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SERVQUAL Model Based Evaluation Analysis of Railway Passenger Transport Service Quality in China

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Abstract: Railway is the backbone of Chinese transportation system, but its poor quality of services for passengers cause complains now and then. This study first analyzed the influencing factors of service quality on railway passenger, and its quality characteristics was also explained, and finally we proposed an evaluation system of service quality on railway passenger transport. Through the statistical analysis and processing of the basic information from survey data from railway station, trains and the official website of the ticket purchase, the evaluation score of question naire was converted into the score in evaluation index system, which was based on SERVQUAL model. Finally, the evaluation index system was applied to the field test, and all levels of indicators and the overall evaluation of railway passenger transport service quality was obtained. The relevant results show that the evaluation model of this study is concise and practical, and the method has certain practicability and promotion value, which is beneficial to the department of management supervision in railway transportation.

Keywords: Railway passenger transport, service quality, evaluation index, SERVQUAL model, passenger satisfaction.

1 Introduction

Railway is the main mode of transportation in China. With the improvement of China's economic level, passengers' perception of service quality is also constantly improving. In the report, China Consumers Association affirmed the achievements of the railway spring transportation passenger service in terms of convenience of ticket purchase, ride comfort, order of entry and exit, convenience of volunteer service and so on. At the same time, the report also pointed out deficiencies in standardized management, software and hardware services, consumer shopping and other issues.

Domestic and foreign scholars have done a lot of research on the quality of passenger service and some intelligent algorithms were also used in the model solution. In the current evaluation index system of railway passenger transport service quality, there is a lack of organic integration of the travel process (before the ride, during the ride, after the

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ride); the evaluation index system is still not perfect enough. The weight of each factor in the evaluation index system has not been given enough attention, and the level of evaluation lacks hierarchy; the characteristics of railway passenger transport service quality are also constantly changing and developing. The progress of the evaluation index system and the current passenger's expectations are insufficient; Specific and detailed evaluation indicators of different parts, stages and levels lack specific case studies. In view of the above deficiencies, this paper summarizes a set of monitoring methods for railway passenger transport service quality under the relevant factors of comprehensive consideration of railway passenger transport service quality, and designs three-level evaluation indicators. The three primary indicators are: passenger station, passenger train, railway ticketing website; safety, comfort, convenience, economy, and punctuality are the five secondary indicators; multiple three-level indicators include: personal safety, baggage safety, ticket pricing, service staff attitude, urban transportation transfer and so on. Based on SERVQUAL model, the paper studies the scoring method suitable for the quality of railway passenger transport service, and expounds the calculation method. Combining with the actual investigation cases, it shows that the monitoring method of railway passenger transport service quality in this study is feasible, reasonable and scientific, so as to evaluate the existing railway passenger transport service quality.

Through the research on the monitoring methods of railway passenger transport service quality, the research results are of great significance for railway passenger transport management departments to improve their service level, to meet the increasing travel demand of railway passengers, to enhance the competitiveness of railway transport in the transport market, and to improve the operation efficiency of the national economy. At the same time, the evaluation of passenger transport service quality is conducive to the supervision and consideration of the daily work of railway departments, finding out the shortcomings of products and services, timely improvement and adjustment, and improving the quality and service level of services.

2 Railway passenger transport service quality evaluation model

2.1 Satisfaction index evaluation

The satisfaction index is measured by the weighted calculation of the score to measure the degree of satisfaction or depth. Customer Satisfaction Index, the CSI, is an economic indicator for measuring customer satisfaction. It is an index obtained by building models and calculations based on customer service quality and enterprise products. China's satisfaction index (CCSI), the subject of CCSI quality evaluation is the user and the quality evaluation is based on the user's needs. According to the research conclusions of marketing and consumer behavior, the paper constructs a rigorous model consisting of seven main indicators: expected quality, perceived product quality, perceived service quality, perceived value, user satisfaction, user complaints and user loyalty to calculate consumer satisfaction index for product use.

2.2 Satisfaction evaluation model

The SERVQUA model is the difference between the quality of service and the expected value of passenger service quality perception and quality of service.

$$SQ = P - E \tag{1}$$

SQ is the quality of service, P is the service perception, and E is the service expectation.

When *SQ*>0, it indicates that passengers' perception of service is higher than service expectation and service quality is high; when SQ=0, it indicates that the passenger's perception of service is equal to the service expectation value, and the service quality is recognized by the passenger; when SQ<0, it indicates that the passenger's perception of service is lower than the service expectation, and the passenger is not satisfied with the service quality assessment.

Basic formula:

$$SQ = \sum_{i=1}^{n} (\boldsymbol{P}_i - \boldsymbol{E}_i) \tag{2}$$

Among them, *SQ* represents the perceived service quality score, *Pi* is the *i*-th factor customer actual experience score (*i*=1, 2, 3, … n), and *Ei* is the *i*-th factor customer expectation Value (*i*=1, 2, 3, ... n).

The perceived service quality obtained from the basic formula is the perceived service level under the condition that five attributes are equally important. But in real life, passengers have different views on the importance of each attribute. Therefore, the weight coefficient of quality of service attributes is introduced, and then a more reasonable SERVQUAL score is obtained by weighted average.

$$SQ = \sum_{k=1}^{3} \boldsymbol{W}_k \sum_{j=1}^{5} \boldsymbol{X}_j \sum_{i=1}^{n} (\boldsymbol{P}_i - \boldsymbol{E}_i) \tag{3}$$

Among them, *SQ*, *Pi*, *Ei* and the above formula have the same meaning, *Xj* is the weight of the second-level indicator, *Wk* is the weight of the first-level indicator, and n is the number of the third-level indicator.

2.3 Index weight calculation model method

The three first-level indicators established in this paper include passenger station, passenger train, and railway ticketing official website. In order to facilitate expression, *Q* is used to indicate the service quality evaluation index system. This paper uses the method of expert matrix to determine the weight, and combines the evaluation system of railway passenger service quality index and the relationship of indicators at all levels. There are three first-level indicators, recorded as: Q = {Q1, Q2, Q3}. There are fifteen second-level indicators, recorded as F = {Q11...Q15, Q21...Q25, Q31...Q35}. The third-level index is marked as H = {Q111...Q114, Q121...Q123, Q131...Q136, Q141, Q142, Q151...Q158, Q211...Q213, Q221, Q222, Q231...Q238, Q241, Q251, Q252, Q311, Q312, Q321, Q341, Q342, Q351, Q352}.

Hire n experts to score the first-level indicators, and obtain n 3×3 matrices to determine the weights of n experts β1, β2, β3,...,βn, comprehensive calculation of the scores of n experts, use the tools such as calculation software and programs to derive the weight of the primary indicator W_{q_i} ($\sum_{i=1}^{3} W_{q_i} = 1, W_{q_i} > 0$).

$$B_i = \begin{bmatrix} b_{11} & \cdots & b_{13} \\ \vdots & \ddots & \vdots \\ b_{31} & \cdots & b_{33} \end{bmatrix} \tag{4}$$

Among them, *Bi* represents the scoring matrix of the *i-th* expert.

To calculate the secondary indicators, the paper takes Q1 as an example and uses Q1 as the research system to score the secondary indicators below the system. In the same way, the paper gets n 5×5 matrices and get the second-level index weights under Q1 is

($W_{q_{1j}} \sum_{i=1}^{5} W_{q_{1j}} = 1, W_{q_{1j}} > 0$), Qij indicator weight is $\omega = W_{q_i} \times W_{q_{ij}}$

$$B_i = \begin{bmatrix} b_{11} & \cdots & \cdots & \cdots & b_{15} \\ \vdots & & & & \vdots \\ b_{51} & \cdots & \cdots & \cdots & b_{55} \end{bmatrix} \tag{5}$$

It is generally believed that the difference between the three grades has little effect on the overall score. Therefore, the weight of the three level indicators is equally important.

A data tool to deal with imperfections and uncertainties-rough set theory was proposed, which can effectively avoid errors caused by subjective factors. In order to meet the operation of classification relationship, only the three-level index and the first-level index are applied to the method in this paper. The relationship between the same dimension indicators will be analyzed below, and the comprehensive weight calculation method of multi-dimensional index is adopted.

Taking the calculation of the routes Q11, Q21, and Q31 as an example, the paper calculates the importance of the attribute $\mathrm{Im}\, q_{ij}$.

which is $\mathrm{Im}\, q_{11}(q_{11}, q_{21}, q_{31})$, $\mathrm{Im}\, q_{21}(q_{21}, q_{21}, q_{31})$, $\mathrm{Im}\, q_{31}(q_{11}, q_{21}, q_{31})$.

Takes Q_{11} as an example to calculate the weight of the underlying attribute:

$$\begin{aligned} \mathrm{Im}\, q_{11} = {} & \mathrm{Im}\, q_{11}(q_{11}, q_{21}, q_{31}) \times W_{q_{21}} \times W_{q_{31}} \\ & + \mathrm{Im}\, q_{11}(q_{11}, q_{21}, q_{32}) \times W_{q_{21}} \times W_{q_{32}} \\ & + \mathrm{Im}\, q_{11}(q_{11}, q_{21}, q_{33}) \times W_{q_{21}} \times W_{q_{33}} + \cdots \end{aligned} \tag{6}$$

Calculate the weight of the first-level indicator attribute, and take the calculation of *Q1* as an example to calculate the importance of the attribute $\mathrm{Im}\, q_i$

$$\mathrm{Im}\, q_1 = \mathrm{Im}\, q_{11} \times W_{q_{11}} + \mathrm{Im}\, q_{12} \times W_{q_{12}} + \mathrm{Im}\, q_{13} \times W_{q_{13}} \tag{7}$$

Similarly, calculate the *Q2* and *Q3* weights. The normalized index weight is $W'_{q_1}, W'_{q_2}, W'_{q_3}$.

It can be concluded that the weight of the three-level indicator in the evaluation index system is:

$$u_{q_{ij}} = W'_{q_i} \times W_{q_{ij}} \tag{8}$$

In this paper, for Qij (Qij, i=1, 2, 3; j=1, 2, 3, ..., n) in set A, X={xi, i=1, 2, 3,. .., m; xi=Qij}, a comprehensive weight evaluation method is used to establish an evaluation system. Each xij score has four levels, and the corresponding scores are [0, 5), [5, 7), [7, 9), [9, 10], representing the four levels of "poor", "general", "good" and "very good". A comprehensive weight set is established in this paper.:

$T=\{t_1,t_2,...,t_3,t_m\}$, $\sum_{i=1}^{m} t_i = 1(t_i \geq 0)$, among them, t_i indicates the importance of the *i-th* indicator.

The paper introduces an expert subjective weight here, $W''_{q_1}, W''_{q_2}, W''_{q_3}$ Combining the research contents of (1) and (2), taking Q1 as an example, W_{q_1} comprehensive weight is:

$$Wq_1 = W'q_1 \times (1-t) + W''q_1 \times t \tag{9}$$

In the formula, t is the subjective opinion, $0 \leq t \leq 1$, and the value of t is closer to 1, indicating that the expert opinion accounts for the greater proportion of the comprehensive weight.

Through the analysis of the expert matrix evaluation method and the comprehensive evaluation method, the weights of the indicators at all levels are determined. Combined with the actual survey of passenger perception, and then according to formula (3), service quality score can be obtained.

Table 1: Secondary indicator weight

Secondary indicators	**Safety**	**Economic**	**Comfort**	**Punctuality**	**Convenience**
Weights	0.3	0.2	0.2	0.2	0.1

3 Case study analysis

The survey selected two different grades of line trains and four different grades of train stations. The sample includes a high-speed rail passenger line (Xuzhou-Shanghai section of Beijing-Shanghai high-speed railway, G117), and a general express line (Shanghai-Changzhou section, Train K1606), a large hub special station (Shanghai Hongqiao Railway Station), a hub transit station (Xuzhou High Speed Railway Station), a large station (Shanghai Railway Station), a general station (Changzhou Railway Station), this investigation time is March 2018, questionnaire survey is the main form of the survey. The questionnaire consists of four parts, the basic information part, the passenger train part, the passenger station part, and the railway ticketing official website. The railway passenger service quality survey was carried out for the passenger line and the station. A total of 605 survey samples were issued, and 555 valid samples were finally recovered. The sample efficiency was 96.35%.

The questionnaire score is combined with the evaluation index system, and the questionnaire survey results are statistically summarized and converted into a ten-point

score, which can be used to obtain the service quality passenger score. The score results are shown in the following table.

Table 2: Secondary indicator evaluation score

Secondary indicators	Safety	Economic	Comfort	Punctuality	Convenience
Score	8.6	7.3	7.9	7.7	7.9

The evaluation of safety reached 8.6 points, indicating that the safety of China's railways has been fully affirmed by passengers. Passengers' evaluation of economics is only 7.3 points, indicating that they are not satisfied with ticket pricing, commodity pricing, and catering pricing indicators. Comfort, convenience, and punctuality are generally evaluated.

$$\begin{aligned} SQ &= (10-8.6)\times 0.3+(10-7.3)\times 0.2+(10-7.9)\times 0.2 \\ &\quad +(10-7.7)\times 0.2+(10-7.9)\times 0.1 \\ &= 2.00 \end{aligned}$$

Convert to a positive score of 8.00 (10 points) or 80.00% (percent), the overall rating is good.

Table 3: First-level evaluation index score

Primary indicator	Passenger station	Passenger train	Purchase ticket official website
Score	7.8	8.1	8.0

The passenger station's comprehensive score is 7.8 points, the passenger train's comprehensive score is 8.1 points, and the ticketing official website's comprehensive score is 8.0 points. Passenger station: Passengers are satisfied with the three indicators of environmental sanitation, safety inspection and service personnel attitude. However, the ticket purchase time at the ticket office is more than half an hour waiting time; the ticket office refunds and changes the ticket, the procedure is slightly cumbersome; at the peak, the number of self-service ticket vending machines is generally insufficient. Passenger trains: Passengers have a good evaluation of train overcrowding and environmental air sanitation. However, passengers are not at ease with regard to the safety of baggage property; the procedures for replenishing tickets are cumbersome; the goods sold in the car are generally considered to be expensive; for train mobile communication devices, the general response signal is not good. In terms of ticketing official website: it is very convenient to return the sign. However, there will be hacking; the peak ticket source is insufficient; there are technical problems in the performance of the ticketing website.

Through analysis, we can conclude:

First, the overall evaluation of the service quality of passenger stations is generally on the upper side. The most obvious problems are the ticket purchase time at the ticket office and the refund and change of the ticket office.

Second, the passenger train service quality is generally satisfactory, and the index evaluation of the high-speed rail passenger line is basically higher than the index evaluation of the express line. However, the average passenger feels that the ticket replenishment process is cumbersome, and the signal in the train is not good, especially for the high-speed rail. For these shortcomings, it is recommended to improve the convenience of the ticket replenishment and upgrade the mobile equipment to strengthen the signal.

Third, the popularity of online ticket purchases has increased, and peak season satisfaction needs to be improved. It should be noted that 76% of the passengers used the ticket rushing software to highlight the contradiction between the supply and demand of the online ticket purchase. It is suggested that the number of network tickets can be appropriately increased and the network ticketing rules can be transparent.

4 Conclusion

This paper proposed a monitoring index system of service quality in railway passenger transport. Through determining the weight of the index evaluation model, the set of procedures for evaluating the quality of railway passenger transport service was established. The railway passenger service quality evaluation index system was applicable to all types of stations and different grades of trains. At the same time, the operation was relatively simple, which allows department of management in railway passenger transportation to facilitate the implementation of the investigation, which had certain practicality and promotion value. The data source for this method was passenger perception, accurate data, and reliable source. This research has both urgency and long-term significance in the context of the continuous expansion of China's high-speed railway operation network and the continuous increase of railway passenger flow.

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