Application Research of Quantitative Deductive Kansei Engineering in APP Interface Optimization Design

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Abstract. In order to better explore people’s emotional appeals in the design of Application interface, this paper applies the quantitative deductive method of Kansei Engineering to the research of its optimization design. Firstly, questionnaire survey, cluster analysis and other methods are used to determine the design elements of APP interface and representative perceptual words, and then the semantic difference method is used to establish the relationship between the two, so as to carry out perceptual evaluation on representative APP interface samples. On this basis, qualitative analysis is used to explore the corresponding relationship between perceptual words and design elements. Finally, the validity of the conclusions obtained from the qualitative analysis is verified by the orthogonal analysis method, and the corresponding relationship between the consumer’s emotional demands and APP interface design elements is thus established.

1. Introduction

As the mainstream media of modern social information dissemination, mobile phones have been integrated into all aspects of people’s lives. The mobile APP interface provides us with a virtual visual environment that transcends physical material. How to utilize mobile phone software interface design with limited design space and visual elements has become an important task faced by the designers.

In order to consider more about the user’s intention in the design, this paper applies the quantitative deductive method of Kansei Engineering to the research of APP interface optimization design. By the means of computer and statistical analysis, this paper aims to effectively obtain the corresponding relation between consumer’s psychological and emotional needs and APP interface design elements, thus improving the emotional and spiritual care of the APP interface for consumers.

2. Application and Implementation of Quantitative Deductive Kansei Engineering in Research

2.1. Analysis of APP Interface Samples
In the research, APP interface samples were collected, cluster analysis was used to cluster the samples, and the samples were divided into 8 categories. Then k-means clustering was applied and the clustering number was set to 8. The coordinate values were analyzed, the distance between each sample and the clustering center was calculated, and the closest interface sample to the cluster center is a representative sample of the class. Taking category 1 as an example, the classification results are shown in Table 1. The sample (21) is the closest to the clustering center and is the representative sample of category 1. Similarly, the eight most representative APP interface samples are finally determined.

| Samples  | Distance to the cluster center |
|----------|-------------------------------|
| Sample (21) | 0.63812                      |
| Sample (19) | 0.77527                      |
| Sample (3)  | 0.82738                      |
| Sample (7)  | 0.97437                      |
| Sample (33) | 1.19268                      |

2.2. Emotional evaluation of semantic differential method (SD)

A 7-level semantic difference scale (SD scale) was established, as shown in Table 2. The subjects were asked to make perceptual evaluation on 8 representative APP interface separately.

| Samples | -3 | -2 | -1 | 0  | 1  | 2  | 3          |
|---------|----|----|----|----|----|----|------------|
| Complicated |    |    |    |    |    |    | Simple     |
| Messy    | -3 | -2 | -1 | 0  | 1  | 2  | 3          |
| Monotonous|    |    |    |    |    |    | Unitary    |
| Ornate   | -3 | -2 | -1 | 0  | 1  | 2  | 3          |
| Conventional|    |    |    |    |    |    | Colorful   |
| Cautious | -3 | -2 | -1 | 0  | 1  | 2  | 3          |
| Hard-to-use|     |    |    |    |    |    | Plain      |
| Inconspicuous|    |    |    |    |    |    | Modern     |
| With low commercial value|     |    |    |    |    |    | Lively     |
| With high commercial value|     |    |    |    |    |    | Easy-to-use|

2.3. Establishment of corresponding relationship between design elements and kansei vocabulary

2.3.1. Qualitative analysis

The perceptual data of APP interface samples obtained from the above SD scale evaluation test were collated and analyzed, and the average scores of kansei vocabulary corresponding to each sample were calculated, the questionnaire results analysis table as shown in Figure 1 was generated through EXCEL, and then the data was qualitatively analyzed according to the chart.
Figure 1. Survey results analysis of SD scale.

According to the content shown in Figure 1, the scores of each APP interface sample and the corresponding kansei vocabulary are analyzed, and the highest and lowest scores corresponding to each kansei vocabulary can be found. In addition, with further comprehensive analysis of each kansei vocabulary and sample design element, a certain correspondence law between the two can be found, and the corresponding relation between the kansei vocabulary and the design elements is obtained as shown in Table 3. In general, the four factors of the layout, color, picture and navigation bar of the APP interface have a greater influence on the emotional appeals of the subjects, while other factors have a less obvious influence on the emotional appeals.

Table 3. The corresponding relation between kansei vocabulary and design elements.

| Design elements | Kansei appeals | Sample | Unitary | Colorful | Plain | Modern | Lively | Easy-to-use | Eye-catching | With high commercial value |
|-----------------|----------------|--------|---------|----------|-------|--------|--------|-------------|---------------|-------------------------|
| Layout          | Regional style | √      |         |          |       |        |        |             |               |                         |
|                 | Freestyle      |         |         |          |       |        |        |             |               |                         |
| Color           | Similar color  |         |         |          |       |        |        |             |               |                         |
|                 | Contrast color |         |         |          |       |        |        |             |               |                         |
| Text            | Same font color| √       |         |          |       |        |        |             |               |                         |
|                 | Different font colors | √      | √       | √        |       |        |        |             |               |                         |
| Picture         | Picture scrolling | √     |         |          |       |        |        |             |               |                         |
|                 | Picture fixed   | √       |         |          |       |        |        |             |               |                         |
| Navigation bar  | In the middle of the interface | √     |         |          |       |        |        |             |               |                         |
|                 | Below the interface | √     |         |          |       |        |        |             |               |                         |
| Link            | Color differentiation | √     | √       | √        | √     |        |        |             |               |                         |
2.3.2. Verifying the Conclusion by Orthogonal Analysis

In order to verify the conclusions of the above qualitative analysis and conduct in-depth analysis, this part will adopt orthogonal analysis method to conduct research.

In the orthogonal test, various experimental conditions are called “factors”, and the state in which each factor is desirable is called “level”, and the quantity to evaluate and measure the experimental effect is called “index”. When different levels of each factor are taken, the index will change, but the change range of the index caused by different factors is different. When the index variation range (range R) caused by different levels of factors is large, the factor has a great influence on the index, which is the main factor. Therefore, by analyzing the range of the orthogonal test, the primary and secondary degree of the influence of different factors (elements) and levels (design elements) on the index (emotional appeal) can be obtained, and the conclusion of “which design elements combination should be selected to achieve a certain sensibility of the APP” can be drawn to guide the emotional design.

In this study, the commonly used $L_8(2^7)$ orthogonal table was used for orthogonal test, indicating that 8 experiments were needed according to 8 samples, and 7 factors could be observed at most, each factor at 2 level.

As some of the 8 representative APP interface samples selected by k-means clustering method before did not meet the requirements of $L_8(2^7)$ orthogonal table and the analysis of APP interface design features, 8 representative samples were re-selected through evaluation to make the factors and levels of each sample meet the requirements of $L_8(2^7)$ orthogonal table.

By using the 9 groups of typical kansei vocabulary selected in 1.2.2, the SD perceptual evaluation of the 8 newly selected representative APP interface samples was re-examined according to the experimental steps of the semantic differential method. Then the evaluation data were sorted out and the orthogonal test table of $L_8(2^7)$ was established. The sum of each index at different levels of each factor was calculated, i.e. T1, T2. The processing results of orthogonal test data obtained were shown in Table 4.

| Index     | Layout | Color | Text | Picture | Navigation bar | Link | Animation |
|-----------|--------|-------|------|---------|----------------|------|-----------|
| Simple    | T1     | 3.35  | 3.86 | 1.35    | 0.93           | 4.31 | 3.38      | 4.15      |
|           | T2     | 1.09  | 0.51 | -0.08   | 0.44           | 0.96 | -0.55     | 3.39      |
| Unitary   | T1     | 3.87  | 2.61 | 1.43    | 2.05           | 2.21 | 4.15      | 1.53      |
|           | T2     | -0.04 | -1.71| -1.95   | 1.40           | -0.42| 1.92      | 1.27      |
| Colorful  | T1     | 2.91  | 2.09 | 1.52    | 1.53           | 2.08 | 0.92      | 3.17      |
|           | T2     | 2.08  | -1.84| -1.33   | -0.68          | 0.25 | -0.65     | -0.02     |
| Plain     | T1     | 2.21  | 2.04 | 1.23    | 3.03           | 1.52 | 3.62      | 1.21      |
|           | T2     | 1.24  | 0.37 | -1.03   | 2.06           | 0.37 | 3.27      | 0.44      |
| Modern    | T1     | 1.91  | 2.75 | 2.63    | 2.07           | 1.09 | 3.87      | 1.93      |

Table 4. Orthogonal Test Data Processing Results.
According to the orthogonal test data processing results in Table 8, the range \( R (|T_1 - T_2|) \) was calculated, and the obtained range calculation results are shown in Table 5.

| Index                     | Factor | Layout | Color | Text | Picture | Navigation bar | Link | Animation |
|---------------------------|--------|--------|-------|------|---------|----------------|------|-----------|
| Simple                    |        | 2.26   | 3.35  | 1.43 | 0.49    | 3.35           | 3.93 | 0.76      |
| Unitary                   |        | 3.91   | 4.32  | 3.38 | 0.65    | 2.63           | 2.23 | 0.26      |
| Colorful                  |        | 0.83   | 3.96  | 2.85 | 2.21    | 1.53           | 1.57 | 3.19      |
| Plain                     |        | 0.97   | 1.67  | 2.26 | 0.97    | 1.15           | 0.35 | 0.77      |
| Modern                    |        | 0.55   | 0.53  | 0.72 | 1.97    | 0.18           | 0.26 | 0.83      |
| Lively                    |        | 1.95   | 2.27  | 4.03 | 1.25    | 1.93           | 1.66 | 4.32      |
| Easy-to-use               |        | 3.24   | 1.55  | 0.69 | 0.43    | 3.37           | 4.03 | 0.55      |
| Eye-catching              |        | 2.65   | 2.62  | 0.96 | 0.57    | 3.26           | 3.83 | 3.57      |
| With high commercial value|        | 0.29   | 0.38  | 0.27 | 2.53    | 2.27           | 3.24 | 2.98      |

According to the standard of “the greater the variation range (range R) of the index caused by taking different levels of the factor, the greater the influence of the factor on the index and this factor is the main influence factor”, the following conclusions can be drawn through the range analysis and factor analysis in Table 5:

(1) The influence of different factors (elements) and levels (design elements) on the index (emotional appeal) is exemplified by the influence of factors and levels on the four indicators of simplicity, integrity, applicability and conspicuousness, to illustrate the influence of design elements on emotional appeal, as shown in Table 6.

| Index                     | The influence of factors on indicators | The influence of level on indicators |
|---------------------------|---------------------------------------|-------------------------------------|
| Simplicity                | Color, navigation bars, and links have the greatest influence on simplicity; layout and text have a greater influence on it; other factors have little influence on it. | The APP interface design consisting of similar colors, navigation bars located at the bottom of the interface, color-differentiated links and other elements is considered to be simpler. |
Similarly, the influence of factors and levels on the seven indicators of color, applicability, conspicuousness, simplicity, modernity, liveliness and high commerciality can be obtained, indicating the degree of influence of design elements on these emotional appeals.

(2) Based on the above analysis of the influence of the design elements on emotional appeal, the four factors of APP interface, i.e. layout, color, picture and navigation bar have the greatest influence on consumers’ emotional appeals, while other factors have a slightly weaker or less obvious influence on emotional appeal.

(3) The conclusions obtained by the orthogonal analysis test are basically consistent with the conclusions obtained from the previous qualitative analysis.

2.4. Interpret the Analysis Results and Provide Design Guidance
Through the analysis of Table 3 and Table 6, it can be seen that in the optimization design process of APP interface, the ideal kansei vocabulary can be selected, so as to obtain the APP interface design elements that can best reflect the vocabulary. For example, the combination of design elements of “integrated APP interface” is roughly as follows: regional type (layout) + similar color (color) + same font color (text) + being located at the bottom of the interface (navigation bar) + color differentiation type (link). In the same way, other combinations of APP interface design elements that reflect the user’s emotional appeal can be obtained.

3. Conclusions
In this paper, the implementation process of the quantitative deductive method of Kansei Engineering in the optimization design of APP interface is discussed in detail. In addition, qualitative analysis and orthogonal analysis are used to verify each other to establish the relationship between relevant kansei vocabulary and design elements, and transform people’s vague psychological and emotional needs for APP interface into specific design elements. The future research will also discuss the rules of the influence of different configuration of design elements on users. As the research progresses further, it will provide more scientific and feasible references for the optimization design of APP interface.

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