Redesign of food packaging using Kansei Engineering and sustainability design

Okka Adiyanto[1*], *Zulfah* Hananti[1], and *Stania* Uswatun Khasanah[1]

[1]Department of Industrial Engineering, Universitas Ahmad Dahlan, Yogyakarta, Daerah Istimewa Yogyakarta, Indonesia

Abstract. Currently, the development of packaging design is very advanced and rapid. One of the efforts that are widely used by Small Medium Enterprises (SMEs) in the food sector is to improve their packaging. Current packaging developments are also starting to collaborate elements of sustainability and also the feelings of consumers. Therefore, the research designed packaging using a psychological approach based on the feelings and emotions of consumers, namely Kansei engineering. In addition to kansei engineering, it also includes sustainability elements in the packaging design. Based on the results, 43 kansei words were obtained and then simplified into 16 kansei words. The selected packaging design is a coloured flat pouch without the use of plastic, complete with product information and packaging attributes. The aim of this research is to evaluate the effectiveness of the new packaging design in garnering positive consumer responses and to assess its potential impact on increasing consumer buying interest in the product.

1 Introduction

Today's packaging manufacturers are constantly looking for ways to increase customer satisfaction, improve business processes, and increase profits. One of the challenges they face is the need to respond quickly to the ever-changing range of customer demands [1], [2]. One of the important customer demands is packaging as a tangible feature of the product that influences consumers' desire to buy. Product packaging, in addition to protecting the contents and expediting transportation, handling, and storage, seeks to attract the attention of potential buyers, influence their desire to buy, and even increase product acceptance during the time the product is purchased [3]. Food packaging, while important for maintaining food quality, extending shelf life, and reducing food waste, has significant environmental implications, particularly in relation to plastic pollution, resource consumption, and waste management [4]. The interaction between food packaging and the SDGs is critical, as sustainable packaging practices can directly and indirectly influence the SDGS goals.

The United Nations-initiated Sustainable Development Goals (SDGs) are a comprehensive global agenda designed to manage some of the most critical challenges currently facing our world [5]. Food waste utilization and reduction is an important goal of

* Corresponding author: okka.adiyanto@ie.uad.ac.id

the sustainable development goals aligned with Goal 12 (Responsible Consumption and Production) [6].

The relations between food packaging and the SDGs highlights the importance of integrating sustainability into packaging practices. By adopting innovative and eco-friendly packaging solutions, we can significantly reduce our environmental impact, encourage responsible consumption and contribute to the achievement of the SDGs. Sustainable food packaging is not only an important element in addressing global environmental challenges, but also plays a vital role in ensuring food safety, health and well-being for everyone. In the world of product marketing, the importance of packaging is highlighted, especially considering the lack of attention paid by most micro and small enterprises (MSMEs) to this aspect [3]. Most entrepreneurs tend to overlook the importance of packaging design, which leads to the use of standardized packaging, minimal information, and even irrelevant to the products offered [7]. As a result, consumer interest in purchasing the product is low, reducing the competitiveness of the product, and removing the differentiating factor between brands in the consumer market. The solution to this challenge requires a deeper understanding of consumers' preferences and emotional responses to packaging.

Packaging plays an important role in purchasing decisions. Attractive packaging plays an important role in product appearance, where most impulse purchases occur because they see the appearance of the product [8]. Impulse buying is the tendency of consumers to buy spontaneously, reflexively, suddenly, and automatically. Consumers can be attracted to a product just by looking at the product packaging.

In several studies, there have been many discussions related to kansei engineering on food packaging design. In the research of Okka et al, the kansei engineering method was used to redesign the packaging on a food [1]. In addition, Fithri et al's research also discussed the redesign of packaging on traditional food in Indonesia[9], [10]. Yang C et al's research also links kansei engineering to product design [11]. However, there is no research that discusses and combines the application of SDGs to food packaging design.

Therefore, this research uses the application of Kansei engineering methods to improve the packaging redesign process with a focus on the concept of SDGs. This research is expected to make a meaningful contribution in increasing consumer satisfaction, providing a competitive advantage for the company, and differentiating products through innovative packaging design related to SDGs.

2 Material and Methods

2.1 Participants

This study consisted of 40 respondents who were regular consumers of “Rambak Crackers” products with a minimum of one purchase per month. The average age of respondents is in the range of 15-64 years. The sampling technique used is purposive sampling

2.2 Measurements of data

The data collection method in this research involves literature studies from related journals as the main reference to solve problems and achieve research objectives. Furthermore, field studies were conducted through interviews with MSMEs, observation of product packaging, and documentation of products and their packaging. Initial observation of product packaging was the first step, followed by a search for related references to identify problems that fit the research background. Furthermore, open-ended questionnaire data was collected to explore consumer concepts and needs. The results of this questionnaire will form the basis for the

preparation of a closed questionnaire, which is then tested for validity and reliability. Valid and reliable data will be used in determining items and categories for designing product designs. The KMO-MSA test was conducted to test the feasibility of the data before designing the design concept.

2.3 Calculating validity and reliability

Validity is assessed by means of factor loadings. The factor loadings of all factor dimension variables (given as standard regression weights in SPSS) should exceed 0.5 or higher, ideally 0.7 or higher and be at least statistically significant[12], [13]. This study conducted reliability and validity analysis of all measurement dimensions. The reliability and validity of the instruments were confirmed through two indicators: Cronbach's alpha and factor analysis. According to Wu and Chang (2016), if Cronbach's alpha value is more than 0.7, the questionnaire has a high level of reliability. The results showed that the overall reliability of the questionnaire was high as Cronbach's alphas of all dimensions met the criteria[13].

2.4 Calculation of Kansei evaluation values

Kansei engineering uses a pair of antonyms to describe a user's emotional response. If a word appears very frequently in a text, then it must be very important, and reflects the main idea of thext. Referring to the traditional Kansei word acquisition method in traditional Kansei engineering, this paper collects Kansei words based on interviews and some literature. The specific process of determining Kansei words can be seen in Figure 1.

Fig. 1. Flow chart of process determining Kansei Engineering

3 Results and Discussion

3.1 Vocabulary from perception

Based on the results of the open-ended quiz, 43 vocabularies of perceptions about the initial packaging of the crackers were obtained. Then it was extracted so that it became 20 vocabularies. The vocabulary was focused on "brand, appearance, function, and SDGs. After discussion with the designer team, 16 suitable perception vocabularies were selected and eliminated the same words, the words that emerged can be seen in Table 1.

Table 1. Kansei Words

No.	Kansei Words
1	Easy to open and close
2	Can stand up
3	Low size
4	Easy to carry
5	Durable label

6	Product composition is clear
7	Market label
8	Easy to understand
9	Production date is clear
10	Expiry date is clear
11	Product net weight is clear
12	Contact number is clear
13	Address is clear
14	Good material
15	Neat logo image
16	Variety of colours

Next, differential semantic techniques were used to further filter the existing words. Following the three layers of criteria of the hierarchical analysis model, the perception terms were filtered and grouped based on brand features, appearance features, and functional features. Furthermore, based on a Likert scale, they were categorized into Very important, important, moderately important, slightly important, and not at all important.

3.2 Calculating and validity

The reliability and validity of the instruments were confirmed through two indicators: Cronbach's alpha and factor analysis. According to Wu and Chang (2016), if the alpha Cronbach value is more than 0.7, the questionnaire has a high level of reliability [13]. The results showed that the overall reliability of the questionnaire was high as the alpha Cronbach of all dimensions fulfilled the criteria. The results of statistical analysis can see in **Table 2**.

Table 2. Statistical analysis

Factor	**Factor loading**	**Croanbach's aplha value**
Sensory expectation		0.912
beautiful	0.801	
Unique	0.800	
Modern	0.761	
Brand attitude		0.881
Unique figures	0.743	
Original	0.892	
Information		0.931
kompotition	0.857	
Expired date	0.803	
Netto	0.818	
SDGs		0.871
Sustainability	0.816	
Eco-friendly	0.778	

3.3 KMO-MSA analysis

Furthermore, factor analysis was carried out on 16 Kansei word criteria. The first step in factor analysis is to look at the Kaiseri-Meyer-Olskin-Measure of Sampling Adequacy (KMO MSA) value and the probability value (sig). If the KMO MSA value> 0.050 and the Barlett's Test of Sphericity value < 0.050, the factor analysis technique can be continued. The KMO value obtained is 0.831 (>0.500) and the Barlett's Test (Sig) value is 0.000 (<0.050). Factor analysis in this study can be continued because it meets the requirements, and the Anti-Image Matrices test is carried out. The test results show that the MSA value for all Kansei words is more than 0.500, which means that the variable is suitable for further analysis can see in **Table 3**.

Table 3. Tes KMO and Bartlett test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.634
Barlett's Test of Sphericity	Approx. Chi-Square	297.218
	Df	91
	Sig.	.000

The KMO and Bartlett's test value shows a figure of 0.634. The process of removing variables with MSA below 0.5, as done in the previous results, will increase the total MSA from before. With the value already exceeding the threshold of 0.5 and significance well below 0.05, it allows further analysis of all variables. Therefore, the fourteen Kansei words can be further analysed in the next questionnaire.

Data processing continued by collecting existing snack packaging samples in the market as a reference for further development. Product samples with design specifications from various sources were used in the semantic differential II questionnaire. The determination of items and categories was used to form a combination of samples that became the subject of the second questionnaire. The samples were divided into five items, namely shape, material, label colour, logo image, and label, which were considered to represent the dominant construction on the packaging of "Rambak Crackers". The categorisation of items was based on the results of previous research on packaging, as seen in the classification of product design elements in Table 4.

Table 4. Item and Categories

No.	**Item**	**Categories**
1	Sensory Expectation	Packaging modern
2	Brand attitude	unique
3	Information	Complete
4	SDGs	Does not use plastic

3.4 Propose Design

After the categorisation was done, it was continued by determining the design specifications that suited the respondents. Determination of design specifications is carried out together with the design team. The design concept that emerged after the design can be seen in Figure 2.

Fig. 2. Propose design of rambak crakers

Design specifications are with thick paper material that has an oil coating without using plastic. In the form of a standing pouch with a size of 35 cm high, 20 cm wide and equipped with production information and product logos. Colours were also chosen with bright colours between green, yellow and red. The design also contains elements of sustainability, which shows that sustainability has an impact on various factors in the fields of waste management, packaging design, industrial, energy, material design [5], [14], [15], [16], [17]

After the new design was completed, the next step was to evaluate consumer response using a questionnaire containing an assessment of the new design. The questionnaire was distributed to 40 respondents who are customers of “Rambak Crackers”. The results of consumer assessments are then used as an evaluation of the design, determining the level of approval of the new packaging design. A comparison of the new and old packaging designs can be seen in Fig. **3**.

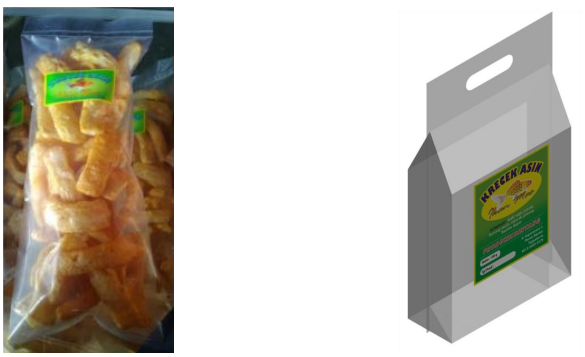

Fig. 3. Comparions before and after design

Analysis of the graph shows that all 24 respondents favoured the new design with the majority of respondents choosing the new packaging design over the old design. This indicates that the new packaging design for "Rambak Crackers", produced through the Kansei Engineering approach, has the most dominant specifications in shaping the image. This shows that changing the packaging design will affect the intention to buy the product.

This is in accordance with several studies that have been conducted, based on the research that has been done, it shows that the kansei engineering method will affect emotional consumers [18], [19], [20], [21], [22], [23], [24], [25].

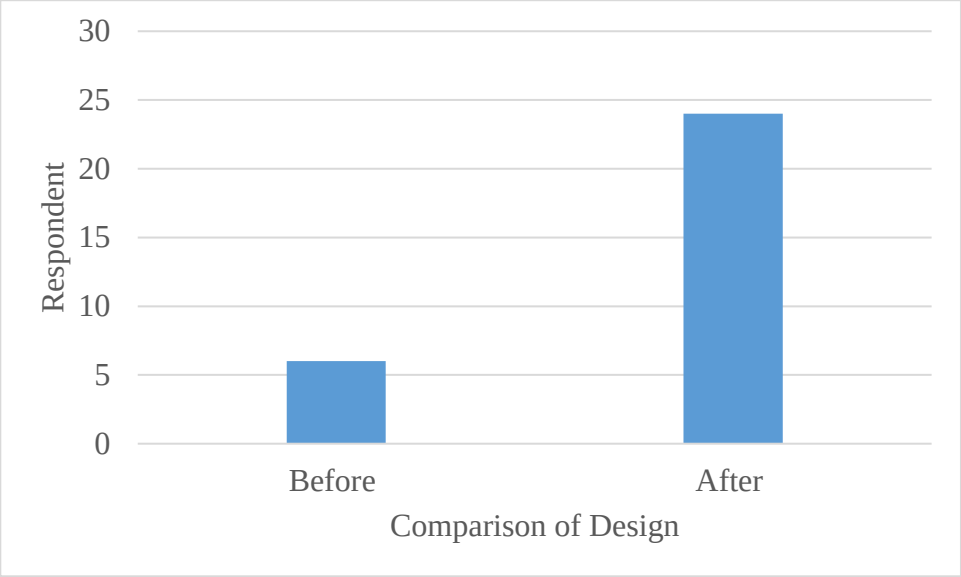

Fig. 4. Results of Comparion questionnaire

4 Conclusion

This study found that food packaging plays a significant role in influencing consumers' emotional responses, particularly in driving purchase interest. The use of the Kansei engineering method effectively evaluated consumer emotions toward various packaging elements of rambak crackers. The data analysis revealed that graphic elements, especially the clarity and relevance of information on the packaging, significantly impact consumers' buying decisions. Moreover, sustainability factors also emerged as a key consideration for consumers when selecting a product, highlighting the growing importance of eco-friendly packaging in consumer preferences.

References

1 O. Adiyanto and H. A. Jatmiko, “Development Of Food Packaging Design With Kansei Engineering Approach,” *International Journal of Scientific and Technology Research*, vol. 8, no. 12, pp. 1778–1780, 2019.

2 A. Dey, C. V. Dhumal, P. Sengupta, A. Kumar, N. K. Pramanik, and T. Alam, “Challenges and possible solutions to mitigate the problems of single-use plastics used for packaging food items: A review,” *J Food Sci Technol*, vol. 58, no. 9, pp. 3251–3269, 2021.

3 S. Maleki, S. F. Amiri Aghdaie, A. Shahin, and A. Ansari, "Investigating the relationship among the Kansei-based design of chocolate packaging, consumer perception, and willingness to buy," *Journal of Marketing Communications*, vol. 26, no. 8, pp. 836–855, 2020, doi: 10.1080/13527266.2019.1590855.

4 Z. Maulana, M. Chanif Hidayat, and I. Agustina, "Using Digital Marketing for Small and Medium Enterprises (SMEs) in Bumdes Remboko Sumberrejo Village Sleman Regency," *SPEKTA (Jurnal Pengabdian Kepada Masyarakat : Teknologi dan Aplikasi)*, vol. 3, no. 1, pp. 31–38, 2022, doi: 10.12198/spekta.v3i1.4563.

5 T. D. Moshood, G. Nawanir, F. Mahmud, F. Mohamad, M. H. Ahmad, and A. AbdulGhani, "Sustainability of biodegradable plastics: new problem or solution to solve the global plastic pollution?," *Current Research in Green and Sustainable Chemistry*, vol. 5, p. 100273, 2022.

6 T. Sharma, G. Kaur, A. Singh, P. Kaur, and B. N. Dar, "Harnessing animal waste proteins for eco-friendly packaging films: A sustainable approach towards SDG-12," *Trends Food Sci Technol*, vol. 147, no. March, p. 104455, 2024, doi: 10.1016/j.tifs.2024.104455.

7 M. Rais Rahmat Razak *et al.*, "Empowerment of Village Owned Enterprises (VOEs) Through E-Commerce Information Technology to Increasing Economy," *SPEKTA (Jurnal Pengabdian Kepada Masyarakat : Teknologi dan Aplikasi)*, vol. 4, no. 2, pp. 176–185, 2023, doi: 10.12198/spekta.v4i2.7129.

8 F. Guo, Q. X. Qu, M. Nagamachi, and V. G. Duffy, "A proposal of the event-related potential method to effectively identify kansei words for assessing product design features in kansei engineering research," *Int J Ind Ergon*, vol. 76, no. October 2019, p. 102940, 2020, doi: 10.1016/j.ergon.2020.102940.

9 P. Fithri, H. R. Zadry, and U. N. Turrahmi, "Kansei-Based Design for an Indonesian Traditional Food Packaging," *ASEAN Engineering Journal*, vol. 12, no. 1, pp. 63–68, 2022, doi: 10.11113/aej.v12.16715.

10 M. Hartono, "Kansei Engineering and Design Thinking Methodology for Product/Service Design," in *Proceedings of the Second Asia Pacific International Conference on Industrial Engineering and Operations Management*, 2021, pp. 14–16.

11 C. Yang, F. Liu, and J. Ye, "A product form design method integrating Kansei engineering and diffusion model," *Advanced Engineering Informatics*, vol. 57, no. July, p. 102058, 2023, doi: 10.1016/j.aei.2023.102058.

12 Y. Zhai, W. Song, X. Liu, L. Liu, and X. Zhao, "A chi-square statistics based feature selection method in text classification," in

2018 IEEE 9th International conference on software engineering and service science (ICSESS), 2018, pp. 160–163.
13 S.-I. Wu and H.-L. Chang, "The Model of Relationship between the Perceived Values and the Purchase Behaviors toward Innovative Products," *Journal of Management and Strategy*, vol. 7, no. 2, Apr. 2016, doi: 10.5430/jms.v7n2p31.
14 P. Upadhyay and A. Kumar, "A house of sustainability-based approach for green product design Setting future research agenda," 2019, doi: 10.1108/MEQ-03-2019-0057.
15 P. Deutz, G. Neighbour, and M. McGuire, "Integrating sustainable waste management into product design: Sustainability as a functional requirement," *Sustainable Development*, vol. 18, no. 4, pp. 229–239, 2010, doi: 10.1002/sd.469.
16 A. Prashar, "Towards sustainable development in industrial small and Medium-sized Enterprises: An energy sustainability approach," *J Clean Prod*, vol. 235, pp. 977–996, 2019, doi: 10.1016/j.jclepro.2019.07.045.
17 O. Adiyanto, E. Mohamad, Irianto, R. Jaafar, M. Faishal, and M. I. Rasyid, "Optimization of PET Particle-Reinforced Epoxy Resin Composite for Eco-Brick Application Using the Response Surface Methodology," *Sustainability (Switzerland)*, vol. 15, no. 5, 2023, doi: 10.3390/su15054271.
18 J. Ge and L. Wang, "Appearance Design Method of Smart Street Lamp Based on Kansei Engineering," *Advances in Multimedia*, vol. 2022, 2022, doi: 10.1155/2022/9467820.
19 M. Hartono, "The modified Kansei Engineering-based application for sustainable service design," *Int J Ind Ergon*, vol. 79, no. January 2019, p. 102985, 2020, doi: 10.1016/j.ergon.2020.102985.
20 K. Grimsaeth, M. Gangwar, B. Baggerud, And R. Narain, "Kansei Engineering Based Emotional Product Design: An Illustration by a Battery Drill Case-Study," *Kansei Engineering International Journal*, vol. 9, no. 2, pp. 67–79, 2010, doi: 10.5057/kei.9.67.
21 Z. Liu, J. Wu, Q. Chen, and T. Hu, "An improved Kansei engineering method based on the mining of online product reviews," *Alexandria Engineering Journal*, vol. 65, pp. 797–808, 2023, doi: 10.1016/j.aej.2022.09.044.
22 X. Lai *et al.*, "Kansei engineering for the intelligent connected vehicle functions: An online and offline data mining approach," *Advanced Engineering Informatics*, vol. 61, no. February, p. 102467, 2024, doi: 10.1016/j.aei.2024.102467.
23 Ó. López, C. Murillo, and A. González, "Systematic literature reviews in kansei engineering for product design—a comparative

study from 1995 to 2020†," *Sensors*, vol. 21, no. 19, pp. 1–19, 2021, doi: 10.3390/s21196532.

24 T. Djatna and W. D. Kurniati, "A System Analysis and Design for Packaging Design of Powder Shaped Fresheners Based on Kansei Engineering," *Procedia Manuf*, vol. 4, no. Iess, pp. 115–123, 2015, doi: 10.1016/j.promfg.2015.11.021.

25 C. Yang, T. Xu, and J. Ye, "Applying TRIZ and Kansei engineering to the eco-innovative product design towards waste recycling with latent Dirichlet allocation topic model analysis," *Eng Appl Artif Intell*, vol. 133, no. PA, p. 107962, 2024, doi: 10.1016/j.engappai.2024.107962.