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Integrated approach to customer requirement using quality function deployment and Kansei engineering to improve packaging design

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Abstract

Packaging is one of the attributes that has a significant impact on the sale of a product. Specifically, it helps customers to notice the product, and it influences their decision to purchase. Several SMEs in Yogyakarta, including those producing crispy wader fish, have failed when it comes to the packaging of their products. This product does not appeal to customers because it is wrapped in transparent plastic. The purpose of this study was to recommend a packaging design for the crispy wader fish product that would attract customers. The first step in this study was to conduct a survey to obtain the Kansei words that could be split into nine categories, including material, model, price, durability, informative, safety, size, appearance, and easy to care. Furthermore, the quality function deployment (QFD) method was used to evaluate the desires of customers in order to design an eye-catching packaging that would meet their expectations. A total of 23 Kansei words were collected, based on an analysis of surveys and interviews. These words were interpreted using QFD to generate eight characteristics, namely, availability, cleanliness, display, durability, power, price, protection, and standard size. These characteristics were used to help develop an appealing outer packaging design. Photoshop software was used to develop the 3D model, while design methods were aligned with the achievement targets of the House of Quality (HoQ), which required the outer packaging to be appealing and disposable to fulfil consumer expectations.

Keywords: Food packaging, Quality function deployment, Kansei engineering, Packaging design

1. Introduction

Packaging plays a vital role in creating a particular market image of a product that can influence the decision of the consumer to buy that item, especially food. Improved packaging can increase sales in SMEs, which are currently experiencing a growth of 8.67% in Indonesia. This is exceptionally higher than the national economic growth of 5.27% [1]. The increasing number of SMEs has given rise to greater competition. Thus, SMEs must introduce commodities and marketing strategies that will help them survive the competition [2]. The aim of this research was to create a food packaging design based on consumer expectations by employing the Kansei engineering approach [3] as well as the QFD method to interpret customer requirements and convert them into a product description [4]. One of the key factors that determines the success of a company is its ability to understand consumer tastes and preferences, anticipate future trends, and make changes accordingly to the existing or new products it is manufacturing [5]. According to Rundh, internal as well as external elements have an impact on determining the outer packaging design of a product [6]. This means that the elements that influence the packaging design are connected to all aspects of a product such as the materials, colours, shapes, images, typography, structures, and product description that go into making the product marketable. Packaging is basically required to identify, send, store, protect and differentiate a commodity in the market [7]. Apart from these aspects, ‘authenticity’ is one more additional aspect that consumers expect, and thus, it should be safeguarded by the company [8]. The Kansei engineering approach is one of the approaches that is applied in

making decisions concerning the packaging of a product. This approach is used to identify the psychological responses of customers while interacting with a commodity. A correlation is then established between these psychological responses and the attributes of the product. In other words, this can be called a "picture in the mind", which is more widely known as "Kansei" [9]. These correlations, which are available in the form of Kansei words, are then converted into a product design via the QFD (quality function deployment) approach [4].

This approach has been effectively used in numerous researches earlier to formulate and create designs. This method was devised in many stages to determine the basic procedures and priorities to manufacture halal food [10]. An inquiry was conducted and it has been proven that this approach can not only be employed to create designs but also to improve quality [11]. Rahman & Kapuria devised a fuzzy QFD to enhance quality as per consumer needs [12]. This approach has also been useful in determining geometrical designs for creating product packaging, with 3D models being created using CAD [13]. Also, Habyba, Djatna, & Anggraeni applied the Kansei engineering approach to create the design for an e-commerce website called Ponorogo for marketing the products of SMEs [14,15]. Hartono et al. devised a model to optimise logistics facilities by combining QFD, Kansei engineering and Kano[16]. Neto submitted a research where, through the use of Kansei engineering and QFD, he discovered that some product attributes bring out the emotions in consumers, and these emotions can become the determining factors in the consumer's purchasing decision [17].

In the QFD approach, a collection of keywords is required to create a design, and Kansei engineering is an effective tool for this. The Kansei engineering approach enables decision makers to select the words that are representative of customer expectations. These words become a useful reference material for developing the packaging design for a product [3]. The Kansei engineering approach has also been employed to model customer responses so as to successfully collect survey responses to a product [18]. When there is a limited budget, fuzzy QFD can be used to emphasise a "sustainable service concept", which can be utilised in the delivery and design services of a company [19]. QFD is also an approach that focuses on identifying initial consumer satisfaction, i.e., at the product design phase itself. This helps a company to be more proactive when it comes to any problem with quality [20]. QFD is also applicable in the healthcare sector by synchronising service intentions and infrastructural designs so as to improve the quality of these facilities [21]. The course of action for creating a product design, especially for food packaging, by combining the Kansei and QFD methods, has yet to be improved. Thus, it is essential to discover a combination that works by studying various combinations of the two approaches. This encouraged the researchers to carry out this study.

2. Materials and methods

In this work, the steps, as depicted in Figure 1, were carried out. The process began with the circulation of open surveys to obtain the Kansei words. Then, these words were grouped more explicitly. A closed survey was then conducted on the basis of the Kansei words attained through a House of Quality analysis. The outcomes of the analysis were given a technical response priority that would be converted into packaging patterns in 3D.

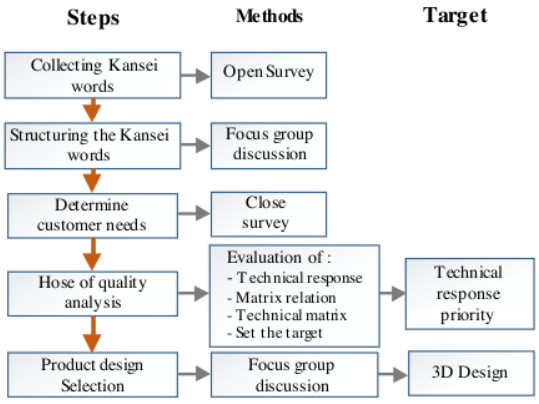

Figure 1 Methodology.

2.1 Case study

BINANISA is an SME that manufactures fish items such as 'otak-otak bandeng', fish nuggets and crispy fried waders. This SME is facing an issue with its sales of crispy fried waders. They are still packed in large, transparent plastic bags, as shown in Figure 2. This product is repacked by resellers in another outer package.

The problem faced by BINANISA is that the repacked product is more popular and has a better market image than their original product. The repacked product comes in 250-gm packets, and now, the challenge being faced by BINANISA is to develop its packaging design to make its product more popular than other similar products.

Figure 2 Initial packaging design of crispy wader fish product.

2.2 Participants

The number of samples to be taken for determining the customer requirements for QFD are collected using the given formula [22].

$$N = \frac{Z_{\alpha}^{2} \cdot p.(q)}{e^{2}} \quad (1)$$

N = minimum number of sample
Z = normal distribution value, α = level of significance, e = error level
p = proportion number of questionnaires with correct answer
q = proportion number of questionnaires with the wrong answer.

40 consumers took part in this research and the level of significance being 95 percent. It was calculated using the following formula.

$$N = \frac{(1{,}96)^2 \cdot (0{,}975).(0{,}025)}{(0{,}05)^2} = 37.45 \approx 40 \quad (2)$$

2.3 Packaging design

In this phase, the QFD technique was used to translate consumer requirements into product specifications, as given below:

• Determine Customer Requirements

The basic needs of the consumers were worked out in a brainstorming session between the designers and SME proprietors in order to create an outer packaging for crispy wader fish, where durability, design, distribution and quality were to be taken into consideration. The basic needs of the consumers were determined using the selected Kansei words.

• Validity and Reliability Test

The reliability and validity of the survey results were examined to determine the degree of significance of the product features before proceeding to the next step.

• House of Quality (HoQ) Matrix

Then, the HoQ matrix was procured on the basis of a survey of customer requirements and interviews of experts.

The HoQ was obtained through these steps: (1) finalise the technical needs (2) define the correlation. The purpose of these was to determine the extent to which the attributes of the product were meeting consumer requirements [4]; (3) specify the target. This was an analysis of the technical attributes; (4) matrix relationship, and (5) calculating the column weights. These were determined using the correlation of consumer requirements and technical attributes and the type of correlation; (6) finalise the sales value. This was an estimation of the selling worth of each attribute of the product.

2.4 3D product design

Once the influencing coefficients were determined using the HoQ analysis, a brainstorming session with the owners of the company was undertaken so that these data could be used to formulate the product design. The 3D design was developed using CAD. The product design method was adapted to the required HoQ target. Then, a review was conducted to match the consumer requirements. The outcomes of this review were used as evaluations, which were employed as suggestions, inputs and complaints so as to upgrade the design as per customer requirements and desires.

3. Results and discussion

The total number of Kansei words was opened via a survey interview to 40 crispy wader fish customers aged between 15-40 years who were from various backgrounds. A brainstorming session with the SME proprietors was held, after which, 33 Kansei words were selected, as depicted in Table 1. Then, these Kansei words were organised by the structuring method.

3.1 Structuring of Kansei words

In this process, the Kansei words with similar meanings and purposes were classified according to the Kansei words that had been obtained from a previous research, and the results were discussed with the owners to facilitate the application of the design [3] .

Table 1 Grouping and election of Kansei words.

No	Survey and brainstorming	Grouping Kansei
1	Packaging form of more good	Packaging model
2	Packaging uses different shapes	
3	The packaging has a modern form	
4	Packaging is different from the others	
5	The packaging is not good	
6	Forms are less good	
7	Absence of packaging size normally	Easy to Carry
8	Not practical	
9	Packaging is not common	
10	It is likely the plastic will tear	Material Resistance, Protection
11	Do not make eating lasting longer	
12	Make eating fast sluggish	
13	Too thin	
14	Plastic is not good enough	
15	Plastic is too thin	Material Durability
16	Does not make long-lasting food	
17	Choosing packaging with quality good at prices affordable	Price
18	Selection of the type of packaging that is nice	Material Safety
19	Selection of plastic quality	
20	Added halal information	Informative
21	Add address	
22	Add food expiration information	
23	Addition of nutritional value	
24	Addition of information on food composition	
25	The packaging is too big	Standard Size
26	Yet their packaging characteristics typical	
27	Package size is missing	
28	Absence of images	Appearance
29	Packaging less attractive	
30	Lack of interest	
31	A description of the food maker should accompany the packaging	
32	The packaging is colored	
33	Packaging given posts that good	

3.2 *Establishing customer needs*

The goal of this step was to establish the customer requirements in the interrelated outer package design for crispy wader fish. It was based on the quality, durability, design and distribution of the product, as shown in Table 2 [4].

Table 2 Customer requirements.

No	Primary customer needs	No.	Secondary customer needs
1	Endurance	1	Power
		2	Protection
2	Quality	3	Durability
		4	Price
		5	Cleanliness
3	The design	6	Display
		7	Standard Size
4	Distribution	8	Availability

SPSS software was used to conduct the validity examination. The outcome showed that all the inputs were valid, as shown in Table 3. On the basis of validity test, $R_{count} > R_{table}$. Thus, it could be seen that all the attributes were valid. At the same time, the reliability test results showed that the Cronbach's alpha value was 0.312 for all the customer needs. This was an acceptable result, which indicated that the attributes were reliable [23].

Table 3 Validity test.

No	R_{Count}	R_{Table}	Result	Attribute
1	0.488	0.312	Valid	Power
2	0.631	0.312	Valid	Protection
3	0.335	0.312	Valid	Durability
4	0.343	0.312	Valid	Price
5	0.374	0.312	Valid	Cleanliness
6	0.508	0.312	Valid	Display
7	0.661	0.312	Valid	Standard Size
8	0.459	0.312	Valid	Availability

3.3 *Quality funtion deployment (QFD)*

3.3.1 *Technical response*

The technical response was the technical ability of the company to fulfil *consumer requirements*. The technical feedback arrived at was the outcome of a brainstorming session between the SME proprietors and the researchers [4].

Table 4 Technical responses.

No	Attribute	Technical response
1	Power Protection	Sturdy
		Can be stacked
2	Durability	Protect crisp waders from collisions
		There is no air cavity to enter
3	Cleanliness	Resistant to weather and temperature
4	Price	Affordable price
5	Standard Size	Have the right dimensions
6	Display	Has a Label
		Modern Display
7	Protection	Resistant to weather and temperature
8	Availability	Available all year long

3.3.2 Matrix relation

This correlation matrix depicts the magnitude of the effect of technical responses deployed by SMEs in fulfilling customer requirements [4]. The symbols in the cells are there to describe the magnitude of the correlation between the consumer requirements and the firm's technical abilities. The following Figure 3 depicts these symbols.

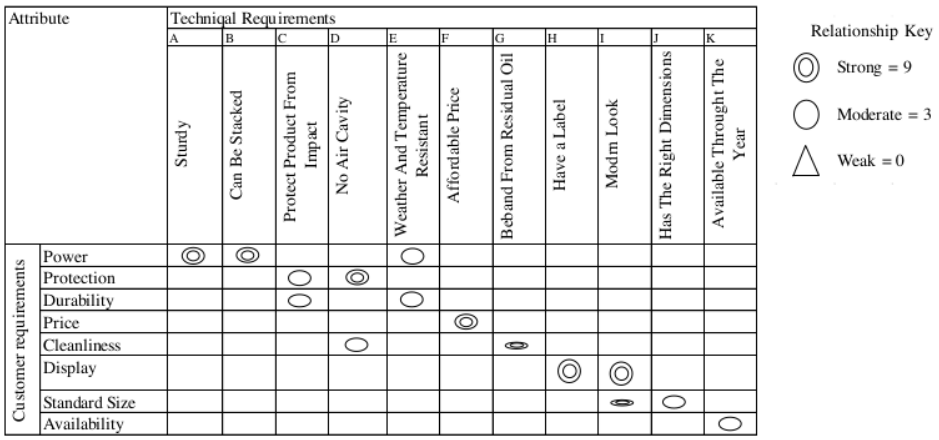

Figure 3 Relation matrix.

3.3.3 Technical matrix priority

Table 5 below illustrates the priority contribution i.e., the efforts by the SME to enhance its technical contributions so as to meet consumer satisfaction. The normalized contribution was a value on a scale of 0 – 1 to depict the percentage. These values were determined after the brainstorming session with the SME owners.

Table 5 Priority matrix.

No	Technical response	Priority contribution	Normalized contribution
1	Sturdy	28.8	40.7
2	Can Be Stacked	28.8	40.7
3	Protect Product From Impact	20.7	26.6
4	No Air Cavity	42.0	50.8
5	Weather And Temperature Resistant	20.1	28.9
6	Affordable Price	28.8	40.7
7	Free Residual Oil	28.8	40.7
8	Have a Label	28.8	40.7
9	Modern Look	57.6	72.6
10	Has The Right Dimensions	9.0	8.4
11	Available Throughout The Year	9.0	8.4

3.3.4 Setting targets

The values of the targets depicted in Table 6 dictated how the technical response could be obtained in relation to customer requirements, and performance expectations and perceptions. The values were on a scale of 1 (low) to 5 (high).

Table 6 Target matrices.

No	Technical response	Contribution	Target
1	Sturdy	28.8	5
2	Can Be Stacked	28.8	3
3	Protect Product From Impact	20.7	5
4	No Air Cavity	42.0	5
5	Weather And Temperature Resistant	20.1	4
6	Affordable Price	28.8	4
7	Free Residual Oil	28.8	5
8	Have a Label	28.8	5
9	Modern / Not Ancient	57.6	5
10	Has the Right Dimensions	9.0	3
11	Available Through The Year	9.0	3

The results of the *House of Quality* (HoQ) are shown in Figure 4, where the information from the previous discussion of tables and figures was used as the input to develop the HoQ.

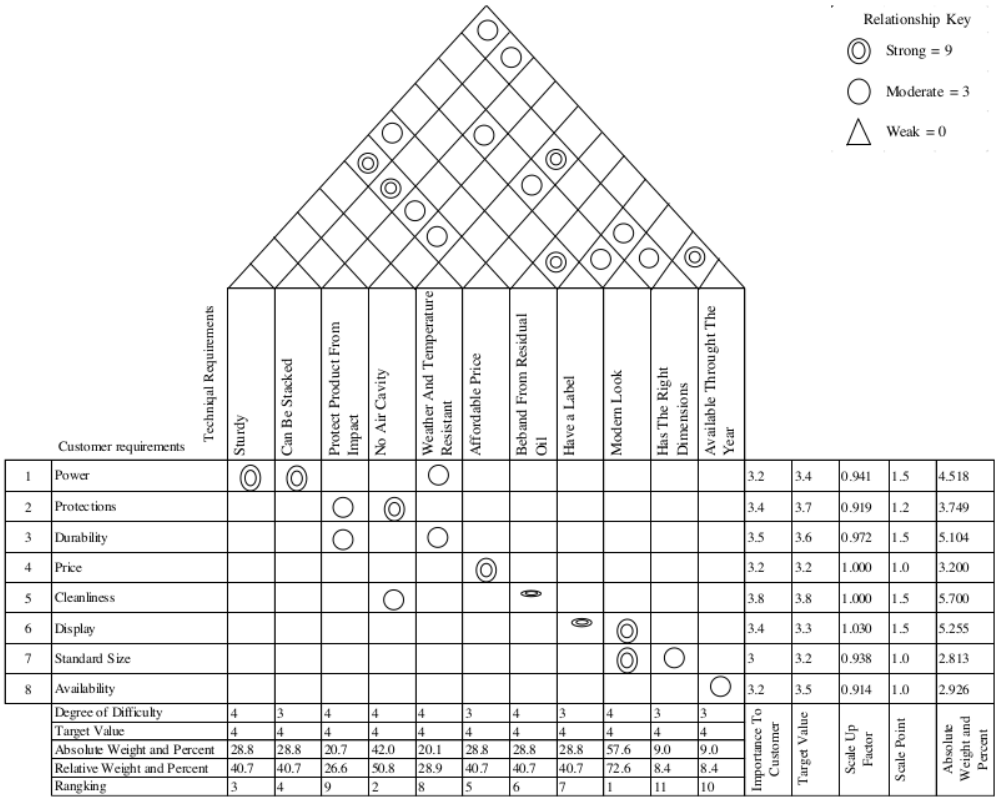

Figure 4 House of quality.

3.3.5 Selection of product concept

Proper packaging is important so as to minimise the chances of damages caused [24].Tension is a measurement of the magnitude of the reaction or force in which a huge union emerges.

$$\sigma = \frac{F}{A} \tag{3}$$

σ = Tension
F = Force (N)
A = Surface Area (m^2)

This computation depicts that the packaging design must be made considering the choice of packaging raw materials which could bear the load which might induce technical harm of 0.027 pa.

3.3.6 Output analysis

The GAP graphs in Figure 5 depict the characteristics of satisfaction that failed to meet customer expectations, and those characteristics for which customers had expressed satisfaction.

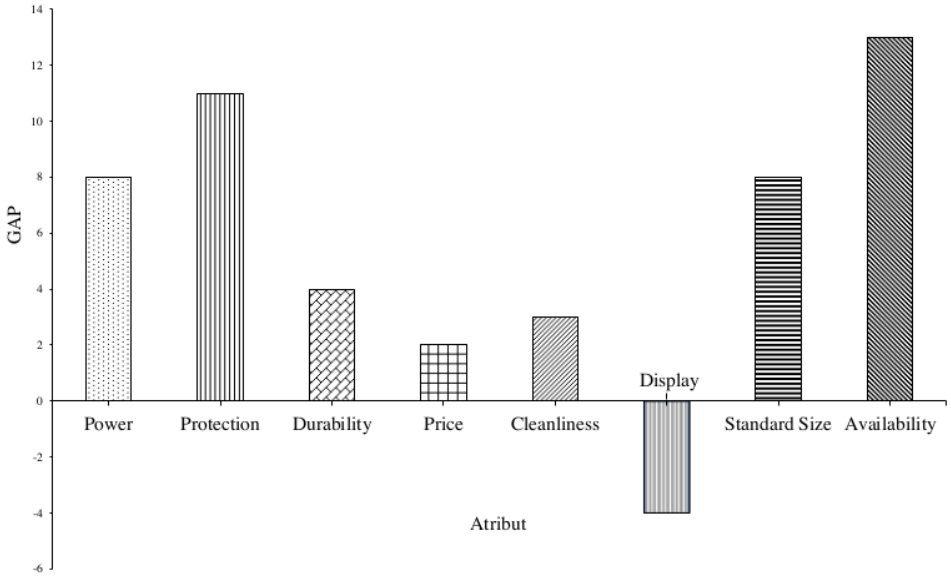

Figure 5 GAP value *Histogram*.

From this diagram, it could be concluded that the majority of the satisfaction value characteristics had a positive feedback, except for the appearance of the product as the packaging used was not very attractive. This meant that when the HoQ was developed, priority had to be given to those aspects for which the satisfaction value did not fulfil customer expectations, i.e., which still had a negative value and display attribute.
On the basis of the above table and diagram, it could be seen that all the characteristics required attention. The attributes were:

- Modern Look

This attribute was given a priority value of 72.6 pertaining to the first technical response. The data demonstrated that this customer need could be met.

- No Air Cavity

This attribute was given a priority value of 50.8 pertaining to the second technical response. The data demonstrated that a higher quality material was required to prevent air from entering the package so as to meet consumer desires in terms of protection, strength and standard size.

- Sturdy

This attribute contributed a value of 40.7 pertaining to the third technical priority. Based on the data, consumer desires pertaining to protection, strength and standard size of packaging design could be met. Thus, it was crucial to employ a durable plastic material for the packaging design that would have excellent impact strength, and tear strength, particularly the type used for side gusset pouches.

- Can be Stacked

This attribute contributed a value of 40.7 pertaining to the response to the fourth technical priority. The data demonstrated that the selection of the right type of plastic for the packaging design was key to meeting consumer desires for strength, protection and standard size.

• Affordable Price

This attribute contributed a value of 40.7 pertaining to the fifth technical response. The data demonstrated that it was crucial to distribute the packaging at the production centre (production area) so as to satisfy consumer desires for price, availability, standard size and strength.

3.7 Selection of product design

Different influencing factors were observed during the determination of the design based on the top five priorities. The packaging dimensions selected were based on the standard size that is usually employed for snack packages, i.e., length = 15 cm, width = 32 cm, thickness = 4 cm. The key considerations behind the size of the packaging design were that the packaging had to have an attractive appearance and should be disposable, and that all the attributes met the desires of consumers pertaining to wader products. The recommended packaging weight was 250 g so as to allow for more air exchange to ensure that the snacks did not become sluggish during shipping and at the point of sale. Photoshop software was employed for the implementation of the design, as presented in Figure 6.

Figure 6 3D design of crispy wader fish product.

3. Conclusion

The purpose of this paper was to use a combination of Kansei engineering and QFD to recommend a packaging design for a crispy wader fish product that would attract customers. The effectiveness of QFD and Kansei engineering is irrefutable, and applications of both have been well-documented. Although the process began with a QFD along with an open survey, in this case, it was different when it was integrated with the Kansei method, which is believed to be involved in the role of substituting the initial QFD method survey, and is also sufficiently capable of capturing the needs of the customers in depth. During the Kansai word selection process, a certain structural analysis was carried out via an open survey. There were eight attributes pertaining to consumer needs in determining the packaging design for crispy wader: Power, Durability, Protection, Standard Size, Cleanliness, Display, Availability, and Price. The material employed for the packaging was plastic side gusset pouches with dimensions of length = 15 cm, width = 32 cm, thickness = 4 cm. In developing the new packaging design, priority was to be given to a packaging with a modern appearance, sturdy, no air leakage, available throughout the year, and stackable. The unique contribution of this paper was the improvement in the quality of the packaging design through an integration of QFD and Kansei engineering. The technical correlations pertaining to this design were found to be positively associated with being stacked, sturdy, having a modern appearance, affordable and with protection against the effects of mechanical damage. Some future research directions are suggested. Due to the limitations, only a small medium enterprise was selected for the quality improvement. Therefore, it would be better to consider all ranges of food companies, from top tier to low tier. Then, more quality problems can be solved. Also, by using Kansei and the QFD method, the packaging quality can be improved.

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