FACTOR ANALYSIS OF HEALTHY FOOD PHOTOGRAPH

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Abstract

Lockdown is one way to reduce the transmission rate of COVID-19. Nevertheless, on the other hand, lockdowns also increase human psychological problems to cause the emergence of emotional eating. In addition, social media exposure that presents food photos can trigger the desire to eat. However, this only applies to high-fat and high-calorie foods, while healthy foods do not have the same stimuli. Therefore, more research is needed on the properties of healthy food photos desired by consumers in order to be able to create or design healthy food photos with an effect that resembles photos of high-fat and high-calorie foods. This study employed the Kansei Engineering approach in designing healthy food photos. Through Kansei Engineering, we can determine the nature of healthy food photos consumers want. The type of Kansei engineering used in this study was Kansei Engineering Type I and was limited to the Semantic Space stage. The process of factor reduction from the results of the semantic differential was carried out by using factor analysis to obtain the most critical factors related to healthy food photos. The semantic space spanning resulted in 23 pairs of Kansei words that related and represented healthy food photos. Based on the factor analysis results, these Kansei words were then into 6-factor groups. Each of the factor groups was represented by the Kansei word pair with the highest loadings value. The selected pair of Kansei words showed that healthy food photos could be represented by Kansei words attractive, contrast, proper lighting, neat, high-quality image, and straightforward.

History:

Received: July 8, 2022
Accepted: July 30, 2022
First published online: July 31, 2022

Keywords:

Healthy Food Photos
Kansei Engineering
Semantic Differential
Factor Analysis

1. Introduction

Lockdown is one way to reduce the transmission rate of COVID-19 that is currently spreading in the community. However, on the other hand, the lockdown caused other problems, especially human psychological problems. Research conducted by Wang et al. (2020) (reported in Hassen et al., 2020) stated that Chinese people experienced depression, excessive anxiety, and stress during the lockdown period at the beginning of the pandemic. The existence of this psychological disorder triggers a person to consume food excessively to meet their emotional needs (emotional eating) (Hassen et al., 2020). Research conducted by Scarmozzino & Visioli (2020) showed an increase in anxiety levels accompanied by an increase in the consumption of comfort foods, namely chocolate, ice cream, and desserts, by 42.5% and salty snacks by 23.5%.

Continuous emotional eating behavior is certainly followed by weight gain. Research conducted in Italy, Spain, and China, reported that part of the population gained weight during the quarantine period due to increased food consumption (Maltoni et al., 2021; Sánchez et al., 2021; Zhu et al., 2021). Urzeala et al. (2021) research show that the world community’s Body Mass Index (BMI) has increased significantly during the COVID-19 pandemic. From the original (before the lockdown period) 24.71 ± 5.04 kg/m2 to 24.78 ± 5.03 kg/m2. If this continues, the potential for an increase in the world's obesity rate will increase. One way to prevent obesity is to increase the consumption of healthy foods. According to Subroto (2008), healthy food contains nutrients for the body and does not contain harmful components.

The quarantine period makes socializing activities face-to-face very limited. So, humans tend to choose social media as a means of socializing. This is done to meet the basic needs of man as a social being. During the quarantine period, there was an increase in social media use by 24.8%. Social media, significantly influences people’s lifestyles, whether it presents writings, photos, or videos. The same goes for people's diets. On social media, many visualizations of food are scattered, either in advertisements or just ordinary photo uploads.

With the increasing use of social media, exposure to food visualization will also increase. According to Wang et al. (2004), looking at food photos can stimulate brain activity to obtain food, while research by Schusser et al. (2012) in Andersen et al. (2021) shows that exposure to food photos can stimulate the hormone ghrelin which is a hormone in charge of regulating visual stimuli and eating behaviors. On the other hand, research by Harrar et al. (2011) in Spence et al. (2016) states that photos of high-fat foods trigger a faster brain response than photos of low-fat foods. Another study by Coary & Poor (2016) showed that food photos could increase the deliciousness of the food but do not apply to healthy foods.

Kansei Engineering is one of the methods that can be used to design healthy food photos to look more attractive and tempting. Through psychological, ergonomic, medical, and technical analysis, Kansei engineering can translate consumer desires into design specifications (Nagamachi, 2011). Kansei can describe the fundamental processes of the human mind by involving emotional feelings such as sensations, perceptions, and cognitions (Adelabu & Yamanaka, 2014). Human interaction with a photo is a cognitive interaction and can trigger emotions to eat. Kansei engineering is the correct method to find consumer expectations of healthy food photos so that the building factors can be known.

There are six types of Kansei engineering that are often used. The difference in each type lies in the engineering process. The most basic Kansei engineering is Kansei Engineering Type I. The method involves a simple engineering process with ten stages, including strategy determination, Kansei word collection, semantic differential scale creation, product sample collection, category creation, evaluation, statistical analysis, interpretation of analytical data, elaboration of data interpretation to the designer, and examining new design ideas (Nagamachi, 2011; Schutte, 2002).

This study is limited to the semantic differential stage. The semantic differential analyzes connotative meanings carried out through the evaluation of words. In a semantic differential, an adjective that can describe an object is paired with its antonym or negative sentence and given a grading scale. We could extract the object-forming components from this assessment using factor analysis (Osgood et al., 1957 Nagamachi, 2011).

Factor analysis is a tool that can analyze the correlation structure between many factors assumed to represent dimensions in the data. This summarizes the data by defining a number of small factors sufficiently representative of the original set of variables (Hair et al., 2014). In this study, factor analysis was used to determine the most important factors in a healthy food photo that will be designed based on the results of a semantic differential assessment so that the characteristics of healthy food photos consumers want can be obtained.

2. Methodology

This study was conducted to determine the properties of healthy food photos that consumers want to achieve the same effect as photos of high-fat and high-calorie foods. This study adopts the Kansei engineering type I stages to accomplish this goal, starting from determining strategies, and collecting Kansei words, to semantic differentials. The initial stage in this study aims to understand the constraints of healthy food photos with literature studies and create healthy food photo engineering strategies to overcome the obstacles obtained. Furthermore, the collection of Kansei words is carried out, namely words representing the nature of photos consumers want and the semantic differential stages used to find the structure of forming photos of healthy food. The flow chart of the study can be seen in Figure 1.

A. The Collection of Kansei Words

The collection of Kansei words was carried out using questionnaires to extract Kansei words related to healthy food photos from the consumer's point of view. The questionnaire used in this stage contains open-ended questions about the character of healthy food photos following consumers' needs.

The criteria for respondents needed in the Kansei words collection were young adults (aged between 17 and 35 years old) and experienced Work from Home (WFH) or School from Home (SFH) activities.

The selection of young adult respondents was based on high interaction habits with social media. Furthermore, respondents who did Work from Home (WFH) and School from Home (SFH), had a high potential for boredom with a low level of discipline, making it easy for them to be distracted from their activities and vent by opening social media.

The distribution of preliminary questionnaire was carried out online using Google Forms. The distribution of the questionnaire was stopped at a time when the respondent's answers already had uniformity.

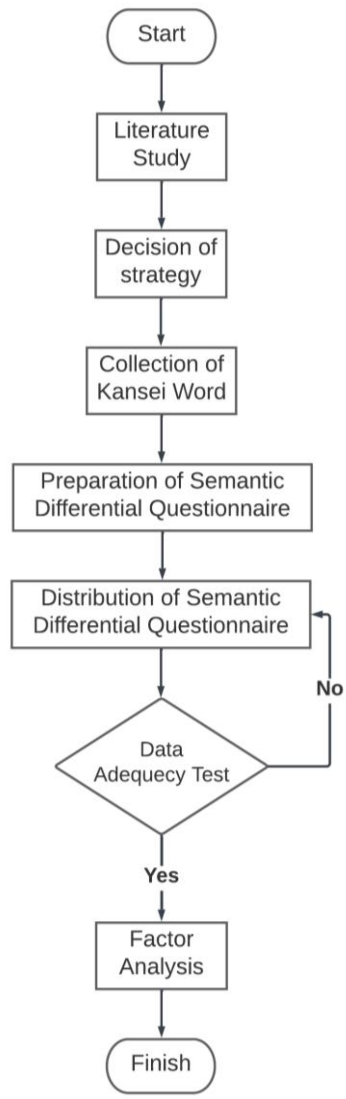

Figure 1. Research flow chart

B. Semantic Differential

Semantic Differential is a scale used to measure the perception of an object using a scale arranged in one line, where the positive answer is located on the right, and the negative response is located on the left or vice versa (Djaali et al., 2008). Nagamachi (2011) mentioned that the semantic differential is used to explain psychological structures.

The Kansei words obtained from the collection stage are then paired with their opposite word or their negative form.

Respondents at the semantic differential stage were asked to assess a scale of 1 – 7 on the Kansei word pair that was closest to the character of the healthy food photo desired by the consumer. The number 1 indicates the proximity to the word on the left, and the number 7 suggests the closeness to the word on the right.

The criteria for respondents needed at the semantic differential stage are the same as those for respondents at the research stage of collecting the Kansei word, namely aged 17-35 years and are or have done Work from Home (WFH) or School from Home (SFH) activities. Data retrieval at this stage is carried out with the help of Google Forms. The number of respondents who contributed to this stage was adjusted to the results of the data adequacy test.

C. Factor Analysis

Factor Analysis is a stage of statistical analysis that is useful for summarizing data or a series of variables representing healthy food's photo properties. Factor analysis represents data with common factors owned by all variables and unique factors only one variable has. Factor Analysis is modeled in Equation 1, in which y is the result of summing the score q of the general factor and the unique factor where the the i- y variable is e_i (Nagamachi, 2011).

$$y_n = first\ factor\ loading_n \times first\ factor\ score_n + second\ factor\ loading_n \times second\ factor\ score_n + \dots + qth\ factor\ loading_n \times qth\ factor\ score_n + e_n \quad (1)$$

Factor analysis models allow the emergence of the term error to represent unique factors because factor analysis reproduces the correlation between the original variables using as few factors as possible (Nagamachi, 2011).

Equation 2 is presented in the forms of vectors as follows (Nagamachi, 2011):

$$Y = \Lambda f + e \quad (2)$$

where Y is an n-dimensional vector built from the original n variables, $Y = \{y_1, y_2, \dots, y_n\}$; f is a q-dimensional vector built from q common factors, $f' = \{f_1, f_2, \dots, f_q\}$; e is an n-dimensional vector built using n unique factors, $e' = \{e_1, e_2, \dots, e_n\}$; and Λ is an n × q dimensional matrix represented as follows (Nagamachi, 2011)

$$\Lambda = \begin{bmatrix} \lambda_{11} & \lambda_{12} & \cdots & \lambda_{1q} \\ \lambda_{21} & \lambda_{22} & \cdots & \lambda_{2q} \\ \vdots & \vdots & & \vdots \\ \lambda_{n1} & \lambda_{n2} & \cdots & \lambda_{nq} \end{bmatrix}$$

We set the following conditions. Each common factor, $f_1, f_2, \dots, f_q$ of matrix f' has 0 for its mean and 1 for its variance. Each unique factor, $e_1, e_2, \dots, e_n$, also has 0 for its mean; their variance is represented as $d_1^2, d_2^2, \dots, d_n^2$, respectively. Let Σ be the variance of a covariance matrix of n-dimensional original variables y. Then, we get Σ as follows (Nagamachi, 2011):

$$\Sigma = \Lambda \Lambda' + D \quad (3)$$

Where D is a matrix of which diagonal elements are $d_1^2, d_2^2, \dots, d_n^2$. From this equation, it can be known that the variance of the covariance matrix of the original variable is the sum of the variance of the factor load and the variance of the unique factor (Nagamachi, 2011).

D. Data Adequacy Test

Before conducting factor analysis, the data used must go through the Kaiser Meyer-Olkin (KMO) data adequacy test. The KMO test is an index for comparing the coefficient of the observed correlation with the partial correlation coefficient (Henry et al., 2003). The determination of data adequacy in the KMO test is determined based on the MSA coefficient's value (Hardisman, 2021). The smaller the value of the MSA coefficient, the less insufficient the data. Index values over 0.6 are considered sufficient, more than 0.7 is considered good, more than 0.8 commendable, and values over 0.9 are considered outstanding (Henry et al., 2003).

3. Results & Discussion

A. The Collection of Kansei Words

Kansei words were obtained from 74 respondents aged 18-34 years; the proportion of respondents was 66.2% females and 33.8% males. The difference in the proportion of respondents is assumed not to affect the outcome. From the results of the collection of the Kansei word, 23 words were obtained which can be seen in Table 1. These words are adjectives obtained from the respondent's answer to how the character of the healthy food photos is desired. Other words or sentences that have the same meaning are not rewritten.

Table 1. Kansei words

No.	Kansei Words	No.	Kansei Words
1	Bright	13	Vivid
2	Clear	14	Aesthetic
3	Real	15	Focus
4	Tidy	16	Seductive
5	Simple	17	Vintage
6	Contrast	18	Clear
7	Colorful	19	Natural editing
8	Clean	20	Proper lighting
9	Sharp	21	High-quality image
10	Attractive	22	Balanced color composition
11	Fresh	23	Describing the benefits
12	Natural		

B. Semantic Differential

The Kansei words listed in Table 1 are the characteristics of healthy food photos that are consumers' preferences. The Kansei word set was then used to compile a Semantic Differential questionnaire. Each Kansei word is paired with its negative form or antonym. Kansei word pair can be seen in Table 2. Respondents at this stage were asked to assess the relationship between the word Kansei and healthy food photos, with a rating of 1 – 7. One hundred seventy-three respondents were assessed with an age range of 17–33 years, with 63% of females and 37% of males. The difference in the proportion of sexes of respondents at this stage is assumed not to affect the results.

Table 2. Kansei word pairs

No.	Kansei Word Pairs
1	Dark – Light
2	Unclear – Obvious
3	Not real – Real
4	Messy – Neat
5	Complicated – Simple
6	Paleness – Contrast
7	Monochrome - Colorful
8	Dirty – Clean
9	Blurry – Sharp
10	Unattractive – Attractive
11	Wilted – Fresh
12	Artificial – Natural
13	Pale – Vivid
14	Unaesthetic – Aesthetic
15	Blur – Focus
16	Not tempting - Tempting
17	Modern – Vintage
18	Noise – Clear
19	Over editing – Natural editing
20	Improper lighting - Proper lighting
21	Low-quality image – High-quality image
22	Lame photo color composition - Balanced color composition
23	Does not describe benefits - Describes benefits

The output of the Semantic Differential questionnaire is in the form of an average score of each Kansei word which will then be analyzed statistically using factor analysis to find out what Kansei words can best represent healthy food photos.

C. Data Adequacy Test

Before conducting factor analysis, the data must go through the Kaiser Meyer-Olkin (KMO) data adequacy test. The KMO test in this study was carried out with the help of RStudio software. In the KMO test, an MSA value of 0.86 was obtained. From these results, it can be decided that the Semantic Differential questionnaire data can be used in the factor analysis because the value obtained is greater than 0.8, which means it is commendable.

D. Factor Analysis

Factor analysis is performed using RStudio software. From the results of the eigenvalue calculation, it is known that out of 23 factors, the number of factors representing healthy food photos is 6. Furthermore, the grouping of Kansei word pairs into six factors was done by comparing the loadings value of each Kansei word in each factor group. The loadings value describes the degree of correlation of the word Kansei with the group of factors. The higher the loadings value, the higher the correlation. In this case, if the Kansei pair has the highest value in a group of factors, then the word Kansei is a member of the related group of factors. The results of the Kansei word grouping can be seen in Table 3.

Table 3. Kansei word grouping results

Factors	Kansei Word Pairs	Weight
1	Unclear – Obvious	0.324
	Not real – Real	0.351
	Dirty – Clean	0.539
	Unattractive – Attractive	0.641
	Wilted – Fresh	0.623
	Artificial – Natural	0.279
	Pale – Vivid	0.474
	Not tempting – Tempting	0.492
2	Complicated – Simple	0.549
	Over editing – Natural editing	0.664
	Improper lighting – Proper lighting	0.684
	Lame photo color composition – Balanced color composition	0.601
	Does not describe benefits – Describes benefits	0.389
3	Dark – Light	0.372
	Monochrome – Colorful	0.620
	Blurry – Sharp	0.592
	Paleness – Contrast	0.637
	Modern – Vintage	-0.307
4	Messy – Neat	0.694
	Blur – Focus	0.679
	Unaesthetic – Aesthetic	0.511
5	Low-quality image – High-quality image	0.829
6	Noise – Clear	0.418

The next stage is to determine the Kansei word pairs most representative of the group of factors they occupy to reduce the number of Kansei word pairs. This determination is done by choosing the word Kansei with the largest weight value in each group. In the Factor 1 group, the pair with the largest weight value is "Unattractive – Attractive" with a weight of 0.641; the Factor 2 group is represented by the Kansei word "Improper lighting – Proper lighting" with a weight of 0.684; the Factor 3 group represented the Kansei word "Pale – Contrast" with a weight of 0.637; the Factor 4 group represented Kansei word "Messy – Neat" with a weight of 0.694; Factor 5 group is represented "Low-quality image – High-quality image" with a weight of 0.829; and Factor 6 represents "Noise – Clear" with a weight of 0.418.

The results of the reduction of the Kansei words and its weight can be seen in Table 4.

Table 4. Kansei word pairs reduction results

Factor	Kansei Word Pairs	Weight
1	Unattractive – Attractive	0.641
2	Improper lighting – Precise lighting	0.684
3	Paleness – Contrast	0.637
4	Messy – Neat	0.694
5	Low-quality image – High-quality image	0.829
6	Noise – Clear	0.418

From these results, it can be seen that the most desired properties of consumers from healthy food photos are “Attractive”, “Precise Lighting”, “Contrast”, “Neat”, “High-quality image”, and “Clear”. These properties can be used as a guidance to build healthy food photos. From these properties, we can make a set of design specifications for healthy food photos so they can stimulate brain activity as the unhealthy ones. For example, we can give some food styling and composition treatments for the pre-production process to meet the Kansei words "Attractive" and "Neat". For another example, we can set the light intensity, light temperature, white balance setting of the camera, and pixelations of camera sensor used to taking photos to meet the Kansei words "Precise Lighting",s "Contrast", "High Quality Image", and "Clear".

4. Conclusion

Healthy food photos trigger a weaker brain response than unhealthy ones. This study aims to improve healthy food photos by looking for the characteristics desired by consumers. The process of extracting the characters of healthy food photos is carried out using semantic space, producing 23 pairs of Kansei-related words representing healthy food photos. From the factor analysis results, six groups of factors were obtained where the factor groups were represented with the Kansei word pair with the largest loadings value. The six words are "Attractive", "Precise Lighting", "Contrast", "Neat", "High-quality image", and "Clear".

5. Acknowledgment

The authors wish to acknowledge financial support from the Directorate of Business Development and Incubation at Gadjah Mada University.

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