Quality characteristic determination of red dragon fruit noodle with Kano Model and QFD Method

M E Isharyani¹,², Y Wijaya¹ and F D Sitania¹

¹ Department Industrial Engineering, Mulawarman University, Samarinda, East Kalimantan, Indonesia, e-mail: murianiemelda@gmail.com

Abstract. Red dragon fruit noodles in Samarinda, East Kalimantan have quality attributes that differ from other food commercial products. Therefore, the determination of quality attribute of red dragon fruit noodles need to be investigated. This paper discusses the use of Kano model and Quality Function Deployment (QFD) method for determining the quality parameters of red dragon fruit noodles. Kano questionnaire and Voice of Customer (VOC) questionnaire were used to categorize consumer-defined attributes and the level of importance of consumer defined attributes. The result obtained that 14 attributes are in One Dimensional category, 1 attribute in Must Be category and 13 attributes in Indifferent category. It is finally concluded that the consumer prefer red dragon fruit noodles with soft texture, thoroughly cooked, easily carried, fast and practical served and served in hot temperature. Technical parameters that need to be exist are technical presentation and the amount of wheat flour.

Keywords: red dragon fruit noodle, Kano model, quality function deployment

1. Introduction

Every human need food to get energy needed for their daily activities. 70% of human health depends on the dietary habit and food. Balanced meal will help human health. Health dietary habit related with carbohydrate, fat and protein. Carbohydrate not only obtained from rice, but can be found in fruits and vegetables [1].

One of the potential of East Kalimantan’s natural resource is red dragon fruit. The production of red dragon fruit in East Kalimantan is very abundant. The benefit of East Kalimantan’s geographical condition made the red dragon fruit production not depends on the season. The other advantages of this fruit are sweeter taste and larger size compare to other red dragon fruit that produced outside East Kalimantan [2]. Red dragon fruit is rich in various vitamin and mineral substances that help increase endurance and beneficial to human body metabolism. Red dragon fruit is very good for the circulatory system, reduce emotional pressure and neutralize toxic in the blood [3]. Red dragon fruit processed products that are suitable to be marketed for the area of East Kalimantan have been studied by [4], namely red dragon fruit noodles and ice cream that have the potential to be developed with franchise cart marketing systems. Therefore, red dragon fruit combined with noodle as one source of carbohydrate would create healthy food for human consumption.

The combination of noodle and dragon fruit has been made by Jember University student at East Java in 2016. The research utilized dragon fruit in Banyuwangi, East Java, in the noodle to provided added value while utilized unsold dragon fruit [5]. Nowadays, there is no commercial product of red dragon fruit noodle in East Kalimantan. Therefore, research needed to create red dragon fruit noodle with preferred quality characteristic by East Kalimantan consumer, which is certainly different from the noodle produced previously.

Kano model and Quality Function Deployment (QFD) method are considered to determine quality attributes of red dragon fruit noodles based on detailed categorized level that could result from these methods. The integration approach of Kano’s model and QFD involves a series of activities, from classifying customer attributes to evaluate the priority analysis of technical characteristics [6][7].
Various researchers have recommended some techniques on how to QFD can be enhanced, whereby surveys, focus group, questionnaire and interviews can be used as the traditional ways of collecting customer requirements and to identify the degree of importance for each customer requirements [8][9]. The Kano model is used to categorize product attributes based on the ability of the product to satisfy the consumer. QFD then connects consumer needs with the technical parameters to create preferred quality characteristic of red dragon fruit noodle. These results compile House of Quality (HOQ) that show information about the needs of consumers with technical parameters to crate preferred consumer product. Technical parameters used in this paper are considered from [10] which did noodle research based on 10 parameters.

2. Research methodology

The design and development of red dragon fruit noodle is based on data from the Kano questionnaire and voice of costumer (VOC) questionnaire. Kano questionnaire are used to classify consumer attributes, while the VOC questionnaire is to obtain the level of importance of consumer attributes. These questionnaires were distributed by using purposive sampling techniques because the selected sample is believed to represent a particular population where in this case are people who have consumed products similar to red dragon fruit noodle. The product is segmented to all ages, therefore the number of samples is determined using the following [7] formula:

\[ n = \frac{(z_{\alpha/2})^2(pq)}{(SE)^2} \]  

With \( n \) = sample size, \( z_{\alpha/2} \) =criticism value, \( \alpha \) =significance level, \( p \) =variance value, \( q = 1 - p \), and \( SE \) =sampling error.

Given that the population cannot be known with certainty, it is assumed that the population is unlimited. Therefore, the value of \( p \) and \( q \) using the highest value, with each of the value is about 0.5, with a confidence level of 95% and an error rate of 10%. From the calculation using the formula (1), it was found that the number of respondents needed was 97 people. The number of questionnaire distributed is 107 questionnaires to anticipate if there is an invalid questionnaire.

Valid questionnaires ready to process after going through the validity and reliability test. Validity test is intended to find out whether the statement items in the questionnaire can measure the interest of consumers, meanwhile reliability test to determine the consistency of measurement results or the extent to which these measurements can be trusted despite repeated measurements [8]. After the results of the questionnaire distribution are declared valid and reliable, then the data is processed through two main stages:

2.1. Grouping consumer attributes into the Kano Model

Kano model is a model used to categorize the attributes of a product based on how well the product is able to give effect to customer satisfaction. Kano model provide a linear view of the results provided by the performance of a product or service to customer satisfaction that can be used to identify attributes that potentially lead to customer satisfaction or dissatisfaction [9]. The Kano model can group product attribute needs into six categories:

2.1.1. Must-be. Attributes belonging to this category are considered the basic criteria of a product. The customer will be dissatisfied if the attribute performance is not met. Customer assumes that the attributes of this product are the attributes that must be present in the product, but if the attribute performance is met then it will not affect the increase of customer satisfaction.

2.1.2. One dimensional requirements. The level of customer satisfaction is directly proportional or linear with the level of fulfillment of the availability of attributes of a product. Customer satisfaction will decrease if the attributes in this product are not met, but customers will be satisfied if the attributes in the product are given. Attributes in the one dimensional requirements category will be explicitly demanded by the customer.
2.1.3. **Attractive.** Customer satisfaction will increase according with the improvement of attribute performance given to the product, but the decrease in attribute performance will not caused decreased of customer satisfaction. Customers will feel satisfied if the attributes on this product continue to be improved, but customers will not feel disappointed if the attributes in this category are not in the product. Customer are not demanding and not expect fulfillment of attributes in this category. Giving attribute in this category will give more positive effect to customer and improve product image in customer mind compared to competitor product. Some customers will even pay more to be able to get products that have this attribute.

2.1.4. **Indifferent.** Attributes in this category are seen as a neutral attribute of attributes for customers, so they will not have any effect on changes in customer upgrade or reduction.

2.1.5. **Reverse.** The customer will be dissatisfied if the attribute in this category is given, otherwise customer satisfaction will appear if the attributes does not exist.

2.1.6. **Questionable.** The attribute needs in this category can not be translated clearly because there is a contradiction between the customer's answer and the paired questions. This category indicates there is confusion and misunderstanding between the questions raised and the answers given.

2.2. **Preparation of House of Quality (HoQ)**

HOQ is the most recognized and widely used form of Quality Function Deployment (QFD) method, which would generate quality characteristics that need to be in the red dragon fruit noodle that will be developed. QFD is a way to improve the quality of a product or service by understanding the needs of consumers and then connecting it with technical provisions to produce a good or service at every stage of making goods and services produced. The dissemination of quality function in QFD is a plan tool used to help businesses focus on the needs of their customers when compile specification design and fabrication [10]. HOQ translate customer requirements, based on marketing research and benchmarking data, into an appropriate number of engineering targets to be met by a new product design. According to [11], it is “a kind of conceptual map that provides the means for inter functional planning and communication.” There are six basic steps performed to build HOQ:

2.2.1. **Identify WHAT customer wants.** It considered as consumer attributed which is obtained based on questionnaires. Consumer attributes used are the attributes of consumer who have been declared valid and reliable. Furthermore, the level of importance of relative consumer attributes, raw weight and normalized raw weight are calculated with formula as shown below.

\[
X = \frac{\sum X}{n}
\]  

With \(X\)=importance to customer, \(\sum X\)=total of score, and \(n\)=number of respondents.

\[
\text{Raw Weight} = \text{importance to customer} \times \text{improvement ratio} \times \text{sales point}
\]  

\[
\text{Normalized Raw Weight} = \frac{\text{Raw Weight}}{\sum \text{Raw Weight}} \times 100
\]

\[
\text{Weighted importance } = \sum (\text{Normalized Raw Weight} \times \text{relationship level})
\]

However, competitor data excluded due to red dragon fruit noodle is still classified as a new product. This makes the value of raw weight determined by normalized level of importance to consumer attributes.

2.2.2. **Identify HOW the product will satisfy the customer.** It refers to identifying specific product characteristics, features or attributes and showing how they will satisfy customer wants.
2.2.3. **Identify relationships between how’s.** It would construct the interrelationship matrix which its main function is to establish a connection between the customer’s product requirements and the performance measures designed to improve the product. After setting up the basic matrix, it is necessary to assign relationships between the customer requirements and the performance measures. These relationships are portrayed by symbols indicating a strong relationship, a medium relationship or a weak relationship. The symbols in turn are assigned respective indexes such as 9-3-1. When no relationship is evident between a pair, a zero value is always assigned.

2.2.4. **Develop importance ratings.** It refers to using the customer’s importance ratings and weights from the relationships in the matrix to compute our importance rating. The calculation of the relative importance of the consumers with the absolute importance level using the Likert scale is done by calculating the average of the questionnaire answers given by the consumers.

2.2.5. **Evaluate competing products or services.**

2.2.6. **Determine the desirable technical attributes.** The absolute importance for each technical requirement is calculated from the cell value and the customer importance rating. Numbers are then added up in their respective columns to determine the importance of each technical requirement.

3. **Discussions**

3.1. **Qualification of consumer preference with Kano model**

Respondent data from Kano questionnaire were calculated into each category in the Kano model. The result show 14 attributes that are categorized as One Dimensional, which are 1) great and interesting appearance, 2) the sweet and salty taste in red dragon fruit noodle blend together, 3) has chewy texture, 4) served in hot temperature, 5) the colour is interesting and appetizing, 6) has natural colour, 7) has soft texture, 8) thoroughly cooked, 9) tasted delicious, 10) the packaging represent red dragon fruit, 11) boiled cooked, 12) served with gravy, 13) can be brought easily, and 14) fast and practical serving process. Attributes that falls into this category means that these attributes result in satisfaction when fulfilled and dissatisfaction when not fulfilled. Therefore, it is important to have these attributes in red dragon fruit noodle.

Moreover, attribute the similarity in thickness of red dragon fruit noodle categorized in Must Be, meanwhile 13 of the rest attributes fall into the Indifferent category. Must be category means this attribute must be included in red dragon fruit noodle; otherwise consumers would be very dissatisfied. The indifferent category considered insignificant because these attributes refer to aspects that are neither good nor bad, and would not result in either customer satisfaction or customer dissatisfaction.

3.2. **Consumer attributes**

Consumer attributes in the questionnaire were compiled based on previous similar studies, namely research on corn noodle [5], strawberry chili chips [12] and guavagua dodol [13]. Only 15 of 34 consumer attributes are considered in building HOQ, since these 15 attributes belonging to the One Dimensional and Must Be categories. These attributes are then calculated normalized relative importance score based on the average score of the questionnaire from the respondents. Top 5 priorities considered from consumer attributes that have the highest normalized relative importance score. Based on the result of calculations using equation (3) and (4) as shown in Table 1, the 5 priorities respectively were soft texture of red dragon fruit noodle, thoroughly cooked, can be brought easily and has packaging design that represent red dragon fruit.

| No | Consumer Attribute | Normalization |
|----|--------------------|---------------|
| 1  | The appearance of red dragon fruit noodle good and interesting | 6,529 |
The thickness of red dragon fruit noodles is relatively same 6,265
3 Sweet and salty flavor in red dragon fruit noodle balance 6,312
4 Red dragon fruit noodle has a chewy texture 6,762
5 Red dragon fruit noodle served with hot temperature 6,823
6 The color of red dragon fruit noodle is interesting and appetizing 6,591
7 The color of red dragon fruit noodle looks natural 6,545
8 The texture of the red dragon fruit noodle is soft 7,103
9 red dragon fruit noodle thoroughly cooked 6,963
10 red dragon fruit noodle tasted good 6,762
11 The packaging design describe red dragon fruit 6,110
12 Red dragon fruit noodle cooked by boil 6,808
13 Red dragon fruit noodle served with gravy 6,606
14 Red dragon fruit noodle can be brought easily 6,948
15 The process of serving red dragon fruit noodles quickly and practically 6,870

3.3. Compiling technical response and relationship matrix
Technical parameters or technical responses obtained based on the translation of consumer attributes. These technical parameters would be a reference in making red dragon fruit noodle. The determination of the technical parameters refers to the research of [5]. There are 9 technical parameters related to consumer attributes, which are the amount of wheat flour, number of red dragon fruit, number of eggs, the amount of salt, volume of water, number of STTP (baking soda), mixing process, length of drying time and presentation techniques.

The strength of relationship between consumer attributes and technical responses as seen in figure 1, includes 25 relationship that are relatively strong, 9 relationship that are classified as intermediate and 2 relationships that are classified as low relations. Each of relationship type is indicated by a particular symbol as follows:

- ● = Strong relationship with weight is equal to 9
- ○ = intermediate relationship with weight is equal to 3
- Δ = low relationship with weight is equal to 1
- Blank = no relationship with weight is equal to 0

3.4. Technical correlation determination
This stage is carried out to determine the relationship between technical parameters with one another. The influence between these technical parameters is classified into strong positive, medium positive, medium negative and strong negative influences. There are 4 strong positive relations and 9 medium positive relations between each other technical parameters. This correlation can be seen as a roof of HOQ in figure 1.

3.5. Technical matrix determination
3.5.1. **Weight importance.** The weight of the technical parameters is obtained by using equation (5), which represent importance to consumer value and the linkage weight (relationship) between the consumer attribute and the technical parameters. The calculation of weight importance for all technical responses placed in the bottom of HOQ, as seen in figure 1. The weight value of each technical parameter is then used as a guide in ranking the priority to determine the characteristics of red dragon fruit noodles. The priority ranking from highest to lowest weight can be sorted as technical presentation as first priority, amount of wheat flour as second priority, followed by number of eggs. Therefore, red dragon fruit noodle favored by the consumer is soft texture noodle which presented in a cooked, hot, quick and easy to carry which is related to the amount of wheat flour and technical presentation.

3.5.2. **Direction of development.** This direction of development was obtained from interviews with a researcher from Balai Riset dan Standardisasi Industri Samarinda (Baristand Samarinda) who had made research on red dragon fruit noodle in 2016. The results show that 2 of technical parameters need to improved, 3 of them need to be reduced and 4 of them need to meet the appropriate target values to satisfy consumer desires. Those 2 technical parameters that need to be improved are the amount of salt and length of drying time. Meanwhile, 3 of technical parameters that need to be reduced are the number of eggs, the volume of water and amount of STTP (baking soda). Furthermore, 4 technical parameters

![Figure 1. HOQ of red dragon fruit noodle.](image-url)
that need to meet certain target values are the amount of wheat flour, the number of red dragon fruit, the mixing process and presentation techniques.

All the steps above are done to get the HOQ components; therefore after all the data in HOQ has been determined, HOQ could be built as seen in figure 1.

4. Conclusions

Red dragon fruit noodle that must be made are red dragon fruit noodles that are preferred by consumers, which are has soft texture of noodle, served in a mature, hot, fast serving process and easy to carry (practical). These quality characteristic of red dragon fruit noodle related to the amount of wheat flour and the presentation techniques. The amount of wheat flour associated with soft texture of the red dragon noodle, meanwhile the technical presentation associated with noodles that served in cooked, hot, fast serving process and easy to carry.

HOQ is only the first stage of the QFD method, therefore further research is needed covering all stages in QFD. The level 2 QFD matrixes is a used during the Design Development Phase, which could discover the assemblies, systems, sub-systems and components have the most impact on meeting the product design requirements and identify key design characteristics. The level 3 QFD is used during the Process Development Phase where examined which of the processes or process steps have any correlation to meeting the component or part specifications. Last but not least, the level 4 QFD would have list all the critical processes or process characteristics in the “What” column on the left and then determine the “How” for assuring quality parts is produced and list them across the top of the matrix.

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