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Satisfaction Analysis of Online Shopping Based on Fuzzy Analytic Hierarchy Process

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Abstract. Through collected data from general consumer questionnaire and scored the key degree of influencing factors with 1-9 scale method, we analyse the consumers' satisfaction with software Python about online shopping. Fuzzy analytic hierarchy process (FAHP) is used to score the satisfaction degree of online shopping, and the rationality model is analyzed with the actual data to obtain the fuzzy evaluation model of satisfaction degree of online shopping.In the last several Consumers's reference factors in online shopping were tested, but it is the first time that an exact, parametric, the fuzzy analytic hierarchy process is compared to data.

Keywords. Fuzzy analytic hierarchy process; online shopping; Consumers' reference factors.

1. Introduction

Even the influence of novel coronavirus in China, the network economy has provided a strong guarantee for China's economic growth. According to the 47th statistical report on the development of Internet in China released by China Internet Network Information Center, by the end of December 2020, the number of Internet users in China has reached 989 million, and the number of online shopping users has reached 782 million. Since 2013, China's online retail sales has become the world's largest online retail market for eight consecutive years, and it reaching 11.76 trillion yuan in 2020. Obviously, online consumption has become one of the mainstream consumption patterns, and online shopping has also become a daily shopping habit. In this paper we will use the fuzzy analytic hierarchy process and weight calculation method to study the impact of consumer online shopping satisfaction, so as to provide reliable business advice and guidance for network operators.

2. Design Influencing Index of Online Shopping Satisfaction

As for different reference factors in online shopping, the different consumers will make corresponding determinant which online store they will select. Online shopping order factors have diversity and complexity, so different factors have different emphasis. In

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this paper, the comprehensive factor scoring system is designed reasonably, and AHP method is used to determine the weight of single factor in online shopping. As for us, AHP is used to analyze the influencing factors of online shopping satisfaction, so as to establish a hierarchical structure model.

According to the online shopping characteristics and different concerns of consumers, we determine the main and secondary factors about the degree of influence on online shopping, then establish the corresponding analytic hierarchy model.

The analytic hierarchy process (AHP) model is constructed as shown in figure 1. As for the actual situation, eight evaluation indicators are selected for analysis, including preferential activities, freight insurance, postal packages, official stores, store level, store sales, store evaluation and shopping software.

Figure 1. Hierarchical structure of influencing factors of online shopping order.

3. Hierarchical Fuzzy Model of Online Shopping Order Evaluation

3.1. Determine the Set of Evaluation Indicators

With the hierarchical structure figure showed in figure 1, we established the evaluation Independent Variable index set $X = \{X_1, X_2, \cdots, X_n\}$, where X represents the first, second, and N evaluation indexes respectively.

3.2. Construct the Comparison Matrix of Evaluation Index

With the initial conditions which given in *A*, we can build the comparison matrix.

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \cdots & \cdots & 1 & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nm} \end{bmatrix}. \quad (1)$$

where A is the results of comparing the importance of factor i and factor j, which the relationship is $a_{ij} = \frac{1}{a_{ji}}$.

On the grounds of the data collection, cluster analysis and hierarchical analysis are carried out, and the importance of each pair of 8 evaluation indexes is scored by 1-9 scale method. Then the index of evaluation judgment matrix A is obtained by summarizing the actual evaluation data collected through the internet contribution. where we represent the matrix as follows,

$$A = \begin{bmatrix} 1 & 3 & 3 & 2 & 5 & 5 & 5 & 7 \\ \frac{1}{3} & 1 & 1 & 2 & 1 & 2 & 3 & 5 \\ \frac{1}{3} & 1 & 1 & 3 & 3 & 3 & 2 & 1 \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{3} & 1 & 1 & 3 & 3 & 3 \\ \frac{1}{5} & 1 & \frac{1}{3} & 1 & 1 & 1 & 1 & 3 \\ \frac{1}{5} & \frac{1}{2} & \frac{1}{3} & \frac{1}{3} & 1 & 1 & 1 & 3 \\ \frac{1}{5} & \frac{1}{3} & \frac{1}{2} & \frac{1}{3} & 1 & 1 & 1 & 3 \\ \frac{1}{7} & \frac{1}{5} & 1 & \frac{1}{3} & \frac{1}{3} & \frac{1}{3} & \frac{1}{3} & 1 \end{bmatrix}$$

3.3. Determine the Fuzzy Weight Vector of Evaluation Index

Then, we will Calculate the weight K for each row of the evaluation matrix

$$K_i = \frac{\sqrt[n]{\prod a_{ij}}}{\sum n \sqrt[n]{\prod a_{ij}}}, (i = 1,2,\cdots,n; j = 1,2,\cdots,n) \tag{2}$$

After calculation and data normalization, the weight vector

$$W = \{K_1, K_2,\cdots, K_n\}. \tag{3}$$

of the evaluation index set is generated.

Weight vectors are calculated by Python software, where

$$W = [0.2760448, 0.1655992, 0.1103903, 0.1103903, 0.099376, 0.099376, 0.099376, 0.039446]$$

3.4. Determine the Evaluation Grade and Corresponding Rating Standard

The set of comments

$$V = \{V_1, V_2, V_3, V_4, V_5\}. \tag{4}$$

The rating is divided into 5 grades, with

$V = \{satisfactory, good, average, poor, extremely\ poor\}$.

3.5. Establishing Fuzzy Matrix

Since the fuzzy matrix R is established, then we can use the fuzzy matrix to represent X. Simultaneously, on the basis of the rating relationship of build set of comments, the elements in the matrix are interpreted as the evaluation grade values of each rating index, where

$$R = \begin{bmatrix} R_{11} & R_{12} & \cdots & R_{1n} \\ R_{21} & R_{22} & \cdots & R_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ R_{n1} & R_{n2} & \cdots & R_{nm} \end{bmatrix}. \tag{5}$$

All kinds of evaluation indexes are evaluated by single factor, 8 indexes are judged under the foundation of 5 grades, and the proportion of different grades of each index is

also counted by the software python. The quantitative fuzzy evaluation matrix R of the indexes is:

$$R = \begin{bmatrix} 0.48 & 0.15 & 0.23 & 0.02 & 0.12 \\ 0.49 & 0.12 & 0.24 & 0.05 & 0.1 \\ 0.63 & 0.13 & 0.15 & 0.01 & 0.08 \\ 0.65 & 0.12 & 0.14 & 0.03 & 0.06 \\ 0.38 & 0.25 & 0.21 & 0.06 & 0.1 \\ 0.42 & 0.25 & 0.23 & 0.04 & 0.06 \\ 0.51 & 0.23 & 0.16 & 0.04 & 0.06 \\ 0.31 & 0.25 & 0.26 & 0.08 & 0.1 \end{bmatrix}$$

3.6. Calculation of Evaluation Score

Establish the comprehensive evaluation result vector $B = W \times R$ calculate the score $N = BE^T$ and E as the score of the evaluation level according to the evaluation vector, and set

$$E = [100,\ 80,\ 60,\ 40,\ 20]. \tag{6}$$

The result vector is calculated by Python software:

$$B = W \times R \tag{7}$$

$$N = BE^T \tag{8}$$

$$N = 78.65829514713188$$

The satisfaction score of online shopping is about 78.7. The goods and services sold by the major online shopping platforms are in good condition, which can meet the shopping needs of consumers to a certain extent.

3.7. Verification of Actual Conformity

In accordance with the actual survey from the web survey , results with data collection have prove that the fuzzy analytic hierarchy process (FAHP) model which we build is reasonable. In our data get from the internet, we take all indicators of sub criteria layer as the topic, let consumers evaluate their satisfaction in the past, implement (1-10 points) scoring system, and collect 3159 valid questionnaire data. In order to verify the reliability of the questionnaire, the reliability of the questionnaire was obtained through the reliability analysis of the scale questions, and the progress analysis table was obtained by calculating 8 factors. From the calculated Cronbach α coefficient, the reliability coefficient is 0.956 > 0.9, which indicates that the questionnaire design is reasonable, reliable and reliable, as shown in table I.

Table 1. Reliability Analysis of the Questionnaire

Reliability analysis table		
Sample size	Number of items	Cronbach.αcoefficient
3159	8	0.956

The average value of satisfaction evaluation in the collected data is used as the evaluation index score to get the actual feeling of consumers after online shopping, as shown in table 2.

Table 2. Evaluation Scores of Each Index

Question	Score
Official store	8.43
Store level	7.08
Store evaluation	7.88
Store sales	7.58
Preferential activities	7.32
Freight insurance	7.36
free shipping	8.19
Shopping software	6.72

It can be seen from the table that consumers' satisfaction with online shopping is on the high side, and there is no average score failure evaluation.

4. Conclusion

In this paper, through the data collection of online random survey shopping satisfaction factors, cluster analysis and fuzzy evaluation, we use Python to process the data, then build the fuzzy analytic hierarchy model which is more reasonable for the analysis of multiple influencing factors and different weights, the evaluation model of online shopping satisfaction influencing factors. And Contrast with the data form the web survey, we find the results of the model match the actual shopping situation reasonably with high accuracy. In addition, this model can be extended to the choice of personnel recruitment by enterprises or the choice of different brands by the public, and has a good fit for the study of uncertain factors.

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