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APPLICATION OF KANSEI ENGINEERING PROCEDURE IN TAIWAN'S AUTOMOTIVE GSP PRODUCTS

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Abstract: Nowadays, markets are moving from the product-oriented type to the consumer-oriented type, in the light that the modern life cycle of product is becoming shorter and shorter. *Kansei* engineering is a method used to link emotions and product features. In this paper, we apply *Kansei* engineering in the automotive GPS industry. This study is of interest to the manufacturers involved, because they wanted to see how the existing GPS designs are perceived by the consumers. The aim of this paper is to propose a conceptual model for connecting the semantic axes to the product properties. By using the factor analysis, quality technology and perceived quality for the GPS monitor center are two main factors extracting from those 8 *Kansei* words, which were used to assess the service quality. Moreover, Appearance-Function and overall design effect were derived from the physical design. The proposed conceptual model for the automotive GSP products is expected to be useful when performing applications.

Keywords: *Semantic Words, Automotive GSP, Quality Technology, Perceived Quality, Overall Design Effect*

1. INTRODUCTION

The Global Positioning System (GPS) is a space-based radionavigation system, which provides reliable positioning, navigation, and timing services to civilian users on a continuous worldwide basis. Users, equipped with GPS receivers, could accurately locate their location and time information in all weather, day and night, anywhere. Over the years, automobile manufacturers have integrated the GPS with the automobile security system, such as install moving-map displays guided by GPS receivers. The in-car GPS is an increasing popular feature in developed countries, the availability of this technology in Taiwan though remains not high but is growing.

Kansei engineering is a method used to link emotions and product features by translating customers' impressions, feelings and demands on existing products or concepts into design solutions and concrete design parameters (Simon, Eklund, Axelsson and Nagamachi 2004). *Kansei* is a Japanese term which means 'consumer's psychological feeling and image' (Nagamachi 1997). *Kansei* incorporates the meanings of the words: sensitivity, sense, aesthetics, feelings, emotions affection and intuition (Lee, 2002). There are different ways to measure the *Kansei*: words, physiological response, people's behaviors and actions and facial or body expressions (Nagamachi 2001, Grimsaeth). *Kansei* has already been put into practice by several companies quite successfully.

Nowadays, markets are moving from the product-oriented type to the consumer-oriented type, in the light that the modern life cycle of product is becoming shorter and shorter. It would be very beneficial for the automobile

manufacturers to understand customers' preferences so that they can incorporate them into their designs, or to predict customers' thoughts to find which model will be popular. *Kansei* engineering has generally been used by manufacturers with the purpose serving the user with a long term perspective and not only to boost their sales.

In this paper, we apply *Kansei* engineering in the automotive GPS industry. This study is of interest to the manufacturers involved, because they wanted to see how the existing GPS designs are perceived by the consumers. It would be possible for the manufacturers to remodel the existing system by incorporating specific design features, which could be obtained by particular responses from the target customers. Questionnaires will be given to GPS customer groups who give information about *Kanseis* and those which are important to the automotive GPS manufacturers. A five point scales, where the *Kanseis* are rated according to the preferences of customers, is given.

This paper is divided into five main parts. The first part is a brief introduction of *Kansei* engineering and the aim of this paper. Secondly *Kansei* engineering procedure will be introduced in section 2. In section 3, we will describe the descriptive words, define the semantic scales, and the collection of samples. Then we will extract the multiple features of automotive GPS products by applying factor analysis and estimate significant characteristics by using factorial analysis in section 4. Finally section 5 is the conclusions.

2. KANSEI ENGINEERING PROCEDURE

There are different types of *Kansei* Engineering which

can be carried out in different ways. Schütte (2005) proposed a general model to embrace all known types of *Kansei Engineering*. The framework for *Kansei Engineering* methodology is presented in Figure 1.

According to the model, the descriptions of semantic and product properties span a vector space each. These two spaces are merged in the semantic phase. Subsequently, validity test is conducted by using several types of post-hoc analyses. The two vector spaces will be updated and the synthesis step will be run again until this iteration process is satisfactory. Finally, a model can be built to describe how the semantic and product properties are associated.

The first step for the *Kansei Engineering* procedure is choosing the *Kansei* domain, which also includes concepts behind a product except for selected target group. Next *Kansei* words have to be collected from all possible sources, such as newspapers, magazines, literature, experts, ideas, visions, and experienced users. Schütte (2006) propose a model to identify relevant product properties. In the first step of Schütte's model is collecting product samples and identifying their properties, creating and identifying new product concepts, and selecting company's image properties. After integrating the product features, the relative importance of these properties should be determined by considering different types of targets, such as customers, marketing experts, or the company. All selected properties will be brought together to be used in a following synthesis step.

The semantic space and space of properties are linked in the synthesis step. Manual methods, statistical methods, generic algorithms, fuzzy set theory rough set theory and so on, are available tools. Data from the above step has to

be checked by conducting validity tests. For example, whether the data comes from a normal distribution could be tested by applying the Kolmogorov-Smirnov tests. The final model is employed to discuss the thesis presenting the connection between product properties.

3. KANSEI WORDS STRUCTURING

What features are important for a particular user are a personal thing. There are two types of GPS units for car navigation. One has large bright screens for comfortable viewing at arms length on car's dashboard. It also provide voice guidance. The other model is handheld car navigation, which has a smaller screen and do not have voice guidance. Nowadays most auto sales managers will be of much interest in understanding the users' perceptions and preferences of their automotive GPS. The target group was middle-aged adults between 30 and 50 years old.

Words describing the product domain were collected from magazines, manuals, product reviews, customers, and related articles on web sites. All words describing the automotive GPS within the chosen domain were included in the first gathering of words. The words could be divided into several broad descriptive headings: address to address routing, units providing voice prompts for turns and guidance included, building in road maps, automatic destination routing, waypoints capability, having voice and visual prompts for turns, intuitive screen, easy navigation, including point-of-point data, managing service qualities including repair and maintenance, quality for server malfunctions and so on. We reduced the above words to the following 16 semantic scales:

- Efficient
- Professional
- Appetent
- Knowledgeable
- Burglarproof
- Instant
- Accuracy
- Safe
- Well-tuned
- Easily
- Convenient
- Stable
- Responsible
- Loyal
- Strict
- Scrupulous

A questionnaire was constructed in order that the semantic scales could be applied to each image in the GPS product. We could extract the emotional response of each respondent to each image.

Figure 1: A model of the *Kansei Engineering* concept

4. GATHERING AND SURVEYING

In our *Kansei* study of automotive GPS, data were collected and validated based on expert validity. The sample of questionnaire respondents were customers from a famous car agency in Taiwan. In the questionnaire, the list of semantic scales was randomly ordered to avoid bias during questionnaire completion. Customers assessed their response to each word on a five point Likert scale ranging from “strongly disagree”=1 to “strong agree”=5.

Respondents were asked to provide information on their gender, age, education level, marriage status, and monthly income. The questionnaire was first piloted to help us find out if the content and form of the questions are satisfactory. We have handed out 100 questionnaires and recycled 90 questionnaires. The response rate was hence calculated to be 90%. All 90 recycled questionnaires were considered valid.

5. STATISTICAL ANALYSIS

Firstly, we will analyze the full set of replies from all valid respondents. Secondly, the respondents were divided by gender, age, education, marriage status and monthly income, respectively. We will investigate whether there exist significant differences in average rating calculated

from each of the semantic scales among difference categories for every qualitative variables, by using the one-way analysis of variance method. Finally, factor analysis was employed to derive the semantic axes in the evaluation of automotive GPS.

The number of completed questionnaires in each of the above categories is given in Table 1. For the 90 valid questionnaires, about 61% were male, about 44% were Junior College level, about 32% were bachelor degree, and about 92% were married. Moreover, there were about 77% family's average monthly income ranging from NT \$30000 to NT\$90000.

The results for testing the significant differences in the average ratings among difference categories for every qualitative variables were demonstrated in Tables 2. We found that the average ratings of semantics “Professional”, “Easily” and “Scrupulous” for the married respondents is significantly different from that for the unmarried respondents. There exist significantly different average ratings of semantics “Accuracy”, “Responsible” and “Scrupulous” among groups of education level. The average ratings of semantics “Burglarproof” and “Convenient” were affected by the respondents' gender. On the other hand, the average ratings of semantics “Efficient”, “Appetent”, “Knowledgeable”, “Instant”, “Safe”, “Well-tuned”, “Stable”, “Loyal”, and “Strict” are not influenced by age and family's

Table 1: Socio-demographic characteristics (n=90)

Characteristics	Total	%
Gender		
Male	77	85.6%
Female	13	14.4%
Age		
30~39	55	61.1%
40~49	35	38.8%
Education level		
Junior College	40	44.4%
Bachelor Degree	29	32.2%
Graduate School	21	23.3%
Marriage Status		
Married	83	92.2%
UNmarried	6	6.6%
Others	1	1.1%
Monthly Income (NT \$1000) ^a		
30~60	26	28.9%
60~90	43	47.8%
90~120	14	15.6%
120~150	2	2.2%
150~180	1	1.1%

^a Four respondents did not disclose their monthly income.

Table 2: Testing results for the significant differences in the average ratings

Semantic Words	Gender	Age	Education Level	Marriage Status	Monthly Income
Efficient	0.008(0.931)	2.538(0.115)	1.017(0.336)	0.219(0.804)	0.788(0.561)
Professional	1.166(0.283)	1.443(0.233)	1.408(0.250)	3.015*(0.054)	1.161(0.335)
Appetent	0.022(0.881)	1.145(0.287)	0.520(0.596)	0.841(0.435)	1.131(0.350)
Knowledgeable	0.784(0.378)	1.776(0.186)	0.684(0.507)	0.317(0.729)	1.212(0.310)
Burglarproof	3.136*(0.080)	0.100(0.753)	0.669(0.515)	0.521(0.596)	0.179(0.970)
Instant	0.544(0.563)	0.186(0.667)	1.568(0.214)	0.683(0.508)	1.845(0.113)
Accuracy	2.333(0.130)	1.198(0.277)	4.060**(0.021)	2.042(0.136)	0.786(0.566)
Safe	0.255(0.615)	0.002(0.965)	0.501(0.608)	0.287(0.751)	1.198(0.317)
Well-tuned	0.452(0.503)	0.052(0.820)	0.997(0.373)	0.824(0.442)	0.328(0.895)
Easily	0.658(0.420)	0.028(0.868)	1.056(0.352)	3.275**(0.043)	0.517(0.762)
Convenient	3.248*(0.075)	0.060(0.808)	0.254(0.776)	1.643(0.199)	0.430(0.827)
Stable	0.866(0.354)	0.285(0.595)	0.268(0.765)	2.324(0.104)	1.382(0.239)
Responsible	1.773(0.186)	1.018(0.316)	3.027*(0.054)	1.057(0.352)	0.475(0.794)
Loyal	0.938(0.335)	0.147(0.703)	0.646(0.527)	1.465(0.237)	1.513(0.195)
Strict	2.028(0.158)	0.050(0.824)	1.180(0.312)	1.084(0.343)	0.805(0.549)
Scrupulous	0.585(0.447)	0.133(0.716)	2.411*(0.096)	2.606*(0.080)	0.849(0.159)

This table reports the F-statistics and corresponding p-values (in parentheses).

(*) and (**) indicate that there is no significant differences among different group means at the 10 and 5 percent levels, respectively.

average monthly income.

Initially, respondents could rate the scales of semantics “Efficiency”, “Professional”, “Appetent”, “Knowledgeable”, “Responsible”, “Loyal”, “Strict” and “Scrupulous” to assess the after-sale’s quality of services offered by the monitor center. The other 8 *Kansei* words were rated to evaluate the physical design of automotive GPS. Therefore, we employed factor analysis to extract the semantic axes for service property and for the physical design separately. We used Kaiser-Meyer-Olkin (KMO) to measure the sampling adequacy. Moreover the Bartlett test for sphericity is used to test the presence of correlation among variables. For data to be appropriate for factor analysis, the result of the Bartlett test should be significant and the KMO value should be at least 0.5.

The 8 *Kansei* words of service property were firstly selected, and we used Barlett’s test of sphericity to test the inter-correlation among these 8 semantic scales. For this data set, the approximate chi-square value 376.672 is significant at $p < 0.000$. Secondly, we then use the KMO measure of sampling adequacy to make sure these 8 semantic scales were properly grouped. The KMO statistic for this data is 0.850, indicating that the data are suitable for factor analysis.

The factor analysis allowed us to identify underlying

patterns of relationships embedded in the data set. After initial factors are extracted, varimax rotation method was used to find our terminal semantic axes. There was only one eigenvalue with value greater than 1, which is the general level for retention of a factor. Even though, we extract two semantic axes to avoid losing too much information contained in the data. The rotated factor loadings, which were used to label the semantic axes, the proportion

Table 3: Rotated factor loadings and communalities for service quality-varimax rotation

Variable	Factor 1	Factor 2	Communality
Efficient	0.235	0.844	0.767
Professional	0.439	0.606	0.560
Appetent	0.195	0.848	0.757
Knowledgeable	0.579	0.440	0.529
Responsible	0.734	0.328	0.646
Loyal	0.919	0.145	0.865
Strict	0.763	0.339	0.697
Scrupulous	0.805	0.234	0.704
Variance (%)	40.43	28.63	69.06

Figure 2: Plot of factor 2 (y axis) versus factor 1 (x axis) for service quality

of variance explained by each factor, and the communalities are displayed in Table 3. Most of the communalities are fairly high indicating that the variance of the variables is accounted for by the two common factors.

Loadings above 0.71 are considered excellent, 0.63 very good, 0.55 good, 0.45 fair, and 0.32 poor (Tabachnik & Fidell, 1983). Based on these criteria, all those *Kansei* words that loaded at 0.45 level or above were preserved. *Kansei* words were extracted and grouped into two main factors after factor analysis. The results of all respondents show that the first factor measures the quality technology. Factor 2 measures the perceived quality for the GPS monitor center. Plot of factor 1 (y axis) versus factor 2 (x axis) is shown in Figure 2.

Similarly, we repeated the same procedures to derive the

Table 4: Rotated factor loadings and communalities for physical design-varimax rotation

Variable	Factor 1	Factor 2	Communality
Burglarproof	0.795	0.130	0.648
Instant	0.511	0.457	0.470
Accuracy	0.248	0.857	0.788
Safe	0.315	0.754	0.667
Well-tuned	0.779	0.346	0.726
Easily	0.821	0.281	0.753
Convenient	0.743	0.350	0.674
Stable	0.222	0.797	0.685
Variance (%)	36.70	30.97	67.66

semantic axes for the *Kansei* words, which were used to evaluate the physical design of automotive GPS. We used Barlett's test of sphericity to test the inter-correlation among these 8 semantic scales. For this data set, the appropriate chi-square value 352.464 is significant at $p < 0.000$. Additionally, The KMO statistic for this data is 0.837, indicating that the data are suitable for factor analysis.

By using the factor analysis to extract the semantic axes, we also found that there was only one eigenvalue with value greater than 1. Even though, we extract two semantic axes to avoid losing too much information contained in the data. The rotated factor loadings, which were used to label the semantic axes, the proportion of variance explained by each factor, and the communalities are displayed in Table 4. Most of the communalities are fairly high indicating that the variance of the variables is accounted for by the two common factors.

Based on the criteria proposed by Tabachnik and Fidell (1983), all those *Kansei* words that loaded at 0.45 level or above were preserved. *Kansei* words were extracted and grouped into two main factors after factor analysis. The results of all respondents show that the first factor measures the appearance and function design of the automotive GPS. We label factor as the overall design effect of this system. Plot of factor 2 (y axis) versus factor 1 (x axis) is shown in Figure 3.

Table 5 presents the derived semantic factors to product properties according to sources mentioned in section 3. Integrating the factor analysis results with Table 1, it was concluded that married respondents care the perceived quality and the physical design of appearance and functions, which was also attracted by respondents with higher

Figure 3: Plot of factor 2 (y axis) versus factor 1 (x axis) for physical design

education level. There might exist gender effect in overall design and after-sales service.

6. CONCLUSIONS

Kansei engineering is a method used to link emotions and product features by translating customers' impressions, feelings and demands on existing products or concepts into design solutions and concrete design parameters. Statistical analysis is required for us to link it to other data set about the customers. The representativeness and sufficiently large sample of respondents are also required to proceed. In the case of evaluating the features of the automotive GSP, we found that the average ratings of semantics "Professional", "Easily" and "Scrupulous" for the married respondents is significantly different from that for the unmarried respondents. There exist significantly different average ratings of semantics "Accuracy", "Responsible"

and "Scrupulous" among groups of education level. The average ratings of semantics "Burglarproof" and "Convenient" were affected by the respondents' gender.

By using the factor analysis, quality technology and perceived quality for the GPS monitor center are two main factors extracting from those 8 *Kansei* words, which were used to assess the service quality. Moreover, Appearance-Function and overall design effect were derived from the physical design. It is concluded by integrating the factor analysis results with Table 1 that married respondents care the perceived quality and the physical design of appearance and functions, which was also attracted by respondents with higher education level. There might exist gender effect in overall design and after-sales service.

The *Kansei* method can be applied to various manufactured products. It would help manufacturers understand customers' perceptions and preferences, so that they could try to incorporate their opinions into their design for new products, or for improve old models.

Table 5: Semantic factors v.s. product properties

Service Quality	Product Properties
Perceived Quality	Appetent and professional services
Quality Technology	After-sales service for repair and maintain
Physical Design	Product Properties
Appearance and Function	Large screen/ Instant Responses
Overall Design Effect	Stability/ malfunction rate

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