



Customer Satisfaction Evaluation Method Based on Fuzzy Hierarchy Analysis

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Abstract. Facing the problem of low rate of change of customer satisfaction evaluation methods, a customer satisfaction evaluation method based on fuzzy hierarchical analysis is designed. Optimising the customer relationship management structure, promoting the transformation of customers from willingness to behaviour, calculating the conflicting values and information content of each indicator, constructing a customer satisfaction quadratic model, calculating the combination weights and designing the evaluation method based on fuzzy hierarchical analysis. Experimental results: The mean value of the rate of change of the two indicator measures of the customer satisfaction evaluation method in the paper is: 9.253, indicating that the performance of the designed customer satisfaction evaluation method is more perfect after fully integrating the fuzzy hierarchical analysis algorithm.

Keywords: fuzzy hierarchical analysis · customer satisfaction · evaluation methods · quadratic graphical model · customer needs · loyalty

1 Introduction

The number of customers in any industry is not infinite, but the number of competing businesses is growing, so how to capture them becomes a topic of greater concern for businesses. One dissatisfied customer with a product or service provided by your business will affect an average of over 300 consumers. It is easier to keep an existing customer than to gain a new one, and the loss of a customer is far greater than the gain of a new one. Customer satisfaction is a person in the purchase of a product or enjoy a service, through the personal experience to obtain the feeling and their own heart expectations to make a comparison, resulting in happy or disappointed emotions. If the feeling obtained through personal experience exceeds the expected feeling, the customer shows a high level of satisfaction, even to a very happy state. If the sensations gained from the experience are lower than the expected sensations, the customer shows a state of dissatisfaction. Particularly in a buyer's market, the overall rush for customers has become the main manifestation of market competition, and whether an enterprise

can establish a loyal customer base depends not only on the relationship between the customer and the enterprise, but also on the degree of customer satisfaction with the products and services provided by the enterprise. The more effective an enterprise is, the more competitive it is in the market and the greater its market share, and the enterprise that is able to do so is essentially the result of having its own loyal customer base and a high level of customer satisfaction. For different customers, they may have different feelings about the same goods or the same services, and sometimes the difference is quite large, so the degree of satisfaction generated varies. It is necessary to provide quality products and services according to the needs of customers to achieve a state of customer satisfaction, forming a quantitative analysis and research on the operation of the company.

2 Optimising the CRM Structure

The focus of customer relationship management is to maintain and improve the relationship between the company and its customers from the customer's point of view, in order to attract new customers, retain existing customers and convert existing customers into loyal customers, ultimately enhancing the company's core competitiveness and maintaining the company's performance and profit growth [1–3]. Promoting the transformation of customers from willingness to behaviour, further enhancing the frequency of customer-enterprise transactions, actively eliminating and preventing customer complaints and grievances, continuously improving customer satisfaction and establishing a quality value chain of mutual trust and interdependence between enterprises and customers [4, 5]. Customer satisfaction is a quantitative description of the degree of customer satisfaction, reflecting the extent to which customers actually feel about receiving products and services compared with their expectations. For the first category of customers, i.e. those who examine the services or products on their own, sign a contract with the company and receive the services in accordance with the relevant requirements and after going through the prescribed procedures, the company's senior and middle management and marketing department staff have more dealings with them and will give more maintenance. The company does not currently pay the necessary attention to this group of customers and the necessary customer relationship management.

3 Building a Four-Point Diagram Model of Customer Satisfaction

The measurement of customer satisfaction is a complex system and is a quantitative process that requires the quantification of multiple indicators that influence customer satisfaction during the purchase and consumption of a product or service. According to the principle of the role of fuzzy hierarchical analysis, the data collected from each indicator needs to be normalised first, so that the influence of the scale on the results can be eliminated, using formula (1) for normalisation, as follows:

Customer satisfaction is a subjective feeling of customers, such as the customer's preference for product appearance and color, whether the product space layout is appropriate, etc. These factors are difficult to measure or define with traditional standard tests or precise scales. Therefore, this paper uses fuzzy analysis hierarchy process to reflect

the actual situation more objectively and truly. However, customer satisfaction includes more data types and contents, so it needs to be normalized. In one sentence, normalization is: to limit the data to a certain range after processing. The measurement of customer satisfaction is a complex system and a quantitative process that needs to quantify multiple indicators that affect customer satisfaction during the purchase and consumption of products or services. According to the principle of Fuzzy AHP, it is first necessary to normalize the data collected by each indicator in order to eliminate the impact of the scale on the results. Formula (1) is used for normalization, as follows:

$$M_{ij} = \frac{\eta_{ij}}{\max \eta_{ij}} + \mu^2 \quad (1)$$

In Eq. (1), η indicates the standard deviation of the indicator, μ indicates the covariance of the indicator and i, j indicates the value of the i -th indicator for a company j respectively. The fuzzy comprehensive evaluation method is a method for comprehensive evaluation of the problem. When performing fuzzy comprehensive evaluation, AHP can be used to assign weights to each factor [6, 7]. In addition, the quadratic model belongs to the diagnostic category and is biased towards qualitative level analysis. On the basis of Eq. (1), the conflicting values of each indicator are calculated as follows:

$$D_j = \sum_{i=1}^{\varphi} (1 - \varphi_{ij})^2 \quad (2)$$

In Eq. (2), φ indicates the correlation coefficient between each indicator. The client calculates the score from both the importance of the indicator and the satisfaction level, distributes the factors affecting satisfaction in four quadrants, and the company targets the distribution of these factors to obtain true and accurate results, the quadratic model is shown in Fig. 1.

Customer satisfaction, also called customer satisfaction index. It is the abbreviation of Customer Satisfaction Survey System for Service Industry. It is a relative concept, which is the matching degree of customer expectations and customer experience. In other

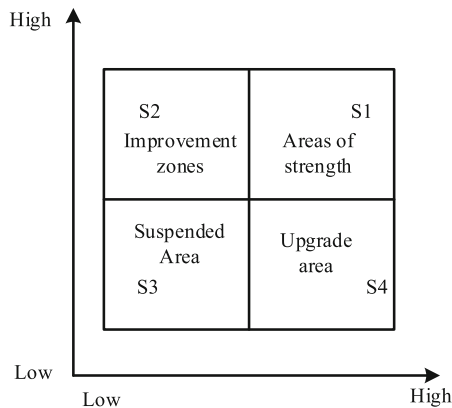


Fig. 1. Customer satisfaction quadratic model

words, it is an index obtained by customers comparing the perceived effect of a product with its expected value. In Fig. 1, the S1 zone (Strengths Zone), for the indicators in the S1 zone, corresponds to factors that are not only critical but also very important for the customer. To do this, calculate the amount of information contained in each indicator:

$$G = \frac{1}{l} \times T_{l-1} \tag{3}$$

In Eq. (3), l indicates the difference in values between the evaluation objects and T indicates the relative benchmark order relationship of the indicators. At the same time, the S2 zone (repair zone), for the indicators in the S2 zone, corresponds to factors that are critical for the customer, and for the time being, most companies have some shortcomings in their treatment of this issue, and customers show dissatisfaction and need to repair and further improve the factors in this zone.

4 Fuzzy Hierarchical Analysis Based Design Evaluation Method

In general, customer satisfaction is defined as a state of mind in which the customer is pleased with the service or service that he or she has received or consumed and with the product or service that he or she had previously expected. In other words, the customer is pleased with the product because the actual experience is better than what was expected. Assuming that the number of independent and dependent variables is known, a sample data matrix for both is derived as shown in Eqs. (4) and (5):

$$P = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1m} \\ p_{21} & p_{22} & \cdots & p_{2m} \\ \dots & \dots & \dots & \dots \\ p_{e1} & p_{e2} & \cdots & p_{em} \end{bmatrix}^{e \times m} \tag{4}$$

$$Q = \begin{bmatrix} q_{11} & q_{12} & \cdots & q_{1n} \\ q_{21} & q_{22} & \cdots & q_{2n} \\ \dots & \dots & \dots & \dots \\ q_{e1} & q_{e2} & \cdots & q_{en} \end{bmatrix}^{e \times n} \tag{5}$$

In Eqs. (4) and (5), p, q represents the independent and dependent variables respectively, e represents the e sample values, and m, n represents the normalised values of the independent and dependent variables respectively. Finally, the evaluation result of the total target is calculated from the bottom to the top according to the affiliation relationship. Then the formula for calculating the combination weight of customer satisfaction is:

$$F = \frac{1}{d} + \phi k \tag{6}$$

In Eq. (6), d represents the linear coefficient, ϕ represents the objective weighted attribute value and k represents the subjective weighted attribute value. And according to the principle of maximum subordination, the result vector matrix of fuzzy hierarchical

analysis is generated. Then the mathematical expression formula for the hierarchy of satisfaction scores:

$$R = H \cdot V^Y \quad (7)$$

In Eq. (7), H denotes the weighted average operator, V denotes the resultant vector matrix and Y denotes the vector dimension. Customers will feel satisfied if the quality of the product (service) they perceive during the actual use of the product is not lower than expected, and vice versa. The customer's expectations will increase according to the level of service provided by the company.

5 Simulation Analysis

In order to ensure that the customer satisfaction evaluation results are objective and effective, the customer satisfaction evaluation method based on combination assignment, the customer satisfaction evaluation method based on neural network, and the customer satisfaction evaluation method in the text are selected for comparison. The corresponding customer satisfaction indicators are first set up and the rate of change of the indicators measured by the three methods is calculated, with the following formula:

$$\Delta L(\delta) = \frac{1}{L(\delta + 1)} - L(\delta) \quad (8)$$

In Eq. (8), L denotes the vector formed by the elements of each row and δ denotes the parameter matrix. Input the relevant element values of the secondary index and the tertiary index into the formula (8). Through the calculation of formula (8), the value of customer satisfaction under different methods is obtained. The rate of change of the measured indicators of the three customer satisfaction evaluation methods was tested in the secondary and tertiary indicators respectively, using customer satisfaction as the primary indicator, and the larger the value, the better the performance of the method. The details are shown in Tables 1 and 2.

As can be seen from Table 1, the highest rate of change in the secondary indicators is in the service quality indicators and the lowest is in the corporate image, indicating that more consideration needs to be given to building the corporate image in the future development strategy of the company. The mean values of the rate of change of the secondary indicators of the customer satisfaction evaluation method in the paper and the other two customer satisfaction evaluation methods are: 9.719, 7.092 and 6.811 respectively.

In Table 2, the mean value of the rate of change of the three-level indicator measures for the customer satisfaction evaluation method in the text is 9.021; the mean value of the rate of change of the three-level indicator measures for the customer satisfaction evaluation method based on the combination assignment is 5.428; the mean value of the rate of change of the three-level indicator measures for the customer satisfaction evaluation method based on the neural network is 5.532.

Table 1. Rate of change of indicators for secondary indicator measures

| Secondary indicators | Customer satisfaction evaluation method based on portfolio empowerment | A neural network-based approach to customer satisfaction evaluation | Customer satisfaction evaluation methods in the text |
|-----------------------|--|---|--|
| Corporate Identity | 6.033 | 5.845 | 9.336 |
| Customer expectations | 5.154 | 7.907 | 8.223 |
| Product quality | 7.915 | 8.136 | 9.254 |
| Quality of Service | 9.331 | 6.248 | 11.306 |
| Cooperation prospects | 7.026 | 5.917 | 10.477 |

Table 2. Rate of change of indicators for Level 3 indicator measures

| Tertiary indicators | Customer satisfaction evaluation method based on portfolio empowerment | A neural network-based approach to customer satisfaction evaluation | Customer satisfaction evaluation methods in the text |
|---------------------------------------|--|---|--|
| General corporate image | 3.369 | 3.748 | 8.134 |
| Ideal expectations | 3.254 | 4.645 | 7.417 |
| Acceptable expectations | 4.481 | 3.310 | 9.451 |
| Price of products | 3.257 | 5.224 | 6.315 |
| Convenience of service | 6.106 | 4.649 | 11.336 |
| Quality of new technology development | 8.978 | 7.711 | 10.548 |
| Reliability | 5.131 | 4.803 | 8.102 |
| Responsiveness | 6.465 | 6.515 | 9.361 |
| Possibility of recommendation | 7.715 | 8.499 | 11.669 |
| Future demand | 5.527 | 6.215 | 7.874 |

6 Conclusion

The article is based on a fuzzy hierarchical analysis method, which allows companies to understand whether and where they are making progress by tracking customer satisfaction levels over time and at regular intervals. On this basis, this paper calculates the longitudinal improvement index of satisfaction. At the same time, the results of this research can be used for further analysis and validation, and can be extended to other industries and fields. The next research focus will be on enriching the customer complaint processing data to produce more accurate findings.

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