

Application of Kansei Engineering to Tactile Sense in the Thai Food Wrapping Materials

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ABSTRACT

The paper investigates tactile attributes of food wrapping materials in Thailand based on Kansei Engineering and finds that 1) there are two major Kansei dimensions in tactile sense of food wrapping materials, 2) the emotion of “like” constitutes one of the two dimensions both with “smooth” and “natural”, and 3) the most favorable wrapping material for Thai is “plastic foam” among nine different wrapping materials; plastic bag, aluminum foil, plastic film, paper, banana leaf, wax paper, plastic net, plastic air bubble and plastic foam. The study was conducted through a questionnaire that asked 6 pairs of emotions about samples; dislike - like, rough - smooth, stable - flexible, tight - wrinkled, fine - fiber and refined - natural. A semantic differential measurement was used for the evaluation and the principal component analysis for the analysis. The study could be applied to the design of many other senses.

Key Words:

Kansei Engineering, Food wrapping, Product development, Tactile

INTRODUCTION

Kansei Engineering (KE) is a design technology that combines Kansei (feelings and emotions) with engineering disciplines [1]. KE can “measure” feelings and emotions that humans find in products and connect them to new product design [2]. According to Schütte and

Eklund cited in Syaifoelida et al. [1], Kansei is the psychological sense which includes all the human feelings and senses to see, hear, feel and smell. Generally, there are five human senses consisting of visual, auditory, olfactory, taste, and tactile ones which influence the human emotion.

KE has been successfully applied to various design products using these senses except for the tactile sense such as running shoes [3], chocolate snacks [4] and E-commerce sunglasses [5]. However, the tactile sense is also important similarly to the other senses because many new modern products are designed based on the premise to be touched by customers [6]. Therefore this sense would affect the customer's decision to purchase the product. It is important to investigate tactile associations that serve the product development process of exposed surfaces when the tactile sense is separated from the other sensations [7].

Some researchers studied the influence of tactile sense in various products, for example, switch of vehicles [8], automotive machine [9] and food packaging [10]. According to Waste Management Act cited in Schou et al. [11], the term packaging includes any material, container or wrapping used for or in connection with the containment, transport, handling, protection, promotion, marketing or sale of any product or substance.

The food wrapping was used to preserve and protect food that is on sell in the stores or to cover unpeeled or peeled fruit in home. Because of the great advantage of the food wrapping for the sales, it has been used very widely in Thai's market. The objective of this study is to evaluate customer's emotion in Thailand using KE by investigating the tactile sense and associations of different types of the food wrapping products. This methodology could be also applied to the design of all the other senses.

THEORETICAL BACKGROUND

Kansei Engineering (KE)

KE was found by Mitsuo Nagamachi at Hiroshima University in Japan [12]. KE is able to translate customers' emotional requirements on existing products or services into practical solutions of

design, which lets us respond to the latent needs of customers [13]. The psychological measurement is also conducted as an impression technique in order to quantify Kansei, and the physiological measurement is also conducted as an expressive technique [14]. To summary, KE is a successful technology for reducing the time and resources invested in new product development and design.

Semantic Differential (SD)

SD is the measurement instrument most commonly used in user centered design techniques to obtain the emotional value of products [15]. SD has been applied in KE to address the relationships between emotions and products in product design such as perfume bottle [16], wheel hub and car [17] and beverage bottle [18]. The reasons of the popular use of SD in the research might be: 1) easy-to-use and low-cost; 2) high reliability and validity; and 3) a unified platform to quantify subjective assessments such as emotions [16]. It measures people's reactions to stimulus words and concepts in terms of ratings on bipolar scales defined with contrasting adjectives at each end [19]. In order to study product semantics, the subject's perception of product forms including styles, color, and other attributes is quantified on a Likert scale [20].

METHODOLOGY

According to Nagamachi [12], the process to translate human emotions to design attributes is summarized as follows: 1) select the design object; 2) collect adjectives to represent emotions about the object; 3) understand meanings of the adjectives; 4) prepare samples of the object; 5) evaluate emotions for the samples; 6) analyze them statistically; and 7) build an expert system. We applied this process steps to our procedures as represented in Figure 1. First, the materials for the procedure were prepared, including the definition of the product samples and

the appropriate semantic space for the SD experiment. Then, in the evaluation step we used questionnaire where the main point is to evaluate all of the semantic attributes. Each of Kansei words was evaluated with a 7-level Likert scale, from +3 level to -3 level, where the respondents checked a mark in the level scale according to how they feel the word effect to the sample. For example, in the case of “Rough - Smooth”, the respondents would check mark in +3 for extreme agreement, which means the sample was the most smooth, in +2 for strong agreement, in +1 for moderate agreement and in 0 for equal agreement. In contrast, to -3 for extreme agreement that the sample was the most rough. During the tactile evaluation, the respondents’ vision was blocked by a blindfold and could touch the samples as much as they wanted (Figure 2). The procedures were explained to all participants in detail about how to fill in the questionnaire and meaning of Kansei words. All the stimuli materials were presented to the respondents randomly arranged in a box, so that the respondents could not see them. Finally, Principal Component Analysis (PCA) was applied to identify the relative correlations between the Kansei word variables and product samples.

Figure 1: Research methodology

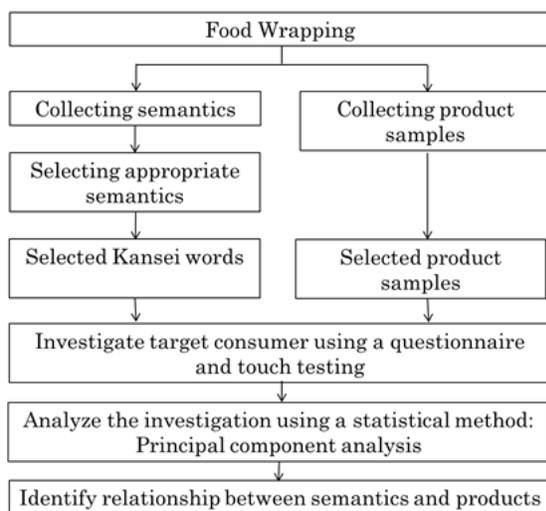


Figure 2: Test situation during the tactile study



RESULTS AND DISCUSSION

Collected and selected Kansei words

After food wrapping was chosen as the object, adjectives whose meaning and information relate to the food wrapping products were collected from many sources, including relevant literature, product advertisements, catalogs, magazines, manuals, product reviews and user feelings [21]. The total number of adjective words collected was 93. Three professional members from Rajamangala University of Technology Lanna (RMUTL) in Thailand were selected to compose an expert team. After brainstorming and discussion by the expert team, 6 pairs of words highly relevant were finally determined in the form of SD Kansei words to enhance the subjects’ feelings, namely: 1) dislike - like; 2) rough - smooth; 3) stable - flexible; 4) tight - wrinkled; 5) fine - fiber; and 6) refined - natural.

Select product samples

Fuji apples were used as the food for wrapping in this experiment because they have strong surface and do not change the shape when the participants touch them in the experiment. After collecting product samples, the expert team selected 9 types

of food wrapping samples which are usually used in Thailand, namely: plastic bag, aluminum foil, plastic film, paper, plastic foam, banana leaf, wax paper, plastic net and plastic air bubble as shown in Figure 3.

Investigation and evaluation

36 participants took part in the experiment. The participants were randomly recruited at RMUTL. Their ages ranged between 18 and 30 years, and 16 participants were male. Figure 4 shows the results of the evaluation which are the average values of the food wrapping samples for all the semantics.

*Figure 3: Food wrapping samples.
Top row from left: banana leaf, wax paper, plastic net and plastic air bubble
Bottom row from the left: plastic bag, aluminum oil, plastic film, paper and plastic foam*



For the overall average mean, the participants agree that the highest favorite food wrapping is plastic foam whereas the lowest favorite food wrapping is paper. Moreover, the plastic foam is the most flexible while the aluminum foil is the most stable. Only food wrapping made from natural in this study is banana leaf and it has the highest score in “Natural” and the second highest in “Like”, “Smooth” and “Wrinkled”. Another interest result is the plastic net which is the highest in both wrinkled and fiber. Tukey’s significance tests for check to confirm the significant differences were used. The results present that there were significant difference ($p > 0.05$) in all Kansei words. Pearson’s correlations between the properties are shown in Table 1. Values in bold were different from 0 with a significant level

$\alpha = 0.05$. Three correlations were greater than $|0.4|$; smooth - like, wrinkled - flexible and fiber - wrinkled. All most value close to zero that means the two variables do not share any particular correlation. There is no strong correlation relationship in one direction or the other.

Investigation and evaluation

Principal Component Analysis (PCA) has used the covariance matrix instead of the correlation matrix to prevent that differences attributable to both the mean and the dispersion of individuals would be removed. A number of statistical criteria were applied to the choice of the dimensionality and interpretation of the product map [22]. From PCA, the food wrapping Kansei dimensions were divided into 2 factors which could explain 88.19 % of the total variance. Factor loadings and communalities are shown in Table 2. Factor loadings exceeding 0.4 are highlighted. The first factor has a contribution of 48.66% and the second factor has a contribution of 39.54%. Meanwhile, the rest of the factors are significantly smaller. Figure 5 represents Kansei words vectors which indicate the strength and directions. In this figure, the sample positions are shown as dots and explain the relation between Kansei words and products. The attributes (we used only positive Kansei words) positively correlated with dimension 1 were “Flexible”, “Wrinkled” and “Fiber”. The attributes most related to dimension 2 were “Like”, “Smooth” and “Natural”. The plastic foam and banana leaf were most preferred with “Like”. Negatively correlated with this Kansei words were aluminum foil, paper and wax paper that are shown in “Rough”, “Stable”, “Wrinkled” and “Fiber”. Similarly, the banana leaf was represented as “Smooth” and the plastic film was illustrated as “Natural”, whereas plastic net and aluminum foil had negative scores on the same factor. The plastic foam was mapped as “Flexible”. The plastic bag and plastic air bubble were unclear to identify because

they were near the origin. These results will be the significant decision of selecting the food wrapping to achieve the customer's emotion.

DISCUSSION

The major objective of this paper was to represent the results from a tactile experiment of the food wrapping samples using KE. This study will help designers to understand the desirable attributes of the food wrapping products perceived by the customers through their tactile sense. From the overall means, the highest favorite food wrapping is plastic foam which is usually used in Thai's supermarket.

In our view, this wrapping is very soft and we feel familiar with fruits wrapped by plastic foam more than the other wrapping such as plastic air bubble or paper, which are used for rigid material such as mobile phone.

On the other hand, paper was the most disliked sample. The reason is that paper is thin layer material and we feel hard when we touch fruits covered by paper. In Thailand, we use the paper to cover fruits when we want to make fruits ripe for fertility but we do not use it into packaging. According to PCA, the plastic net and aluminum foil were evaluated to be refined and rough but the banana leaf and the plastic film were smooth and natural. Similar results were

Figure 4: The Mean of Kansei words

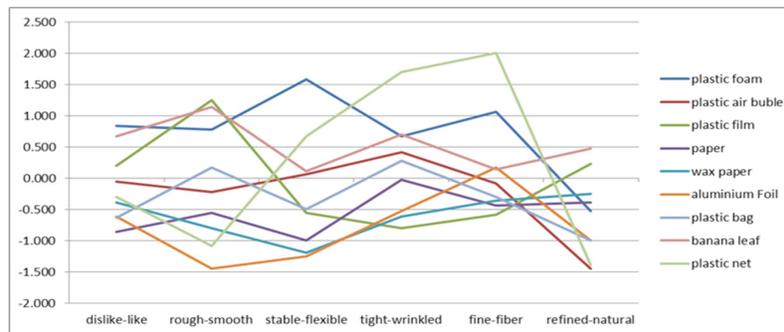


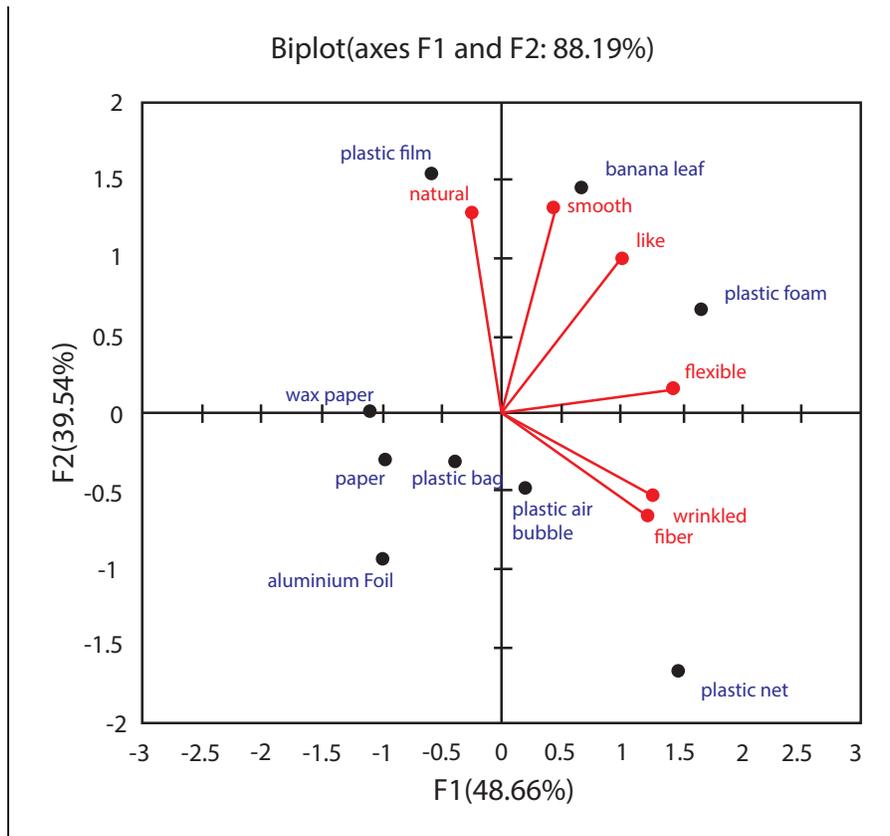
Table 1: Correlations

Variables	like	smooth	flexible	wrinkled	fiber	natural
like	1	0.4928	0.2720	0.2058	0.1676	0.3501
smooth	0.4928	1	0.2948	0.0959	-0.0443	0.3398
flexible	0.2720	0.2948	1	0.4947	0.3987	0.0850
wrinkled	0.2058	0.0959	0.4947	1	0.4585	0.0958
fiber	0.1676	-0.0443	0.3987	0.4575	1	0.0241
natural	0.3501	0.3398	0.0850	0.0958	0.0241	1

Table 2: The factor loadings

Kansei words	F1	F2
dislike-like	0.3933	0.4382
rough-smooth	0.1740	0.5836
stable-flexible	0.5676	0.0696
tight-wrinkled	0.4990	-0.2302
fine-fiber	0.4833	-0.2907
refined-natural	-0.1018	0.5701
Eigenvalue	2.9195	2.3721
Variability (%)	48.6580	39.5357
Cumulative %	48.6580	88.1937

Figure 5: Position of 9 the food wrapping relate to 6 Kansei words.



obtained by Tom Childs et al. [23] as they found that glass, plastic and aluminum foil were considered as “Not genuine” while grapefruit skin film, leaf and cork were considered to “Genuine”. The plastic foam was the optimum food material to wrap fruits from this study.

CONCLUSIONS

This study investigated how the tactile attributes of the food wrapping perceived and interpreted semantically by applied KE in Thailand. The food wrapping samples included plastic bag, aluminum foil, plastic film, paper, plastic foam net, banana leaf, wax paper, plastic net and plastic air bubble. Only one sample that made from nature was banana leaf. The 36 participants evaluated the samples by the 6 SD Kansei words as dislike - like, rough - smooth, stable - flexible, tight - wrinkled, fine - fiber and refined - natural. The evaluation based only on tactile sense meanwhile vision sense was blocked. PCA determined two main dimensions of perceived attributes and impressions. The banana leaf was perceived as particularly smooth, while plastic net and aluminum foil perceived as roughness. The plastic foam was the most favorite wrapping that customer like by tactile and defined based mainly on the descriptors flexible, wrinkled and fiber. The study also indicates key concepts and procedures to link sensory attributes to physical specifications in the new product design.

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