrup, part specification of carrot candy, and part specification of the packaging of carrot candy. Part specification is placed in the left part of the product design matrix.

The next step is calculating importance degree of customer need attributes. The degree refers to the scale which is used to calculate importance value. This scale, namely Likert scale, is affected by the importance degree of attributes. Likert scale is explained as follows:

Table 1 Likert scale value

Score	Explanation
1	Strongly unimportant
2	Unimportant
3	Neutral
4	Important
5	Very important

The importance degree of attributes is determined by categorized respondents that have the same questionnaire value. It has also been determined by evaluating the attributes' degree on the number of respondent. The formula used to calculate the importance degree of attributes is explained as follows:

$$\text{DKA} = \text{modus}(N_1, N_2, N_3, N_4, N_5) \quad (1)$$

Whereas,
DKA = Importance degree of attributes
N_1 = Number of respondents selecting 1
N_2 = Number of respondents selecting 2
N_3 = Number of respondents selecting 3
N_4 = Number of respondents selecting 4
N_5 = Number of respondents selecting 5

After determining the importance degree of attributes, the next step is specifying absolute weight of technical requirements. The formula used in specifying absolute weight of technical requirements is explained as follows:

$$a_j = \sum_{i=1}^{n} R_{ij} C_i \quad (2)$$

Whereas:
a_j = Row of absolute weight from technical requirements
R_{ij} = Weight value in correlation matrix (*i* = 1,…,*n* and *j* = 1,…,*m*)
C_i = Degree of importance of attribute *i* (*i* = 1,…,m)
m = Identifying number of technical requirements
n = Identifying number of customer needs

After specifying the absolute weight of technical requirements, the next step is determining relative weight of technical requirements. The formula used in determining relative weight of technical requirement is explained as follows:

$$b_j = \sum_{i=1}^{n} R_{ij} D_i \quad (3)$$

Whereas:
b = Row of relative weight from customer needs
R_{ij} = Weight value in correlation matrix (*i* = 1,…,*n* and *j* = 1,…,*m*)
D_i = Value of absolute weight of customer needs from attribute *i* (*i* = 1,…,*m*)
m = Identifying number of technical requirements
n = Identifying number of customer needs

The next step is moving technical requirements from the QFD phase I to the left part of the QFD phase II. Importance degree of part specification attributes then is calculated using the formulas explained as follows:

$$TK_{sp} = \frac{\text{Relative weight of technical requirements}}{\text{Sum of relative weight of technical requirements}} \quad (4)$$

It shows that relative weight of part specification, which is shown by its percentage, has the same value as the degree of importance. The reason behind this formulation is because the calculation of part specification attributes have used the entire technical requirement attributes (Wagiono, 2007).

After calculating the importance degree, production process and its procedure are assigned. By following the procedure, it hopes that the result of the production process meets the standard. The production process should also follow SNI standard and government regulations. SNI standard is not only used to guarantee a quality product, but also used to design the packaging to make sure that the packaging is not harmful to its users.

Identifying critical part is the next step of this research. Critical part should be corresponding to the part specification that has been determined previously. Critical parts are divided into two parts which are primary critical part and secondary critical part. Primary critical part is general attributes which are corresponding with part specifications. In this research, product and the packaging are become the primary critical parts whereas the components of products and packaging become the secondary critical parts.

Critical part is built by brainstorming and interviewing experts in the field of agriculture and food technology. The results of

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brainstorming are discussed intensively with respondents so that it will be consistent with the research. Interview process aims to improve the construction of critical part. The numbers of critical parts produced are not necessarily the same with the numbers of part specification attributes. These critical parts are then placed in the upper part of the product design matrix.

The next step is building a correlation matrix. This correlation matrix intends to evaluate the relation between part specification and critical part. Each part specification attribute can influence more than one critical part attributes and vice versa. The relation has several levels and is symbolized specifically. The explanation of the symbols in the correlation matrix is explained as follows:

Table 2 Symbols in correlation matrix

Symbol	Value	Information
(empty)	0	No relation
Δ	1	Weak relationship
○	3	Medium relationship
●	9	Strong relationship

Correlation point is given to all available attributes. The evaluation of correlation aims to provide as a basis for weighting the most correct priority to critical part attributes

The next step is constructing trade-off value from the critical part attributes. It aims to discover correlation among critical parts and to provide as a basis for weighting priority. The evaluation process is similar to the process in the previous step in which we evaluate the correlation value between part specifications and critical parts.

The final step is determining the importance value of critical part and its weight. The formula used to evaluate importance weight is explained as follows:

$$BK = \sum A \; x \; B \qquad (5)$$

Whereas:

A = Relative weight of part specification

B = Correlation matrix value

After evaluating the importance weight, every critical part is given its weight and priority. Attribute with highest priority is the attribute with the highest value of importance weight.

4. RESULT AND DISCUSSION

This research generates the QFD phase II for carrot syrup and its packaging; and for carrot candy and its packaging. For carrot syrup there are six critical parts corresponding with six part specifications. As this research intends to develop a new product, all of the attributes must be considered in producing the product. A producer has to concern with the attributes get higher values.

This research also focusses on the packaging of carrot syrup. It is found that there are five critical parts corresponding with four part specifications. All of the attributes must be considered in producing the packaging with more concern in the attributes get high values.

The next product developed in this research is carrot candy. The research found nine critical parts corresponding with twelve part specifications. All of the attributes must be considered during the production implementation since it is a new product development. Some attributes with high values must get more concern.

The last QFD phase II generated in this research is for the packaging of carrot candy. There are five critical parts corresponding with four part specifications. A producer who intends to produce carrot candy with its packaging must consider all of the attributes.

5. CONCLUSION

There are six critical parts needed to be taken into account when designing carrot syrup that fulfills customer requirements. The design of the packaging of the syrup should pay attention to five critical parts. There are nine critical attributes that need to be taken into account when designing a carrot candy. The design of the packaging of carrot candy also needs to pay attention to five critical part attributes.

To be able to apply the carrot based products' design in production process two additional phase of QFD needs to be done. QFD phase III, process planning, and QFD phase IV, production control, need to be conducted in order to get a complete design of the product and the production process.

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