Research on Public Satisfaction of Metro Fare Reform in Wuhan City

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Abstract: Based on the subway fare reform in Wuhan on February 1, 2019, this paper makes an empirical study on the subway satisfaction of the people after the subway fare reform in Wuhan, in order to explore the effect of the reform and the direction of opinion revision after half a year, and further determine the factors that can best affect the subway satisfaction of the people. On the basis of ensuring the reliability of the questionnaire and the rationality of the question setting, this survey uses the survey data to carry out basic descriptive statistical analysis and further satisfaction model analysis. It is concluded that ticket price is not the most important factor to determine satisfaction, and the improvement of comfort and convenience can effectively improve the satisfaction of the public, and put forward targeted improvement suggestions.

1. Introduction

In Wuhan, rail transit is also commonly known as "subway". Since the reform of Wuhan rail transit fare policy on February 1, 2019, people have different comments on the great changes that have taken place in Wuhan rail transit. Among the many evaluations, we find the factors that can best affect the satisfaction through a series of surveys and data analysis.

As an important part of the urban transportation system, subway has developed rapidly in recent years, and plays an important role in the construction of the city. To meet the needs of subway development, subway research from different points is plentiful. Based on the research results of previous scholars, this paper uses the way of quantitative analysis to demonstrate the important factors affecting public satisfaction under the background of fare reform, and finds out the shortcomings of Wuhan subway in management service, supporting hardware and so on. Thus targeted to formulate improvement measures, in order to improve the service level of Wuhan subway, to meet the needs of Wuhan citizens for rail transit.

Public satisfaction is an important basis for testing the service quality of subway operation companies. In the evaluation of passenger satisfaction of Xi'an Metro, Ren Na (2018) expressed many variables involved in subway passenger satisfaction evaluation that cannot be directly observed, such as comfort, safety and so on. Then some clear indicators (explicit variables) are used to measure these latent variables. In the evaluation data analysis, the explicit variables are used to observe the latent variables, and finally the key influencing factors of passenger satisfaction are analyzed. Bausen (2018) believes that the length of business relationship between passengers and subway can only reflect the indicator of loyalty. In order to enhance loyalty, the MTRC must improve the satisfaction level of the major of passengers using rail transit. In the subway satisfaction evaluation link, it mainly focuses on eight links, such as environmental hygiene, information propaganda, equipment and facilities, order and safety, guidance and so on. Zhao Huike, Han Lulu and Zhou Li (2016) set passenger perceived quality, perceived value and passenger satisfaction as satisfaction index system in Changsha subway satisfaction investigation and research, so as to evaluate passengers' overall satisfaction with subway. Liu Meili (2018) uses the ACSI method to determine the customer satisfaction index, uses the Delphi method to determine the weight of the index, uses the fuzzy comprehensive evaluation method to evaluate the subway satisfaction degree, and analyzes the passenger satisfaction degree. So as to provide a reference for the subway to improve the level of passenger service. She combined with the American satisfaction index (ACSI),

passenger satisfaction is determined as the first index, passenger perceived quality, passenger perceived value, passenger complaint, passenger satisfaction, passenger loyalty and passenger expectation as the secondary indicators. Guidance guidelines and other 20 indicators for the third level. Then the weight is given by Delphi method, and finally, the fuzzy comprehensive evaluation is given and some suggestions are given.

Different scholars usually use different methods and evaluation indicators in the evaluation of subway passenger satisfaction, and the conclusion has a certain practical significance. In this paper, on the basis of the thinking and methods of scholars before learning, combined with the actual situation of Wuhan, the general structure RV model is selected, and the public satisfaction scale suitable for Wuhan is found.

2. Problem Description and Research Hypothesis

Wuhan subway fare has been raised since February 1, 2019. As an important part of the urban transportation hub, the decision of fare adjustment has been at the forefront of public opinion. So what is the impact of fare adjustment on the overall satisfaction of Wuhan Metro, and how much impact does it have? What is the most important factor affecting subway satisfaction? After the fare adjustment, is there any fluctuation in the loyalty of Wuhan residents to the subway? Prior to the formal survey, we conducted an interview survey and made the following assumptions:

(1)Several latent variables can pass the reliability and validity test, and on this basis, the structure of the general RV model can be established, and the importance of several latent variables can be judged by the measured coefficient value.

(2)Ticket price has a certain impact on subway satisfaction, but it is related to the service quality of subway, that is, high ticket price should have its corresponding service quality.

(3)This fare adjustment will lead to a decline in loyalty in a short period of time.

3. Model Construction and Data Acquisition

3.1 General Structure RV mode

After referring to the questionnaire design of our predecessors, we worked out our own questionnaire and sent out the questionnaire. At the same time, we drew up an interview report on the quality of the questionnaire, in parks, cafes, offices and other places. The citizens were selected for questionnaire interviews. At the end of the paper, we discuss the results of the questionnaire and the interview results, and finally get the following index system-the satisfaction index system of ticket price reform. The following figure shows the ticket price satisfaction index system.

According to this system, we assume that there is a pairwise correlation between the two variables, and draw the path diagram of the general structural RV model, as shown in the following figure:

Through the Amos program, according to the covariance matrix of each measurement item score, we use the maximum likelihood estimation method to carry on the confirmatory factor analysis. According to the index system, we adopt the general structure RV model. This model contains four latent variables: fare service, convenience and comfort, service management, ticket price reform satisfaction, of which the first three are the prerequisite variables and the latter is the result variable. We looked at the relationship between the result variable and the prerequisite variable by processing the questionnaire of the interviewees. 13 indexes are used as observation variables (a1, a2, a3, b1, b2, b3c1, c2, c3, c4, d1, d2, d3). Among them, the error variables of 13 observed variables (e1, e2,., e13), each path is the load of the factor, and the error variables of the 13 observed variables are the error variables of the observed variables (a1, a2, a3, b1, b2, b3, b2, b3,c1, c2, c4, d1, d2, d3). Represents the magnitude of the variation of the potential variable to explain the observed variable.

Table. 1 ticket price satisfaction index system.

	level 2 index (latent variable)	level 3 index (observation variable)
Fare reform satisfaction	Ticketing service (A)	I think the price of subway is very cheap (a1)
		I think the monthly subway fare is very reasonable (a2)
		I think the variety of subway fares meets the demand (a3) **
	Convenient and comfortable (B)	I think the subway facilities are very convenient (b1)
		I think the subway is very convenient (b2)
		I think the subway environment is very comfortable (b3)
	Service management (C)	I think the subway staff service is in place (c1)
		I think the subway passenger flow is in good order (c2)
		I think the subway travel conditions meet my requirements (c3)
		It is very easy for me to get the subway information I want (c4)
	Satisfaction (D)	I am very satisfied with the subway in general (d1)
		I think Wuhan subway is in line with my ideal subway (d2)
		Even if the subway price goes up, I will take the subway (d4)

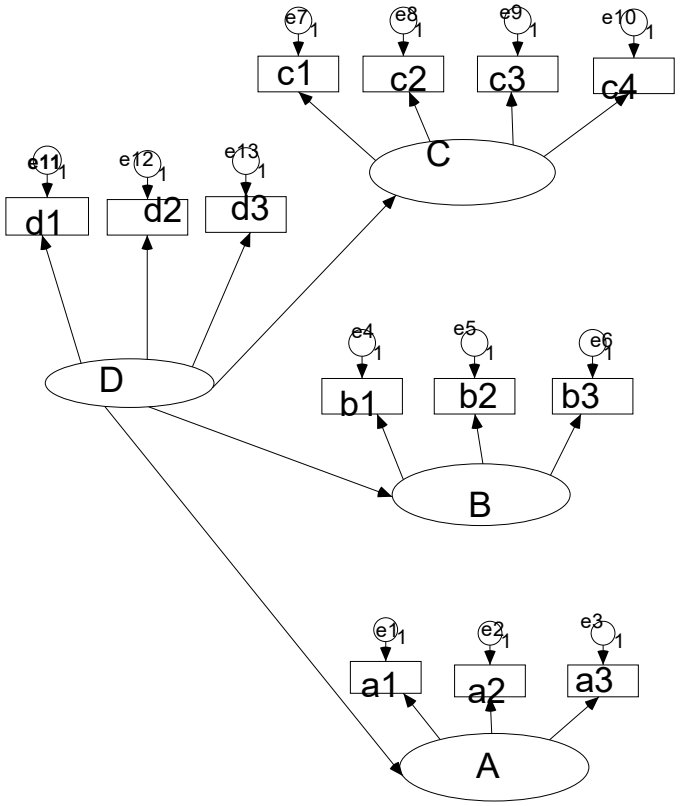

Fig. 1 General structure RV model analysis model path diagram

3.2 Data Acquisition

According to the population distribution of each district registered in Wuhan in 2019, we used the method of stratified sampling and three-stage unequal probability sampling to carry out a sampling survey on the satisfaction of Wuhan subway. The whole survey lasted 3 months, the sample size was 377, and the effective sample size was 345. The scope of the survey was 13 counties and districts in Wuhan. The subjects were resident residents who lived in Wuhan for more than half a year and aged between 18 and 64 years old.

The composition of the sample size is as follows: the ratio of men to women is 51.71% to 48.29%, close to 1:1. The age distribution was 51% between the ages of 18 and 22, 35% between the ages of 23 and 40, and 12% between the ages of 41 and 64. The frequency of taking the subway is mostly less than 10 times a week, accounting for 77% of the total.

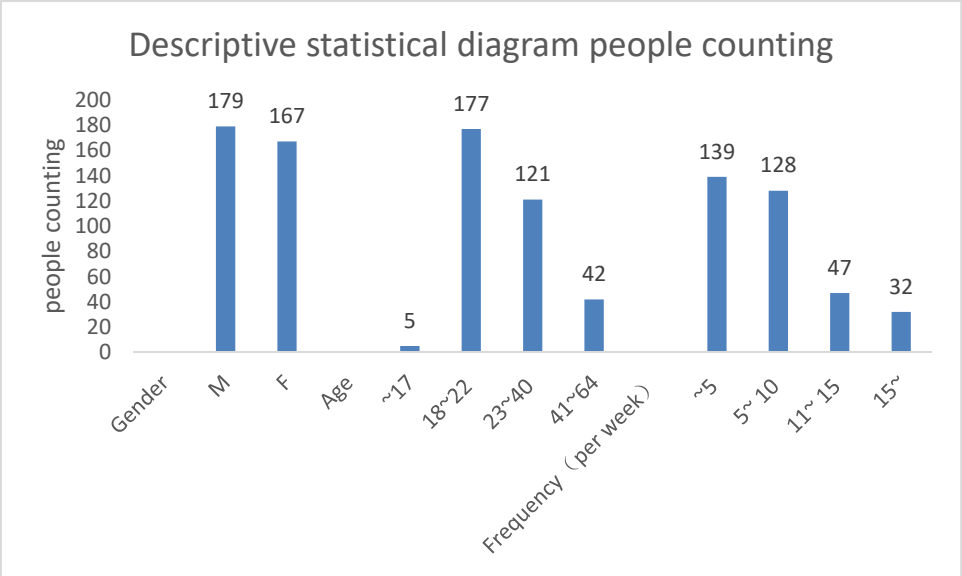

Fig. 2 Descriptive Statistical Diagram

4. Data Analysis

We use the Richter scale to quantify the satisfaction of the public. According to the degree of approval of the respondents, the description of each item was divided into 5 orders of magnitude from very disapproval to very recognition, and was given 1 to 5 points respectively. We sort out the survey questions and extract four secondary indicators, which are fare service, comfort and convenience, service management and overall satisfaction.

Because the direct observation is the third grade index, the 13 third grade indexes cannot directly reflect the distribution of the second class index (a1, a2, a3, b1, b2, b3, c1, c2, c4, d1, d2, d3) as observation variables (a1, a2, a3, b1, b2, c1, c3, c4, d1, d2, d3) cannot directly reflect the distribution of the secondary index. In this paper, the weighted three-level index is used to reflect the second-level index, and the calculation formula is as follows:

$$K_{im} = \sum_{j=1}^{P} x_{ij} y_{ijm}$$

K_{im} represents the number of i secondary indicators with a score of m, P_i represents the number of tertiary indicators contained in i secondary indicators, and X_{ij} represents the standard weight of i secondary indicators and j tertiary indicators. Y_{ijm} represents the I second indicator, the j third indicator, and the number of people with a score of m. Among them, i = 1, 2, 3, 4. m= 1, 2, 3, 4, 5. Weight X_{ij} is the result of factor load standardization. The distribution of the number of secondary indicators obtained is shown in the table below:

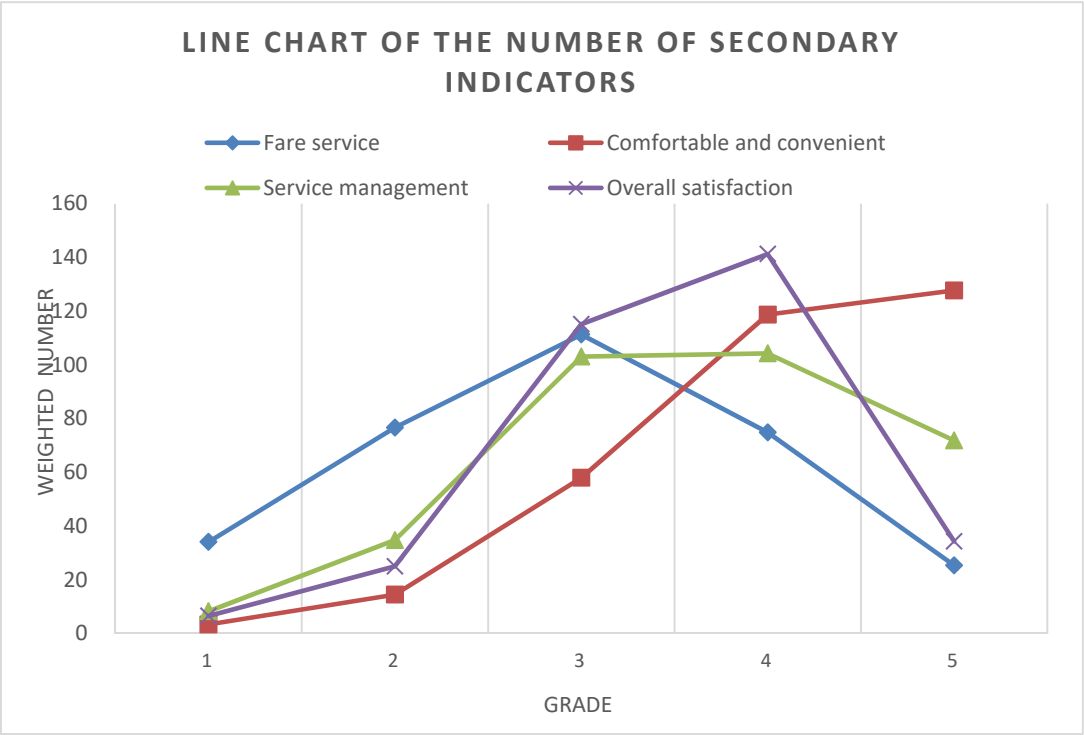

Figure. 3 Line chart of the number of secondary indicators

From the trend of the broken line in the chart, it can be seen that the score of the index of fare service is close to the normal distribution with an average of 3. 5, and the service management and overall satisfaction show a right partial normal distribution with an average of about 3.5, and a comfortable and convenient S-type distribution. From the point of view of the distribution of the number of people, except for the index of comfort and convenience, all other indicators show a distribution of "small at both ends and large in the middle." the average of these three indicators is in the range of 3 to 4, indicating that Wuhan Metro is in fare and service. The overall satisfaction performance is good. On the other hand, the index of comfort and convenience presents S-shaped distribution, and the number of people with 4 points and 5 points is relatively large, indicating that the biggest advantage of Wuhan subway lies in "convenient facilities and comfortable environment". The average value of fare service is the smallest, which means that Wuhan Metro is still insufficient in terms of "subway ticket prices, ticket types".

We divide the questionnaire questions about satisfaction into four aspects, form four latent variables, and place three or four direct observation variables on each latent variable. We choose to construct the general structure RV model through *Amos* software, and extract the index system of satisfaction. And based on the above system to carry out the satisfaction model analysis.

According to the investigation results, the combined reliability of potential variables is as follows: the combined reliability (CR) value of each latent variable is greater than 0.7, and the combined reliability (CR) value is more than 0.5, indicating that the construction reliability of each latent variable is higher. It has good aggregation validity.

Table 2 AVE and CR index results of the model

Latent variable	Average variance extraction AVE value	CR value of combinatorial reliability	Reliability evaluation
Ticketing service	0.819	0.931	good
Comfortable and convenient	0.899	0.964	good
Service management	0.834	0.953	good
Satisfaction	0.880	0.957	good

The factor loads and parameter estimates produced by confirmatory factor analysis show that most of the parameter values are very good. In significant cases, the factor load is more than 0.7, indicating that the quality of the whole verification model is good. The statistical results confirmed the reliability of the preparatory survey before the questionnaire. According to the previous exploratory factor analysis, the KMO value is 0.648, indicating that the validity is acceptable. The Barrett spherical test card value is 168 493, the degree of freedom is 66, the significant P value is less than 0.000, the spherical hypothesis is rejected, indicating that the questionnaire items are not independent, the question setting is valid

Table 3 Model fitting index

Common index	X^2	df	p	Chi-square degree of freedom ratio (X^2/df)	GFI	RMSEA	RMR	CFI	NFI	NNFI
Criterion	-	-	<0.05	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9
Value	264.780	59	0.000	4.488	0.888	0.101	0.108	0.971	0.963	0.961
Evaluation	-	-		Good	Good	Good	Good	Better	Better	Better
Other indicators	AGFI	IFI	PGFI	PNFI	AIC	BIC				
Criterion	>0.9	>0.9	>0.9	>0.9	The smaller the better	The smaller the better				
Value	0.827	0.971	0.576	0.728	11700.962	11823.955				
Evaluation	Good	Better	Good	Good	-	-				

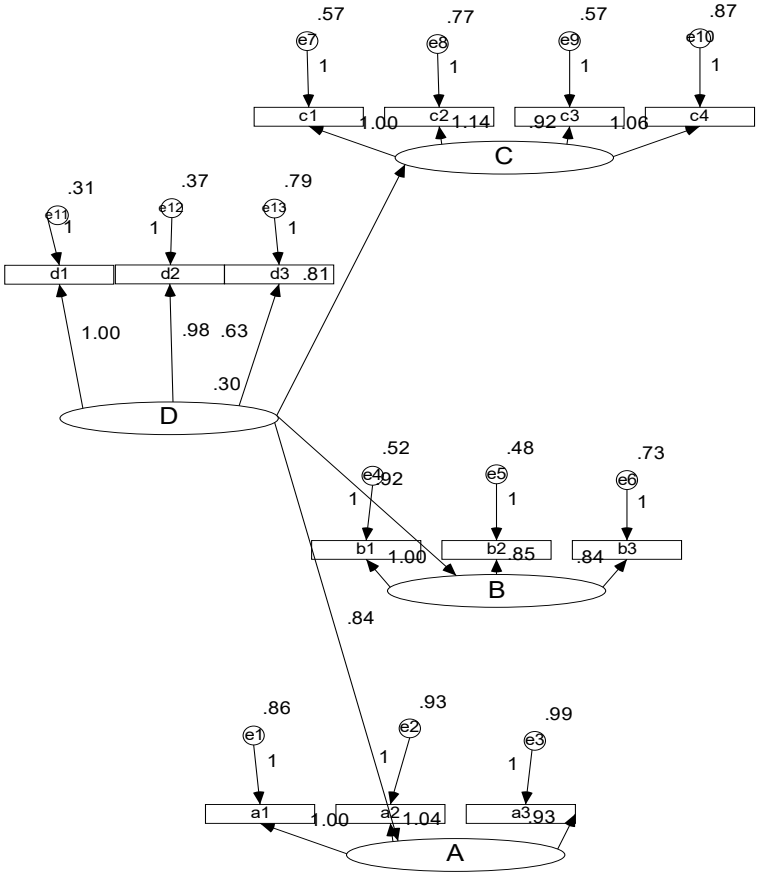

Fig. 4 Analysis path diagram of general structure RV model

The reliability of the questionnaire refers to the consistency and stability of the results of a test. According to the value of standardized regression coefficient (factor load), the reliability coefficient and measurement error of observed variable and primary factor construct validity can be obtained, and the construct validity and average variation extraction value of each potential variable can be obtained.

The analysis path diagram of the general structure RV model is shown in the figure. We first draw the following diagram in Amos, in which each letter represents the same meaning as above, and then we import 345 valid questionnaire data, through Amos analysis, get the correlation coefficient between the following factors. In the graph, we know that the correlation coefficients between A, B, C and D are all greater than 0.85, which shows that the hypothesis of our questionnaire is credible. There is also a strong correlation between A, B, C and D. We can also draw the conclusion that A, B, C can affect D, which also provides a scientific and credible basis for us to make suggestions for Wuhan Metro. From the picture, we can see that: first, the correlation coefficient of passenger satisfaction-fare service is 0.82; second, the correlation coefficient of passenger satisfaction-comfort and convenience is 0.92; third, the correlation coefficient of passenger satisfaction-service management is 0.87. All the above values are higher than 0.85, and the investigation results are good.

5. Discussion of Results

In the general structural RV model, the smaller the correlation index, the lower the degree of influence. From the results of the index, we can know that the most important factor determining satisfaction is comfort and convenience, followed by service management, and finally fare service.

As a potential variable that has the greatest impact on satisfaction, it is a more effective way to improve subway people's satisfaction from the point of view of improving comfort and convenience. If passengers take the subway, in a comfortable and convenient environment, and the basic needs of travel are guaranteed, then the situation of dissatisfaction will be reduced, and the loyalty of passengers to the subway will not be reduced.

The decline of satisfaction caused by the increase of subway ticket price can be balanced by improving its comfort and convenience and improving its service management. Subway operation, if you want to consider whether the fare increase is meaningful, refer to an important evaluation criterion: After the fare increase, can the financial pressure of Wuhan subway be reduced? Therefore, to comprehensively improve the performance-to-price ratio of subway fares is the best way to improve satisfaction when the price increase policy has been introduced.

6. Suggestions for Improvement

6.1 Improve Subway Comfort and Convenience

The fastest way to improve satisfaction is to maintain subway facilities, improve the convenience of public use, and improve the comfort of subway ride. For example, improve the smoothness of the gate and the sensitivity of the ticket vending machine. Increase the number of ticket vending machines, improve the convenience of bill printing, and improve the stability of mobile phone APP in the new era of Metro. The daily repair of the elevator and the sensitivity and safety of the two safety doors in and out of the subway are all effective ways to improve the comfort and convenience of the subway.

The use of big data cloud computing technology, accurate scheduling of vehicle departure time, to achieve seamless connection between transfer stations, reduce passenger transfer waiting time.

Increase the number of direct drinking water equipment and seats at the waiting station, provide open seats for passengers, reduce the burden of travel, increase WiFi coverage, and facilitate the use of free WiFi for passengers.

Reasonable planning of bus stops and shared bicycle placement, reduce walking distance and improve transfer efficiency.

6.2 Improve Service Management

Increase the intensity of propaganda and increase the channels of propaganda. Adopt more diversified ways of self-propaganda, more widely cover the sources of public information, and push the subway information to Wuhan citizens in a centralized and efficient way in a short period of time. The publicity information needs to include charging method, subway use mode, business closing time, subway frequency time and so on. At the same time, it should be integrated into the 3D panoramic introduction of Wuhan subway, so as to facilitate passengers to understand the subway spatial structure and make better use of the subway.

In view of the Spring Festival travel, holidays, students return to school and other special time periods, to improve the efficiency of evacuation. The subway station is located in a corner and in all directions, undertaking the important task of the transportation hub, Due to the internal structure of the MTR, there are a large number of people in some waiting areas and very few people in some waiting areas. This situation has greatly reduced the efficiency of the use of subway stations. If the staff can guide the crowd to areas with fewer passengers in time, it can effectively reduce the degree of crowd congestion and reduce the risk of stampede, slip and other events. All these are conducive to the establishment of a good service image.

In some special moments, for some special people, special times appropriately extend the operation time of the subway. For example, on holidays or weekends, people who often go out early and return home later, the time of subway operation is not very convenient for them. If we can measure the costs and benefits of subway operation in the extended period of time. Combined with the actual demand, adopt a flexible departure schedule, for the subway company, it is also a good way to improve satisfaction.

6.3 Innovative Fare System

Try subway package services, such as monthly, seasonal or annual card systems. Passengers can enjoy an unlimited number of subway trips in a certain period of time.

For the idea of floating fares, we can make reference to the airline ticket floating system, using high fares during the rush hour in the morning and evening, and a low fare system at other times, so as to reasonably balance the flow of personnel in each period of time. Reduce subway congestion and improve service efficiency.

Enrich the types of subway tickets, speed up the implementation of return tickets, for passengers or foreign personnel who do not have traffic cards, directly check the return tickets when buying subway cards. When you leave the station for the first time, do not put the card coin into the card slot, but choose to swipe card coins out of the station. When taking the return subway, take the subway card coin into the station, arrive at the destination and put the card coin into the card slot to get out of the station. Such return tickets can reduce the number of times customers buy subway cards, improve customer satisfaction, and reduce unnecessary queuing time.

7. Concluding Remarks

Through the sampling survey of three-stage unequal probability sampling method, this paper analyzes the influencing factors of satisfaction by using the general structure RV model, and finally draws the following three conclusions: first, the fare is not the most important factor to determine the satisfaction; The second is to improve the comfort and convenience can effectively improve public satisfaction; third, the subway fare increase caused by the decline in satisfaction can be balanced by improving its comfort and convenience and improving its service management.

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