Kansei engineering, MANOVA and quality function deployment to design bottle packaging and seasoning quality

Fransisca Dini Ariyanti, Senny Chan
Industrial Engineering Department, Faculty of Engineering, Bina Nusantara University, Jakarta, Indonesia 11480
Email: dini.ariyanti@binus.ac.id, senny.chan14@gmail.com

Abstract. Customers at recent time, want practical consumer goods, eye catching designs, with low price, so smart producers should realize all customer desires in the appropriate products and packaging. One of “ready to eat seasoning” producer, PT Kiantaka Rasa, KR, has planning to be more popular among the “end user” customer, by launch their ready to eat seasoning series. Their goal of new packaging is expected to attract public’s interest for buying KR’s products. In this research, we use Kansei Engineering, Quality Function Deployment, QFD, and Multivariate Analysis of Variance (MANOVA) in purpose ergonomic, simple and attractive packaging and products. Nine prototype packaging design was offer into focused discussion group respondent, using Kansai word then Manova, the result, Design 2 is the best design. So as to fit the "end client" desire for the surface of fine flavors, fiery taste, reusable and solid bundling, we utilized QFD technique. The result, the seasoning particle size is less than 250 microns, increase composition of spicy material, bottle design is slim shape with a thickness of 0.05 cm, the bottle cap has many small holes for sprinkle option.

Keywords: Packaging Design, Kansei Engineering, Quality Function Deployment, Multivariate Analysis of Variance, Statistical Package for the Social Sciences.

1. Introduction
To improve the taste and aroma of ready-to-eat food, food makers are used to adding food flavorings, including seasoning powder. In General, The prepared to-eat nourishment vendor in Indonesia today, changing it up of flavoring to the last touch before overhand the supper, for example, tofu ball, egg rolls and sweet potatoes, according to purchaser demand. Many Indonesian street foods use seasoning, so public begin to know about seasoning with various flavored.

PT Kiantaka Rasa, KR, produces seasoning with various flavored during 30 years and prioritized taste of archipelago in their products, so KR’s seasoning products are able to known public and become superior product. The seasoning products produced by KR 3 types, namely ANTAKA, ANTAKA Premium and TumTum. Three packaging types of products are bag pack in rotogravure with various sizes for Business to Business, B to B, customer instead of “end user”. The seasoning ANTAKA and ANTAKA Premium have 3 types of bag pack sizes, namely 100 grams (gr), 1 kilogram (kg) and 20 kg. TumTum also have 3 types of bag pack are 100 gr, 800 gr and 20 kg. Although KR had 3 bag pack in various flavors and sizes for 30 years in ready-to-eat seasoning business, especially end-users, don’t know about KR’s seasoning. In Indonesia, the seasoning products
are most known by food and beverage sellers or B to B customer, which used KR’s seasoning as final sprinkle flavor in their ready-to-eat foods and beverages.

KR intending to infiltrate end customer and become “ready to eat” seasoning marketing leader, by inventive packaging design. The new packaging is expected to attract public’s interest for buying KR’s seasoning which is convenience, re-used able and durable packaging for end user customers.

2. Literature Review

2.1. Kansei Engineering
Kansei is a Japanese word that communicates emotions that are situated in vision, hearing, smell and taste. In Japanese terms, Kansei has numerous understandings, to be specific inclination, affectability, depiction, feeling, want and need [1]. Kansei is an engineering based on psychology, ergonomics, health and engineering data to design new products based on information analysis. This method is building by translating the feelings of consumers into a particular design. Kansei is a feeling that is felt by the recipient of the stimulus based on the atmosphere of the situation. If the recipient is full of emotions, the feelings that match the stimulus will come out, but when the recipient has no emotions, then the stimulus will be partially responded to and those feelings will be distorted [2].

Kansei’s consumers have different expressions. If Kansei technician wants to make a new Kansei product, determine the right Kansei by making observations based on electroencephalography (EEG), electromyography (EMG), behavior or word [2]. Three step of designing new product using Kansei engineering, are, first to decide Kansei's shopper on specific items utilizing psychological estimations. Second, investigate Kansei information utilizing factual, wellbeing or procedure strategies to clarify the Kansei structure. Last step, make an interpretation of information into the most recent Kansei item structure.

2.2. Quality Function Deployment
Quality Function Deployment, QFD is a systematic procedure that ensures control and twisting when setting info plan and converting into yield structure. QFD can be applied when creating exercises or plans and characterizing customers. This incorporates items, parts, materials, services, occasions, software and sites [3]. QFD is six Japanese ideograms, which give unique strategy to guarantee quality at steps of item advancement. The motivation behind this strategy is to draw an item that addresses purchaser issues and portrays the quality control process before genuine creation. Organization can create items that are in accordance with purchaser interests with the QFD framework [4].

In QFD method, there is a 4-phase that must be followed, namely Voice of Customer, Product Development, Process Development and Production Planning. First phase is Voice of Customer, a definition of customers’ needs. Customers’ needs will increase in according with experience on similar products. After defining customer’s needs, the method of settlement is given to meet customers’ needs. This phase is known as Product Development. The Process Development, a production process is developed to satisfy the most crisis production parameters. The last phase is Production Planning, which control product tolerance in development [5].

2.3. Multivariate Analysis of Variance, MANOVA
Multivariate Analysis of Variance is a generalization of analysis of variance with many factors. MANOVA could utilized to compare the mean estimations of a few gatherings in non-exploratory research that assess differences in average patterns. In addition, MANOVA could utilized to test critical contrasts in the normal research [6].

The post hoc strategy on MANOVA should be utilized after hypothesis H0 is rejected or H0 doesn't give the ideal outcomes. From the aftereffects of the hypothesis is that there are at least one different group compared to the other groups [7].

Tukey is commonly used as a post hoc test, which is a pairwise comparison technique developed by Tukey. Tukey tests are also referred as the honestly significant difference, HSD [8]. The main
function of HSD is to calculate honest significant differences between the two averages using predetermined statistical distributions.

By utilized software Statistical Product and Service Solutions (SPSS), MANOVA can be shown utilizing the general linear model. General linear models can beat the numerous mixes of estimations, variables and reiterations. The general direct model at SPSS gives four multivariate measurable tests to test the invalid speculation of Wilks' Lambda, Hotelling's Trace, Pillai's Trace and Roy's Largest Root [6].

The main purpose of this research is to innovate convenience, re-used able and durable packaging and to know customer preferred ready-to-eat seasoning product quality.

3. Research Methodology
3.1. Step of research
a. In order to meet low price packaging, source local general product of 3 different bottle packaging volume 100 grams and 3 different caps with small hole suitable to sprinkle
b. First Questionnaire of Kansei Word Method to focussed group discussion – 26 respondent who are KR’s seasoning food maker, agent and distributor, end user who known well KR’s seasoning
c. The data obtained on the questionnaire distribution was processed using SPSS software and tested with the Multivariate Test.
d. Second and third questionnaire of QFD, contain Product and Quality question to find out data of focussed group discussion – 26 respondent who KR’s seasoning food maker, agent and distributor, end user who known well KR’s seasoning
e. QFD analysis of product and quality
f. Decided design packaging and product quality

3.2. Flow Chart Research

Figure 1. Flow Chart Research Methodology – Packaging Design of seasoning
3.3. The scope of research
The scope of this study, which is limited to the framework proposed by the research object, is national ready-to-eat flavouring company, Kiantaka Rasa, located in near Jakarta. There are two questionnaires, which have been filled by focused group discussion respondents (food maker customer, agent and distributor of KR’s seasoning, end user). The result is 16 first Questionnaire respond is valid, 19 second questionnaire respond is valid and 22 third questionnaire respond is valid.

4. Result and Analysis

4.1. Design bottle packaging
In order to get lower price packaging, packaging seasoning bottles sourced from local, general mass-produced bottles and caps. There are 3 different bottles and caps, shown on figure 2:

![Figure 2. Local source 3 different mass-produced bottles and caps volume 100 grams](image1)

Three of bottles and caps’ bottle shapes are crossed into 9 designs as figure 3.

![Figure 3. Nine design of body and caps](image2)
First questionnaires 26 respondents full filled, but only 16 valid questionnaire data were obtained. The results of the questionnaire are useful to get the results of focused group discussion of the design of seasoning bottles that appropriate with the Kansei Words expected by KR: are ergonomic, simple and attractive. The calculation of the average value of each Kansei Word in each design, the results obtained that top three average values are Design 1 dan 2. Design 1 has the largest average in ergonomic and simple words, with each value of 5.875 and 6.125. Design 2 has the largest average value of 5.6875 in attractive word.

The data obtained on the first questionnaire then analysed using SPSS software and tested with the Multivariate Test. Multivariate Test is used to find the effect of variables on an object simultaneously. The variables in this study are Kansei Words are used or those that want to be highlighted on the bottle sprinkle packaging, while the objects in this study are the nine designs that have been made. The following are the results of the Multivariate Test (figure 4):

| Effect         | Pillai's Trace | Wilks' Lambda | Hotelling's Trace | Roy's Largest Root |
|----------------|----------------|---------------|-------------------|--------------------|
| Intercept      | 0.974          | 0.926         | 37.765            | 37.765             |
| F              | 1681.654^a     | 1681.654^a    | 1681.654^a        | 1681.654^a         |
| Hyp. df        | 3,000          | 3,000         | 3,000             | 3,000              |
| Error df       | 132,000        | 132,000       | 132,000           | 132,000            |
| Sig.           | .000           | .000          | .000              | .000               |
| Partial Eta Squared | .974      | .974          | .974              | .974               |
| Noncent. Parameter | 4984.953   | 4984.953      | 4984.953          | 4984.953           |
| Observed Power  | 1.000          | 1.000         | 1.000             | 1.000              |

a. Design: Intercept + DESAIN
b. Exact statistic
c. The statistic is an upper bound on F that yields a lower bound on the significance level.
d. Computed using alpha = .05

**Figure 4. Multivariate test result**

From the Multivariate Test results, the p value (sig.) is between 0.01 and 0.119. Most of these values are greater than 0.05 so H0 is accepted which means the three Kansei Words in Design 1 to Design 9 have the same variance. The same variance can be caused because there is not much data collected and between respondents give the same answer so there is no significant difference in data.

After the Multivariate Test was conducted, the questionnaire results were also processed by the Tukey HSD test. Tukey HSD is a multiple comparison test to compare groups or objects, so that differences in each of the Kansei Words can be seen for the nine designs. This comparison is presented in the form of multiple output comparisons. Based on the results of the Tukey HSD test in the form of multiple output comparisons, the following sequence of designs can be analysed according to each Kansei Words, show in figure 5. Ergonomis is Ergonomic, Sederhana is Simple and Menarik is Attractive.

Based on the results of the Tukey HSD test, there are only 1 subset column in the Kansei Words which shows that there are no significant data differences in the nine designs. In addition, the sequence is presented sequentially from the data with the smallest to the highest average value. The results presented in SPSS are the same as the results of the average calculation manually, namely Design 1 is best suited for ergonomics and is simple, while Design 2 is most suitable for attractive. Based on these data, Design 2 is chosen that best matches the three Kansei Words because the position of Design 2 in each Kansei Words is in the top 3 of the design corresponding to Kansei Words. Although Design 1 has the largest average on ergonomics and is simple, but in interesting words, Design 1 has a small average compared to 5 other designs which means Design 1 is not suitable for attractive keywords.
4.2. Develop Product and Packaging Quality

Second questionnaires 26 respondents filled, but only 19 valid questionnaire data were obtained. Two categories in second questionnaire those are product quality and packaging. In the product quality category, contain 3 target qualities that are desired by consumers, first smooth texture, second chili sweetness taste and third spicy taste. In the packaging category, those are 4 targets desired by consumers: reusable, easy-to-grip shape, durable, and packaging has sprinkled holes option.

Based on the results of the QFD analysis, the texture of fine spices, bottle packaging, reusable and non-damage packaging has the highest importance value, which is equal to 5. The chilli-sweet taste, packaging is easily grasped, and the packaging has a lot of sowing hole of 4, while the spicy taste is getting an interest of 3.

In customer competitive assessment, KR’s product position and two other competitors were determined based on the results of the distribution of the third questionnaire with respondents as many as 22 respondents and the questionnaire data were valid and could be used in this calculation as many as 18 respondents. The highest rating number meaning, the better, example, rating 4 is better than rating 2. The two competitors used as a comparison is Competitor 1 (Mamaqu) and competitor 2 (Indofood). Based on the average results of the questionnaires that were distributed directly, KR’s 100 gr bag pack get a rating of 3 because there are found some caking seasonings. The rating is lower compare 2 competitor products that get rating 4. For the quality of chilli and spicy sweetness, KR’s get the highest rating of 3 and 4 respectively, while Competitor 2 gets the lowest rating for taste, which is 2 for sweet chilli and 3 for standard spicy.

In terms of packaging, KR, Competitor 1 and 2, all used aluminium foil bag pack which can’t reuse, so that all producer got a rating 1. While small size bag pack shape is easily grasped, all three-producer got rating 3. From 3 seasoning products, KRs get a rating of 2 for non-damage packaging because easily wrinkle, while 2 competitors get a rating of 3. In the term of hole for sprinkle easy packaging, all three producers got a rating 1, because aluminium foil bag pack is not possible to make hole to sprinkle seasoning.

After analysed QFD rating, it’s strongly recommendation for KR to develop new product quality and new design bottle packaging, to improve competitive value and then increase market share. The expected target of the new product quality is the finer seasoning particle size but not easily caking, that will increase rating to be 4, the taste quality of chilli sweetness and spicy flavour shall keep maintained at rating 4, the new bottle packaging which can be reused will increase to be rating 3, the shape is slim and easy to hold, durable and has many holes sprinkle will increase to rating 4.

In the middle of the QFD there is a linkage matrix between needs and solutions. If needs and solutions have strong correlation then given a value of 9, if the relevance is medium, being given a value of 3, but if the relationship is less or likely to be negative then given a value of 1. For example, in the texture needs of fine spices, if associated with the size of seasoning, the linkage is very strong.
because of one of the causes of fine spice texture or not due to the size of the marinade so that it is given a value of 9. The fine texture needs of spices when associated with packaging design, so there is enough linkage to be given a value of 3. This is due to finer particle size is more bulky volume, easier to occupy empty space on the bottle so that the bottle looks full. But when the texture of the fine seasoning is associated with the packaging material and the design of the packaging lid that has too many sprinkle holes, it can have a bad impact, while with the number of holes designed to facilitate air entering the packaging, causing the seasoning to moisten and clump or clump so that the texture of the spices looks rough. The use of polypropylene or polysulfone materials can damage the texture and taste quality of seasoning.

Based on the relationship matrix between needs and solutions can be seen which needs are important. From these results, the needs that should be fulfilled are fine spice texture, bottle packaging design, reusable packaging and durable packaging.

In the inter-solution correlation matrix, there are several solutions that can support each other and not support each other. The solution seasoning particle size less than 250 microns is negatively related to the design solution to close many sprinkle holes. Supposing that the lid is wider and the client isn't close appropriately, it will make damp air entering through the gap, which can cause the flavors solidify and become rough. The composition containing onions and chili is negatively related to polypropylene or polysulfone packaging because polypropylene or polysulfone packaging when exposed to sunlight can cause damage to the composition of the ingredients in the sprinkle seasoning. The bottle packaging design has a good correlation with the slim shape on the packaging body, the packing thickness is 0.05 cm and the lid design is made of many sprinkle holes. It was conclude that the bottle packaging are made slim, thick wall and has a sprinkle holes, resulting the bottle should strong and easy to use by consumers, especially in terms of holding packaging and sprinkle methods. Finally, 0.05 cm of packaging thickness has a correlation with polypropylene or polysulfone packaging. The thicker the packaging made from polypropylene or polysulfone, the packaging will be strong and hardiness.

Based on the relative weight value of QFD, the solution that should be done is bottle packaging design, polypropylene or polysulfone as material packaging and 0.05 cm packaging thickness because the three solutions are 3 large solutions that have the highest relative weight value and have relative weight values above 15%, while other solutions have relative weight values below 15% and even below 10%.

Based on the results of the distribution of the third questionnaire, KR's rating compare with 2 other competitors regarding the application of the solutions offered was not very different from the results of the rating on the part of needs. There are several solutions where KR seasonings lead the current rating, but there are also solutions where competitors lead the rating. For seasoning less than 250 microns in size, KR 100 gr products are rated 3 while the other two competitors are at rating 4. The composition solution contains onions and chili, KR and Competitor 1 get a rating of 4, while Competitor 2 gets a rating 3. In a slim packaging design, KR and Competitor 1 get a rating of 3, while Competitor 2 gets a rating of 2. Competitor 2 leads the rating for 0.05 cm packaging thickness, while KR gets the lowest rating 2. Bottle packaging design solutions, packaging made from polypropylene or polysulfone and lid design are made of many sowing holes, the three seasoning products get a rating of 1.

Based on the rating results given by this respondent, hope that the expected rating for KR bottles is 4 for spices less than 250 microns, the composition contains onions and chili, a sleek design on the body of the packaging, packaging made from polypropylene or polysulfone and the design of the lid is designed with many sowing holes. For bottle packaging design and 0.05 cm packaging thickness is targeted to get a rating of 1.

When the three prioritized solutions at Quality Function Deployment are combined with Design 2 on Kansei Engineering, then PT Kiantaka Rasa can also increase the rating on the packaging having a large sowing hole because in Design 2 the bottle cap have several small sprinkle and large size sowing holes to facilitate consumers in sow option.
4.3. Result discussion
Based on QFD analysis and interview with KR’s Board of management, to fulfil the consumer desires, the solution offered by KR are to meet smooth texture, seasoning particle size reduce to be less than 250 micron. To increase taste of chilli sweetness and spicy taste, KR will improve the formulation by re-composite of onion and chilli. While to improve packaging quality, choose a bottle cap that has 2 semi-circular openings, one opening has several small hole sprinkle and other opening has large size sowing hole [10]. For re-use-able and durable, thickness minimum is 0.05 cm [9] and packaging material using polypropylene or polysulfone.

5. Conclusion
Based on research that has been done, Design 2 is the best packaging design that matches Kansei Words, which is ergonomic, simple and attractive. Furthermore, packaging design that chosen will improve based on QFD. The important improvements based on QFD are to develop bottle packaging, packaging made of polypropylene with thickness 0.05 cm. The important improvement of seasoning quality are particle size less than 250 micron and re-formulate composition of onion and garlic to appropriate the consumer expectation.

The consequence of this research, bottle design and improved quality of food ingredients has been concluded. The company is ready to start launching ready-to-eat seasoning products to direct consumers.

References
[1] Nagamachi M and Lokman AM 2015 Kansei innovation: practical design applications for product and service development CRC Press
[2] Nagamachi M 2011 Kansei/affective engineering and history of Kansei/affective engineering in the world. Kansei/affective engineering 13 1-12
[3] Jensen F 2017 Quality Function Deployment: The Evolved 4-Phase Model Lulu. com
[4] Maritan D 2015 Quality function deployment (QFD): definitions, history and models. In Practical Manual of Quality Function Deployment Springer Cham pp 1-32
[5] Franceschini F 2001 Advanced quality function deployment CRC Press
[6] Warner RM 2013 Applied statistics: from bivariate through multivariate techniques: from bivariate through multivariate techniques Sage
[7] Warne RT 2014 A Primer on Multivariate Analysis of Variance (MANOVA) for Behavioral Sciences Practical Assessment, Research & Evaluation, 19 1-10
[8] Abdi H and Williams LJ 2010 Tukey’s honestly significant difference (HSD) test Encyclopedia of Research Design Thousand Oaks CA Sage 1-5
[9] Bhandari BR, Bansal N, Zhang M and Schuck P 2013 Handbook of food powders: Processes and properties Elsevier
[10] Gilbert M 2016 Brydson’s plastics materials William Andrew
[11] Saeed K and Nagashima T 2012 Biometrics and Kansei engineering Springer Science & Business Media