The extended Kano model based on moderated regression analysis: A case study of express delivery service

Zhen Li* and Qingliang Meng
School of Management & Economics, Jiangsu University of Science and Technology, Zhenjiang, Jiangsu, China

*Corresponding author. Email: li17851000903@163.com

Abstract. Not all product and service quality are equally important to customers. Several studies have applied regression analysis to identify the key elements affecting customer satisfaction. This paper used an extended Kano model based on the moderated regression analysis to improve the defects of the traditional Kano model. The model is validated using data collected from express delivery service. And the empirical results show that the method produces more accurate classification. Overall, this study makes contributions to both Kano model improvement and express delivery service quality optimization.

Keywords: Kano model, moderated regression analysis, express delivery service.

1. Introduction
Since its introduction in the 1980s, the Kano model [1] has become one of the most popular quality models. The Kano model address the nonlinear relationship between the quality performance level and customer satisfaction [2], it can classify quality attributes into five categories (attractive, one-dimensional, must-be, indifferent, and reverse quality). But the Kano model is found to be too complex and difficult to implement [2]. The Kano qualitative categories could not precisely reflect the extent to which the customers are satisfied [3].

To realize the objective and accurate classification of the quality elements of the Kano model, relevant scholars at home and abroad have made a lot of beneficial exploration from the aspects of questionnaire design, improvement of classification criteria, and the refinement of classification results. For decades, various approaches to regression analysis have been applied to explore asymmetric and non-linear relationships in the Kano model. Using popular tools and techniques for the measurement of customer satisfaction, the regression methods can simplify the process of collecting data, making it far easier to implement than the traditional Kano model [3].

Brandt [4] firstly developed a dummy variable regression model. Customer satisfaction was taken as the dependent variable and the quality elements performance level is the independent variable, defined as a pair of dummy variables for two levels of performance, low and high. The quality elements were classified by the regression coefficient [3]. Lin et al believe that the dummy variable regression model ignores the impact of the common performance level of quality elements on customer satisfaction, the exclusion of this information would result in inaccurate classification results. Lin et al [2] proposed a moderated regression model, the performance levels (low, average, and high) of quality elements are set as moderated variables. Therefore, considering the applicability of Lin’s
approach, this paper explores the extended Kano model based on moderated regression analysis and its application in express delivery services.

The reason for choosing express service as an empirical object is to consider the following two reasons: There are some literatures [5, 6] use the Kano model to carry out useful explorations on the classification of express delivery service quality elements. To verify the feasibility and effectiveness of the proposed method, it can be compared with the empirical results of the existing literature. Besides, with the rapid development of e-commerce in recent years, the express delivery business has grown dramatically. In 2020, the total domestic express delivery service business totaled 83.36 billion pieces, a year-on-year increase of 31.2%, and the total business revenue was 879.54 billion yuan, a year-on-year increase of 17.3%. But behind the rapid growth of the express delivery business, customer satisfaction of express delivery service quality has declined. From a customer perspective, it is of great practical significance to comprehensively detect the elements of express delivery service quality and improve customer satisfaction.

2. The Kano model

![Figure 1. The basic principle of the Kano model.](image)

The Kano model consists of five different curves, as shown in Fig. 1. Attractive quality element is a quality element that surprises customers and is a product/service quality characteristic that is completely unexpected by customers. If this quality element is fulfilled, it can greatly improve customer satisfaction, if this quality element is not fulfilled, it will not cause customer dissatisfaction. One-dimensional quality element represents the functions and characteristics that customers want for their products. The impact of such quality elements on customer satisfaction is generally linear. Must-be quality elements represents the quality characteristics that must be possessed by the products. Such quality elements will not increase customer satisfaction when it is fulfilled and will result in strong customer dissatisfaction if not fulfilled. Indifferent quality element is the quality characteristics of products that customers do not care about. Reverse quality element is contrary to the characteristic of the one-dimensional element, customers do not want the quality characteristics of products.

Kano et al [1] used a questionnaire that includes questions about functionality and dysfunctional for each element to identify categories of quality. And the frequency for each element is the main basis of classification. The highest frequency represents the dominant customer view.

If a quality element is a must-be quality element, it must ensure that the basic quality characteristics meet the criteria to meet the basic needs of customers. If a quality element is a one-dimensional quality element, the organization should be concerned about how to improve the
criteria to promote the improvement of customer satisfaction. If a quality is an attractive quality element, the organization needs to fully tap, create new quality unexpected by the customer, to achieve customer joy. However, the Kano model is essentially a qualitative analysis method. And the form of the questionnaire is more complicated, which will cause some problems for the customer [2]. the classification criteria of quality elements of the Kano model are relatively subjective.

3. The extended Kano model based on moderated regression analysis

Combined with the research results of Lin [2], to further realize the objective classification of quality elements by the Kano model, an extended Kano model based on moderated regression analysis can be constructed. The moderated effect is to verify the influence of the moderated variable on the independent variable acting on the dependent variable. The performance level of the quality element is set as the moderated variable, and the quality element of the Kano model is divided by the significant characteristics of the regression coefficient. As shown in equation (1):

\[
CS_i = \alpha + \beta_{1j} X_{ij} + \beta_{2j} X_{ij} \times Z_{ij}, \quad \begin{cases} 
1, & X_{ij} < m \\
2, & X_{ij} = m \\
3, & X_{ij} > m 
\end{cases}
\]

(1)

Where CSi is customer's overall satisfaction, Xij is evaluation of customers, Zij is moderated variable, β2j measure the influence coefficient of the moderated effect of Xij and Zij on CSi, β2j≠0.

By designing a Kano questionnaire that contains only the quality element "fulfilled state" customer perception evaluation, to collect the customer's perceived satisfaction when the quality element is fulfilled, using the Likert five-level scale, that is, from "very dissatisfied" to "very satisfied" are assigned from "1" to "5".

Construct the initial regression equation (2), and construct the moderated regression equation (3). Calculate the change of the determination coefficient \( \Delta R^2 \) between the two equations in equation (4). The significance level of \( \Delta R^2 \) reflects the changes in the goodness of fit of the regression equations.

\[
CS_i = a + \beta_{1j} X_{ij}
\]

(2)

\[
CS_i = a + \beta_{1j} X_{ij} + \beta_{2j} X_{ij} \times Z_{ij}
\]

(3)

\[
\Delta R^2 = R^2 - R^1
\]

(4)

Table 1. Quality elements of express delivery service.

| Number | Quality Element                                                                 | Customer revenue          |
|--------|---------------------------------------------------------------------------------|---------------------------|
| f1     | Express point facilities are complete, self pick-up function is perfect          | Convenient and safe       |
| f2     | Perfect transport function for special goods                                   | Safe and convenient       |
| f3     | Express website, official account, and client function are perfect.             | Convenient and fast       |
| f4     | Express personnel uniform and clean and tidy                                   | Cheerful                  |
| f5     | The goods were delivered on time within the prescribed time                     | Convenient                |
| f6     | Pick up at the agreed time and place                                           | Convenient                |
| f7     | After-sales service is handled timely and effectively                          | Fast and value-added      |
| f8     | Quality assurance                                                              | Security                  |
| f9     | Convenient query                                                               | Convenient and fast       |
| f10    | Goods are delivered quickly within the province and in neighboring areas        | Fast                      |
| f11    | Goods in remote areas are delivered within 3 days                              | Fast                      |
| f12    | Courier service personnel are friendly and trustworthy                          | Pleasure and safety       |
| f13    | Express service personnel have skilled professional skills                      | Convenience and safety    |
| f14    | Reasonable Courier charges                                                      | Affordable                |
| f15    | Provide follow-up personalized service for undelivered goods                    | Convenience and safety    |
| f16    | A service that changes order information                                        | Convenient                |
| f17    | Door-to-door delivery service                                                   | Convenient                |
When $\Delta R^2$ is not significant, the difference between the fitting effects of equation (3) and equation (2) on the data is not obvious. In this case, the corresponding quality elements can be divided into one-dimensional quality elements, because the moderated effect does not exist. When $\Delta R^2$ is significant, regression equation (3) with increased moderated effect fits the data better, the moderated effect exists, and the regression equation needs to be tested next.

When $\beta_{2j}>0$, the quality element has a greater impact on overall customer satisfaction at high-performance levels than low-performance levels and average performance levels. Therefore, this type of quality element can be divided into attractive quality elements. When $\beta_{2j}>0$, this quality element has a greater impact on overall customer satisfaction at low-performance levels than high-performance levels and average-performance levels. This type of quality element can be divided into must-be quality elements.

Table 2. The classification result of quality elements.

| Quality elements | Standardized factor load | Cronbach’s $a$ value | $\Delta R^2$ | $\beta_{1j}$ | $\beta_{2j}$ | Categories |
|------------------|-------------------------|----------------------|--------------|--------------|--------------|------------|
| $f_1$            | 0.694**                 | 0.777                | 3.63         | 0.790        | 0.694**      | O          |
| $f_2$            | 0.693**                 | 0.777                | 3.70         | 0.802        | 0.693**      | O          |
| $f_3$            | 0.690**                 | 0.777                | 3.80         | 0.734        | 0.690**      | M          |
| $f_4$            | 0.671**                 | 0.839                | 3.60         | 0.808        | 0.671**      | O          |
| $f_5$            | 0.755**                 | 0.839                | 3.81         | 0.852        | 0.755**      | O          |
| $f_6$            | 0.755**                 | 0.839                | 3.89         | 0.771        | 0.755**      | O          |
| $f_7$            | 0.718**                 | 0.839                | 3.64         | 0.835        | 0.718**      | O          |
| $f_8$            | 0.781**                 | 0.839                | 3.67         | 0.862        | 0.781**      | O          |
| $f_9$            | 0.725**                 | 0.839                | 3.89         | 0.742        | 0.725**      | O          |
| $f_{10}$         | 0.783**                 | 0.839                | 3.83         | 0.784        | 0.783**      | O          |
| $f_{11}$         | 0.720**                 | 0.839                | 3.64         | 0.835        | 0.720**      | O          |
| $f_{12}$         | 0.734**                 | 0.753                | 3.86         | 0.813        | 0.734**      | O          |
| $f_{13}$         | 0.824**                 | 0.753                | 3.73         | 0.846        | 0.824**      | O          |
| $f_{14}$         | 0.721**                 | 0.803                | 3.78         | 0.762        | 0.721**      | O          |
| $f_{15}$         | 0.697**                 | 0.803                | 3.61         | 0.858        | 0.697**      | O          |
| $f_{16}$         | 0.717**                 | 0.803                | 3.71         | 0.833        | 0.717**      | O          |
| $f_{17}$         | 0.711**                 | 0.803                | 3.73         | 0.788        | 0.711**      | O          |

4. An empirical study
Combined with express delivery service, empirical research is carried out along the proposed method.

4.1. The application case
With the SERVQUAL model, references [5, 6], and specific express enterprise practice, the paper gives the elements of express service quality as shown in Table 1 and the benefits provided to customers. The questionnaire design of the Kano model is divided into two parts. The first part is about the demographic characteristics of customers; the second part is about the investigation of express service quality elements, using a Likert five-level scale to investigate the customer's perception and satisfaction level of quality elements, a total of 17 questions.

The respondents of this paper are randomly surveyed from social customer groups, mainly in two forms: online questionnaire survey and face-to-face survey. A total of 262 questionnaires were issued on June 15, 2019 solstice on July 15, 2019. A total of 213 questionnaires were finally recovered, among which 186 were valid and the effective questionnaire recovery rate was 71%. Descriptive statistics were conducted on the humanistic statistical characteristic data of customer survey samples. Reliability and validity of the survey data are analyzed. The standardized factor load values of each service quality element is above 0.5 (0.690-0.824), and the scale had good convergence validity; Cronbach's value of five dimensions of express service is higher than 0.70, and the measurement scale had good internal consistency.
4.2. Classification results of express service quality elements

The classification results are shown in Table 2. The quality elements "Express website, official account, and client functions are perfect (f3)" and "After-sales service timely and effectively handled (f7)", \( \Delta R^2 \) was 0.019 (0.043), 0.024 (0.027), \( \beta_{2j} > 0 \), and the classification results are must-be quality elements. Other quality elements, such as "the express facilities are complete, the function of taking containers by oneself (f1)", "the function of transportation for special goods (f2)", "the uniform and clean clothes of express personnel (f4)", and so on. \( \Delta R^2 \) is not significant enough, the quality elements are divided into one-dimensional quality elements. There are no "attractive quality elements" and "indifference in quality elements".

5. Conclusions

Compared with the results of the previous relevant literature, it is found that the quality element "express website, public account and client function is perfect" along the evolution process of "A→A→M", It can be seen that the development of information technology has a great impact on express delivery services, indicating that customers are increasingly demanding the information level of express delivery services and convenience. The quality elements, such as "courier service personnel are friendly and trustworthy", show the evolution of "I→O→O", which further verifies the professional quality and workability of courier service personnel. Express delivery companies need to combine the cutting-edge technology of logistics to provide professional training for employees, and ensure maximum customer satisfaction. There are no "attractive quality elements" in the classification results of express service quality elements. The reason may be that the express service quality element measurement scale in this article is mainly the service elements provided by the current express delivery company practice, and does not fully consider those potential quality elements that may cause customer surprises and are unexpected. Providing attractive quality elements is a powerful tool for express delivery companies to meet new customer needs and quickly develop new markets.

This paper explores the extended Kano model based on the moderated regression analysis and its application problems. This method can make the classification result more accurate, and the respondents were comfortable with the simple questionnaire design. But, the collection time of empirical data is short, and the scope of questionnaires is limited. What's more, although the empirical object has selected the contact surface wide range of express delivery services, the selection of quality elements does not pay enough attention to new logistics technologies and new models.

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