A successful statistical procedure on kansei engineering products

Mitsuo Nagamachi*,Masami Tachikawa**, Nobuyuki Imanishi**,
Taichi Ishizawa** and Shingo Yano**

*Hiroshima International University, nagmit@za3.so-net.ne.jp
**Tsumura Life Science Co.,Ltd, tachikawa_masami@mail.tsumura.co.jp

Abstract

Purpose－Kansei Engineering have been applied to so many different industrial fields. This is a new example of application of Kansei Engineering in packaging designing of bathtub salt.

Methodology－Kansei words were selected according to the project concept and 23 sample product were chosen from the different manufacturers. Before the kansei evaluation experiment, the item/category which mean the new packaging design properties were decided and thirty adult subjects evaluated these samples on 5-point kansei SD scale. These data were analyzed by Principal Component Analysis, Factor Analysis and Partial Least Square Analysis.

Findings－From statistical analysis, we found two main factors which consisted of aesthetic and young-resort kansei. From Partial Least Analysis, these new concepts were transferred to new design specifications that became the basic design concepts. After then, we conducted the reconfirmation survey by retesting the old and new packaging design through Kansei Engineering procedure. As the results, it became clear that the new packaging design were excellent compared with the old one.

Keywords: Kansei Engineering, Kansei Methodology, Development of Bath salts,
Statistical kansei analysis, Kansei packaging design

Category: Technical paper

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1. Introduction

Kansei Engineering was founded 35 years ago at Hiroshima University and since then more than 30 new products have been developed using Kansei Engineering. All Kansei products sold well and made a lot of profits the manufacturers.

Kansei Engineering is defined as a technology that translates for costumer's kansei(psychological feeling) into design specifications (Nagamachi, 2008). Kansei Engineering is some time useful in creating a new invented product. Nagamachi invented a quite unique refrigerator in Sharp which is a reversed shape style with a vegetable compartment at the top and freezer at the bottom. This type of refrigerator is a standard in Japan nowadays. He supported Sharp Kansei team to invent an original video camcorder, in which the camera lens can rotate in 350 degree with liquid crystal display. This was extended technically to the kind of digital camera that many people now possess.

We have developed a lot of Kansei Engineering methodology to produce the kansei products. Category Classification which was used to create Miata from Mazda, Computerized Assisting System which is called as Kansei Engineering System, Virtual Kansei System which is a integrating Kansei Engineering and Virtual Reality Technology, Vehicle room space diagnosis system using Genetic Algorithm, Word Image Diagnosis System (WIDIAS), Hybrid Kansei Engineering which has double kansei systems of forward Kansei Engineering and backward Kansei Engineering, and Kansei Rough Set Model. We utilize a standard kind of Kansei Engineering in general, if it is applicable, which is called Kansei Engineering Type I. In this paper, we treat this method in detail in the application to bath salts.

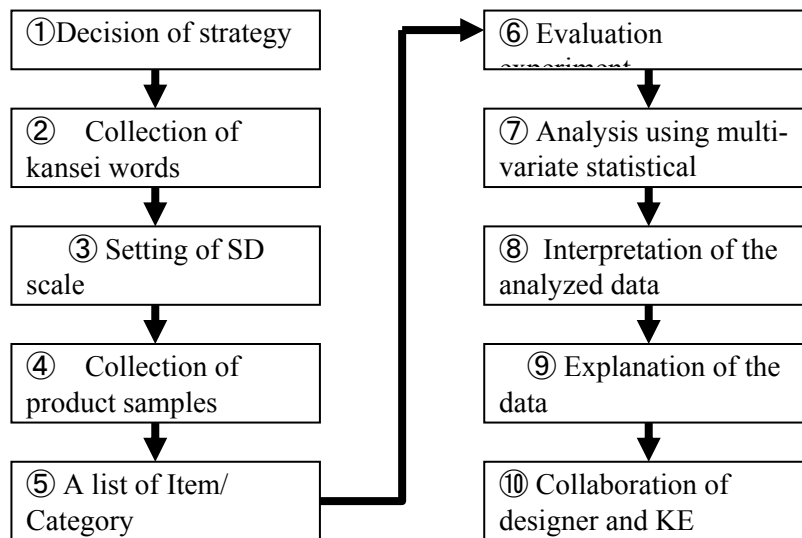| ① Decision of strategy	→	⑥ Evaluation experiment
② Collection of kansei words		⑦ Analysis using multi-variate statistical
③ Setting of SD scale		⑧ Interpretation of the analyzed data
④ Collection of product samples		⑨ Explanation of the data
⑤ A list of Item/ Category		⑩ Collaboration of designer and KE

Fig.1 A flow of the kansei engineering type I.

Figure 1 illustrates the general flow of Kansei Engineering Type I.

① Company strategy:

Kansei Engineering starts from the decision of a client company strategy. The company wishes to create a new product in a specific product field using Kansei

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Engineering. The company should have the specified concept or strategy for the new product. The kansei engineer has to utilize this strategy to apply to the new field.

② Collection of kansei words

The next step after decision of the new strategy is to collect the kansei words related to the new product concept (about 20-30 kansei words).

③ The collected kansei words are arranged on a 5-point or 7-point SD scale. The 5-point scale is better for panel's work on easy evaluation.

④ Collection of other product samples

For comparison among the similar products from the company and other makers, samples are collected from the different companies including benchmarks (about 10-20 samples).

⑤ A list of Item/Category

Item/Category implies the design specifications concerning collected sample products. All product properties are described, for instance colour, shape, size, logo mark, etc.

⑥ Evaluation experiment

After employment of panels of male and female (students or adults), all subjects participate in the evaluation experiment. They record their feelings with kansei words to each sample on the SD scale sheet.

⑦ Statistical Analysis

The evaluated data are analyzed by statistical methods, especially by the multivariate statistical analysis.

⑧ Interpretation of the analyzed data

All analyzed data should be interpreted from the viewpoint of Kansei Engineering. Our purpose is to find the relationship between human kansei and product property. From the analyzed data we find the relations of each kansei with design specifications.

⑨ The explanation of data

The data interpretation should be explained to the company designer(s) in order to make the new design with the help of the designer(s).

⑩ Collaboration with designer(s)

The kansei engineer motivates the company designer(s) to create the new emotional product design stepped up over the analyzed data. In this process, the kansei engineer should support the designer's creation based on the kansei engineering data. This is a kind of collaboration between the kansei engineer and the designer(s).

2. Application of Kansei Engineering to bathtub powder packaging design

2.1 Company strategy for bathtub powder

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Tsumura Life Science Co., Ltd is one of very well known companies as a maker of bath salts. The management of Tsumura Life Science Co., Ltd wanted to increase the company profit from bath salts sales. He asked Nagamachi to create a more fascinating packaging design for summer bath salts, COOL series. Nagamachi recommended the management to create the modern packaging design using Kansei Engineering method. Marketing survey tells us that the bath salts are selected mostly by housewives. Therefore, we decided to do the kansei engineering research on housewives feelings on bath salts

2.2 Collection of kansei words

Nagamachi proposed Tsumura Life Science Co.,Ltd to organize the kansei engineering project team of which mission is to create more emotional packaging design for COOL series, based on the kansei engineering procedure. First we started to collect the kansei words. Nagamachi has met the team to discuss about the kansei engineering procedure and we decided that he collected the kansei words from the viewpoint of bathtub kansei and that the team asked the sales people to write down the customers' words concerning bathtub life.

We constructed the 5-point SD Scale with 45 kansei words as shown in Table 1, in which there are three stages, feeling for looking at the packaging design, feeling after opening the lid and feelings when putting the material into the bathtub.

2.3 The evaluation experiment

We collected 23 samples from five different makers. We invited 30 adult subjects (17 males and 13 females) and asked them to evaluate these samples on the 5-point SD scale. The experiment was conducted in Tokyo and in Hiroshima separately.

Table 1. A list of kansei SD scale.


```
K a n s e i S D  S c a le  L ist
(1). F e e ling w a ch ing at the p ackag ing  de sign
   1  E asy to ho ld  up                   □  □  □  □  □
   2  E asy to o pen th e  cover           □  □  □  □  □
   3  P rem  ium                          □  □  □  □  □
   4  H igh ly  qua lified                 □  □  □  □  □
   5  G orge ous                          □  □  □  □  □
   6  S oph is c a te d                    □  □  □  □  □
      . . . .                             □  □  □  □  □
      . . . .                             □  □  □  □  □
  32  W ant to buy                        □  □  □  □  □
(2) F e e ling  after op en ing  the  cover
   1  E asy to o pen th e  cover           □  □  □  □  □
   2  E asy to o pen th e m  idd le cover  □  □  □  □  □
   3  E asy to m  easure th e m  ateria l  □  □  □  □  □
(3) F e e ling  after pu tting  in to  the  b athtub
   1  C lear                              □  □  □  □  □
   2  L ike  southern  coun try  sea       □  □  □  □  □
      . . . .                             □  □  □  □  □
      . . . .                             □  □  □  □  □
  10  W ant to use da ily                 □  □  □  □  □
```

Fig. 1   Samples used in the kansei experiment.

3. Statistical Analysis

3.1 Factor Analysis

First of all, we conducted Factor Analysis to find a small number of factors which will constitute the 23 dimensional bathtub sphere. We found five factors as follows:

(1) Contribution

From cumulative contribution in Factor Analysis (see Table 2), five factors can explain 86.06% concerning the bathtub kansei dimensions. Factor 1 has 35.63%, in contribution and this factor is the largest factor. Other factors have almost the same weight. Accordingly we can say that psychological sphere of the bath salts consist of these five factors. On the other hand, from Table 3, we can find which kansei is weighed more in each factor. In Factor 1 "relax", "colourful", "want to buy", "effectiveness" and others are of importance as the effectors, and this factor will be named "Healing Effectiveness". In Factor 2 "effective to skin", "smooth skin" has the larger weight and this factor will be named "Effectiveness to Skin". Factor 3 concerning" individuality"," fresh", "celebrity", " premium" and so on are important factors and we can name this factor as "High grade designing". Factor 4 has large weight in "young",

Table 2 Contribution table.

Eigen value after varimax rotation

	square sum	contribution	cumulative
Factor 1	11.40144	35.63%	35.63%
Factor 2	4.711995	14.72%	50.35%
Factor 3	4.654092	14.54%	64.90%
Factor 4	3.730676	11.66%	76.56%
Factor 5	3.040801	9.50%	86.06%

Table 3. Factor loading table

Factor 1	Factor 2	Factor 3	Factor 4	Factor 5

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11.good ser	0.807	31.effective	0.301	13. m atch t	0.395	6.sophistic	0.243	6.sophisti	0.224
20.free from	0.813	4.highly qua	0.345	32.want to b	0.411	29.healing	0.269	4.highly qu	0.237
16.understa	0.846	3.prem ium	0.397	6.sophistica	0.455	5.gorgeous	0.276	25.effecti	0.243
10.good des	0.861	30.celebrity	0.422	4.highly qua	0.503	30.celebrit	0.323	11.good s	0.25
22.effective	0.865	13. m atch t	0.435	27.clean fair	0.511	27.clean fa	0.446	26.sm ooth	0.328
17.good qua	0.868	23.become t	0.548	5.gorgeous	0.554	23.become	0.455	27.clean f	0.35
31.effective	0.87	2.easy to op	0.669	3.prem ium	0.585	24.refresh	0.524	13. m atch	0.365
32.want to l	0.873	8.fem inine	0.775	30.celebrity	0.596	28.resort f	0.805	1.easy to	0.523
12.colorful	0.884	26.sm ooth s	0.84	18.fresh	0.842	7.western	0.907	19.clear d	0.896
21.relax	0.922	25.effective	0.885	15.individual	0.891	9.young	0.925	14.simple	0.936

"western" and "resort" kansei and we can name this as "Young Resort-like Sense". Finally Factor 5 may be named as "Simplicity", because there are "simple" and "clear design" kansei. These important kansei should be selected as design specifications in the final designing stage.

3.2 Principal Component Analysis

Principal Component Analysis (PCA) is very useful for decisions on the new product strategy. We applied PCA to the bathtub kansei data and obtained the relations between kansei and samples as shown in Figure 2. This figure shows number of kansei vectors which suggest the strength and directions of each kansei and sample positioning as dots. The figure illustrates each sample position in principal component sphere and we can see how each sample is close to what specific kansei direction.
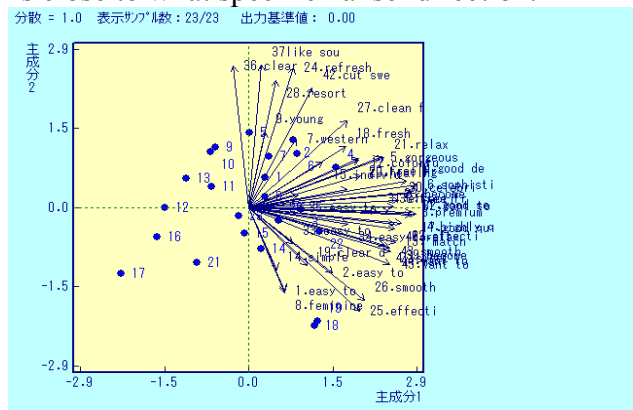

Fig. 3 Positioning of samples related to 32 kansei words

Cumulative contribution of PCA is almost the same as the results of Factor Analysis. Five principal components can explain over 80% f the data. The 1st component has 44% in contribution and other components have almost the same weight as the same as in Factor Analysis. Figure 3 illustrates the dimension surrounded by Component 1 and 2. Many kansei gather around Component 1 which means "Good Sense, Leading to Healing"and Component 2 "Resort Feeling". Accordingly the final strategy of the new packaging design should be heading to a combination of "Good Design Sense" and "Resort Feeling". Tsumura Life Science Co.,Ltd 's products are No. 1, 2, 3, 4, 14, and 22. In Figure 3, No. 3 are close to Component 1 and No 2and 4 are on Component 2.

3.3 Selection of strategic kansei words

In this stage we understand now that we should select the appropriate kansei words leading to the strategic packaging design. We know that we have two factors, one

consisting of Component 1 and another consisting of Component 2. The components coincide with Factor 1 and Factor 3 in Factor Analysis.

Component 1 consists of "sophisticated", "premium", "highly qualified" ,"good design" and "want to buy", that is a combination of aesthetic factor plus purchase motive .

Component 2 consists of "young" and "resort". We can reach good design if we transfer these two components to the new packaging design. For this purpose we have to find the Item/Category related to these kansei.

3.4 Experiment pouring the material into hot bathtub water

We conducted the evaluation experiment when pouring the material into bathtub. When pouring material into bathtub, it makes a good smell and the hot water changes colour for instance white, pink green or blue, etc. The subjects evaluate these changes on the 5-point SD scale.

The contributions are focused on Component 1(64.4%) and Component 2 (27.7%), totally 92.1% for two components. Component 1 consists of "smooth skin", "become healthy" and "want to buy", and Component 2 of "cut sweat", "relax" and "feel southern country-sea".

These kansei will be added to the final decision of selecting the strategic kansei reaching to the new product packaging design.
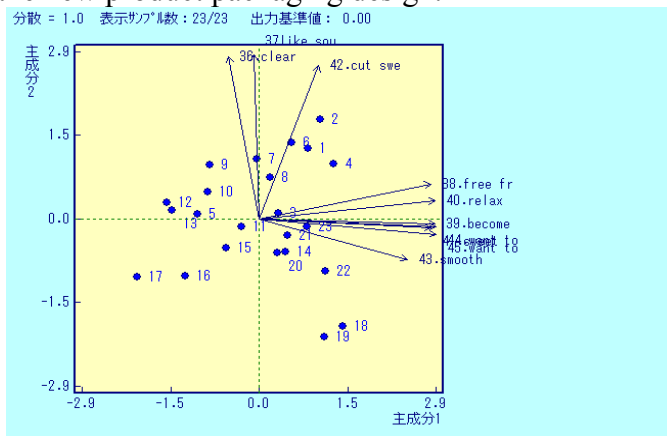

Fig. 4. Positioning of material in the hot water experiment.

3.5 PLS (Partial Least Square) Analysis

PLS Analysis leads to Item/Category, namely to the new product properties with design elements. We already have the candidates of important kansei words concerning the new design. Before conducting PLS calculation, we wrote off Item/Category list related to 23 product samples and we calculated PLS based on 32 items/120 categories. We obtained the relation list between the candidate kansei and each Item/Category concerning 14 strategic kansei. Table 3 shows a part of PLS calculation results.

Table 4. A part of PLS calculation for strategic kansei.

	Item	Category	3.premium	4.high qua	5 gorgeous	6.sophistc	10.good desig
		Intersection	2.779532	2.894091	2.586308	2.836594	2.9158588
1	Logo	Logo	0.029991	0.022021	0.032302	0.025016	0.0240024
		No logo	−0.02999	−0.02202	−0.0323	−0.02502	−0.024002
2	Number of comments	No comments	0.100562	0.077618	0.024438	0.056021	0.0249342
		one comment	0.013363	0.016373	0.027373	0.024779	0.0348228
		Three comment	−0.05396	−0.03072	−0.04295	−0.0489	−0.04295
		Four comments	0.015202	−0.01745	0.05355	0.011327	0.0088825
		No relation	−0.02999	−0.02202	−0.0323	−0.02502	−0.024002
3	Number of	One color	−0.02324	−0.01408	−0.0392	−0.01762	−0.035697
		Two colors	0.017868	0.009939	0.012273	0.010878	0.0393882
		Three colors	0.051175	0.042968	0.04976	0.017032	0.019695
		Four colors	0.005262	0.010012	0.008343	0.02064	0.0117418
		More than five	−0.02142	−0.02662	0.00586	−0.02077	−0.018827

PLS table shows that the biggest positive value in each column means the design item which should be selected and that the biggest negative value leads to the bad design. In Table 4, "Logo", "No comment" and "Three colours" should be selected for premium kansei. Following this procedure, we checked all of strategic kansei design specifications. The strategic kansei were as follows:

Component 1: sophisticated, premium, high quality, good design, sensitive, want to buy.
Component 2: young, resort, feeling southern country sea.

We integrated all item/categories related kansei of Component 1 and 2 and drew the new packaging design.

4. Final design

After following the procedure described above, we created the following designs.

A **B** **C**

Fig. 5   The new packaging designs, peppermint, lemon and rose geranium.

5. Reconfirmation of the hew packaging designs

We conducted a reconfirmation survey about the new packaging designs to see whether the new ones fitted to the customers' upgrade feeling. We utilized the same kansei words which we used in the former research. They were 32 kansei words concerning kansei watching at the outside package.

Nine female subjects who joined the former research participated in the reconfirmation research. The new packaging designs (A,B,C) and the former designs (a, b, c) were arranged in the experimental room and each subject evaluated a product

randomly on the 5-point SD scale sheet. The evaluated data were analyzed by PCA. Figure 6 is one of analyzed data by PCA. In Figure 6, No.1, 3 and 5 are the old designs a, b and c, and No.
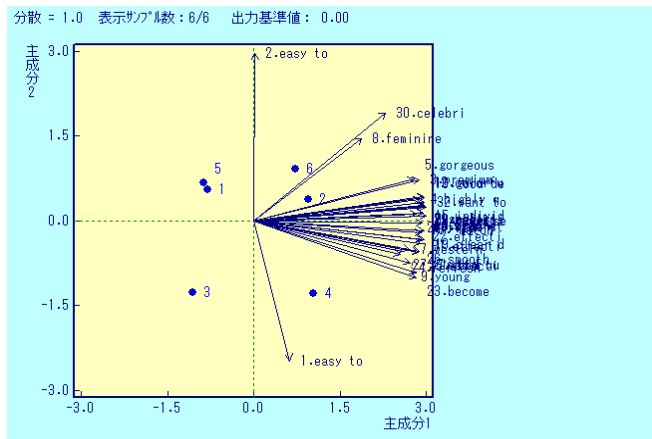

Fig.6. PCA chart of reconfirmed research for Component 1 and 2

2, 4, 6 are the new designs, A, B and C. It is clear that A, B, C positions are apart from the old designs. A is on the aesthetic factor of "sophisticated" ," premium" and others, B is close to "young", and C is on "celebrity" factor. It is clear that the new designs moved to the side of strategic area.

We estimated statistical differences between the new designs and the old ones. The estimation tells us that there are meaningful differences with $p<0.0001$ between the new designs and the old ones.

5. Conclusions

We tried an application of Kansei Engineering to the new packaging design of bath salts. Following Kansei Engineering Type I procedure, we collected the kansei words (45 words) related to the evaluation of bathtub powder and collected the product samples (23 products). The evaluated data were analyzed by multivariate analysis and then we decided the new design specifications based on the statistical calculation. Collaboration with the designers who understood the kansei data provided us the beautiful new packaging designs.

The new designs were reconfirmed by another kansei survey and the evaluated kansei data were analyzed by difference estimation and PLS as well. Both analyses suggested the new packaging designs were excellent and more emotional over the old ones.

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