Research of Urban Rail Transit Passengers' Evaluation Index on the Large-Scale Events---Take Shanghai F1 Formula as an Example[1]

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Abstract

For urban rail transit, how to evaluate passenger's satisfaction of security work,, and discover the existing problems quantitatively is an important and indispensable subject for better service level during large-scale events or events. This paper focuses on the passengers' aspect, to do a questionnaire survey during the period of large-scale events, put forward the evaluation index system in order to establish the framework of passenger evaluation index on the large-scale events. It aims to provide some better guidance evaluation for urban rail transit security during large-scale events.

Key Words: urban rail transportation, questionnaire, index system, security work

1Introduction

With the rapid growth of the world economy, the frequency for large and medium-sized city organizing large-scale events is becoming more and more frequent. The conflict between the large passenger flow the large-scale events brings and the originally crowded city is fierce enough to take some measures to relieve the traffic pressure for operation management department. As we know, just rely on building large traffic hardware facilities is not economic and realistic, the only way is to formulate reasonable transport support scheme to ease the contradiction between traffic supply and demand during large-scale events. How to evaluate and optimize the operation security has very important significance for improving the operation management level during the large-scale events.

The paper attempts to combine a questionnaire survey and from the most concerned points of passenger to establish the urban rail transit passengers' evaluation index system on large-scale events.

2The Establishment of Evaluation Index System

In order to make the indexes completely reflect the operation of urban rail transit passenger security work during the large-scale events, the paper insists on seeking truth from facts and people-oriented principle, to do a questionnaire survey to these passenger who anticipate the large-scale events and at the same time take the urban rail transit to provide the basis for passenger evaluation index [1,2,3]. Survey time is set on the moment half an hour after the large-scale events, namely the peak hours of passenger flow; the location of survey is urban rail station platform, the selected passenger who are requested to do a questionnaire survey surely have a deepest feelings to the operation management department's security work[4].

The paper takes the Shanghai formula one (F1) for example to elaborate these index. According to the number of participants in the large-scale events and requirements of the sample quantity, the paper search for 423 passengers to do the questionnaire survey.

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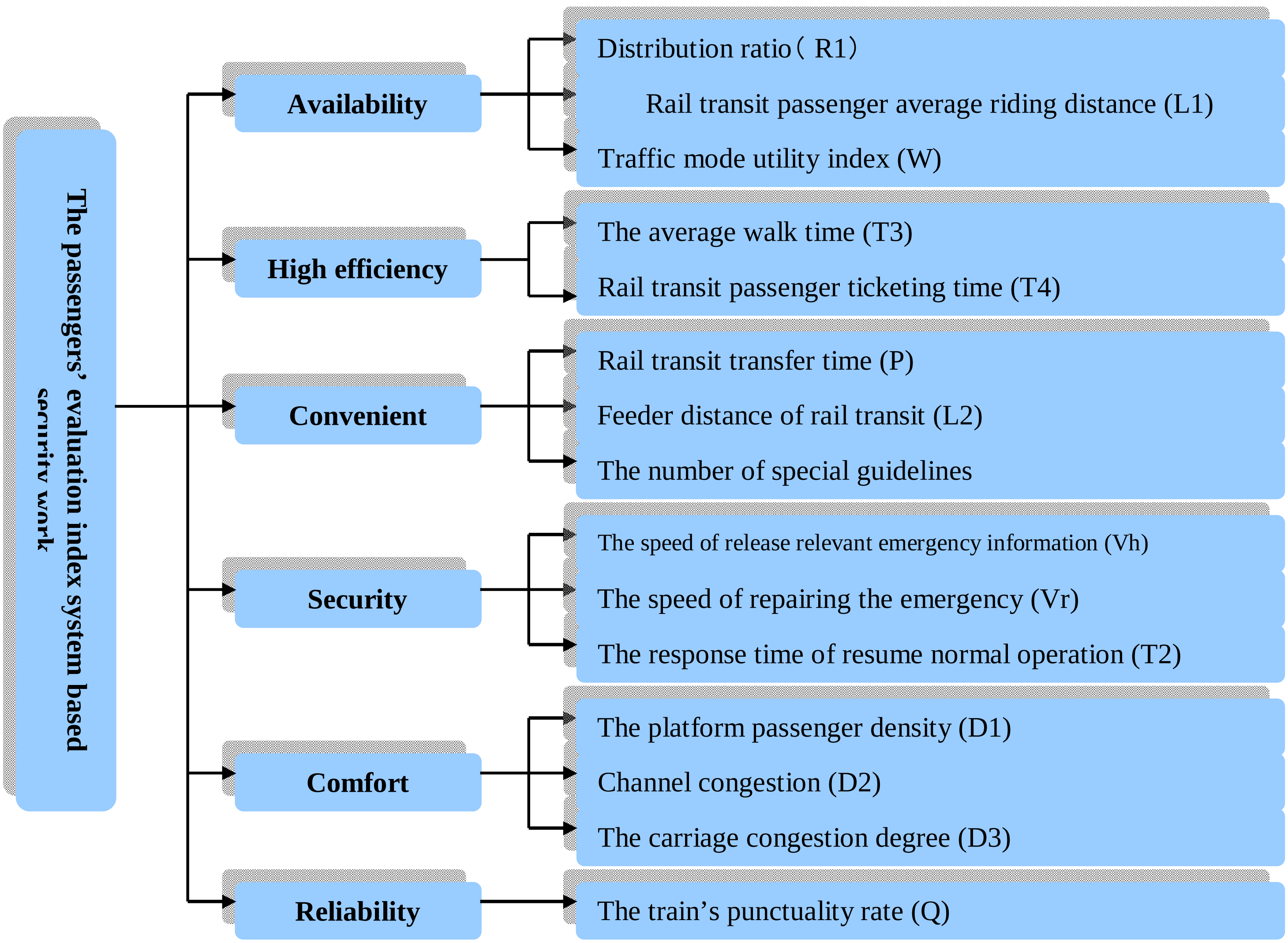
The 295 passengers thought it is necessary to increase the number of the train, in order to increase the speed of passenger transportation, this point is reflected in the availability; 282 passengers argue that the urban rail transit is convenient, so they choose to take the rail transit to the events, which is reflected in the convenience; 157 passengers like the less delay, it is concluded in reliability and high efficiency; 62 passengers consider that the urban rail transit is more safe than other transportation, which is shown in the safety; there are 21 passengers refers to the comfortable, this is explained in comfort. As shown in Figure 1-1, the urban rail transit passengers' evaluation index system of operation security work during large-scale events contains six aspects. It respectively is the availability, convenience, reliability, high efficiency, safety, comfort [5]. Table 1 shows the index system.

Table 1: The Passengers' Evaluation Index System Based Security Work



2.1Availability evaluation

Availability reflects the product's realization of the predetermined function or specified effect [6]. For urban rail transit during large-scale events, its intended function includes distribute high density and large-scale passenger flow, provides a more economical, time-saving, reliable, suitable transportation mode for medium and long distance, to satisfy passengers' diversification and high standards of travel demand[7]. Therefore, the availability includes rail transit distribution rate, rail transit of passengers' average riding distance and mode of transportation utility index.

a. Distribution ratio（R1）: it refers to the ratio of the passengers(A1) who reach (left) the race field and also audience of the events by taking rail transit and the total passengers(A) that anticipate the events on the racing day(April 14, 2013). A1 is the passengers who take rail transit to the race field minus the passengers who take rail transit to the same station on weekdays, the figures can obtain by the Automatic Fare Collection (AFC).

A can be obtained by tournament organizers.

$$R1 = \frac{A1}{A} \times 100\%$$

b. Rail transit passenger average riding distance (L1): it means the average riding distance to the race field by taking rail transit. The paper sorts the top 20 stations according to the number of transported passengers to the station near the events field. The figures can be acquired by analyzing the AFC data.

$$L1 = L_i * \beta, \quad \beta = \frac{A_i}{\sum_{i=1}^{20} A_i}, \quad i = 1, 2 ... 20.$$

c. Traffic mode utility index (W) refers to the reciprocal of the average time multiplied the average cost by taking rail transit to the race field. As we know, smaller W is, more attractive to passengers. The average time and cost can be acquired by weighted average of the top 20 stations. The figures can be acquired by analyzing the AFC data.

$$W = \frac{1}{T1*C}, \quad T1 = T_i * \beta, \quad C = C_i * \beta, \quad i = 1, 2 ... 20.$$

2.2Convenience Evaluation

The convenient evaluation reflects the degree of convenience by taking rail transit during the large-scale events, such as F1. This includes the passengers' transfer times by taking rail transit, the feeder distance between the station and the stadium entrance, the number of special guidelines for the events.

a. Rail transit transfer time (P) refers to average transfer time by taking rail transit to race field. The average transfer time can be obtained by transfer times' (Pi) weight average from the selected top 20 stations to the race field. The figure can get by combining AFC data and line graph. The less transfer times are, the more passengers it attracts.

$$P = \sum_{i=1}^{20} P_i * \beta, i = 1, 2 ... 20.$$

b. Feeder distance of rail transit (L2) means the service coverage radius of rail transit station (Shanghai Park) entrance to the arena entrance. It reflects the degree of convenience by taking rail transit to the race field. The data need to be measured.

c. The number of special guidelines for the events means the number of the guide mark specifically for the F1 event. In general, the guide mark is not either the more the better or the less, the ideal state is labeled with the least guide, and make the maximum passengers to the on-site events. It can not only reduce the workload of rail transit staff, but also save cost.

2.3 Reliability Evaluation

Reliability evaluation reflects the ability of completing the expected functions under stipulated conditions or within the specified time. It mainly means the train's punctuality rate.

a. The train's punctuality rate (Q) refers to the ratio of the punctual arrived train (Qp) and the total operated train (Qt) according to a predetermined train time scheme during the event. The index statistics can be obtained by the urban rail transit operation department.

$$Q = \frac{Q_p}{Q_t}$$

2.4 Security Evaluation

Rail transit with its large capacity, high degree of automation, closed space characteristics, is high reliability, but fragility, especially during a large-scale events, high density and large scale of passengers demand brings challenges to the rail transit operation.

From the point of passengers' view, the safety index refers to the operating release relevant emergency information, the speed of repairing the emergency and the response time of resume normal operation.

a. The speed of release relevant emergency information (Vh) means the average speed from the emergency happen to its known to passengers. Vhj is the speed of each speed of release relevant emergency information.

$$V_h = \frac{\sum V_{hj}}{j}, \quad j = \text{the times of emergency.}$$

b. The speed of repairing the emergency (Vr) refers to the average repairing speed from the emergency happen to its resume to normal. Vrj is the speed of each speed of repairing the emergency.

$$V_r = \frac{\sum V_{rj}}{j}, \quad j = \text{the times of emergency.}$$

c. The response time of resume normal operation (T2) refers to the time from the operational emergency happen to restore to the normal operation function. The index is the rate of the all emergency response time (Tj) together and the times of emergency (j).

$$T2 = \frac{\sum T_j}{j}, \quad j = \text{the times of emergency.}$$

2.5 Comfort Evaluation

Comfort evaluation contains the rate of sitting passenger, the congestion in the train, environmental temperature and other factors. Large passenger flow characteristics of large-scale activity determined that the comfort is mainly reflected in the degree of congestion levels, including the congestion of station platform, the pedestrian from the export of race field to the station and train.

a. The platform passenger density (D1) refers to the maximum number of standing passengers on one unit area of station platform during the peak hours during the large-scale events.

$$D1 = \frac{D_s}{S}$$

b. Channel congestion (D2) refers to the ratio of the number of passed passengers (Dp) on the bottleneck channel between venues from export to the rail station platform and its designed passing capacity(Dd) during the large-scale events.

$$D2 = \frac{D_p}{D_d} * 100\%$$

c. The carriage congestion degree (D3) refers to the ratio of the actual passengers (Da) of carriage and the designed capacity (De) on the peak period during the large-scale events.

$$D3 = \frac{D_a}{D_e} * 100\%$$

2.6 High Efficiency Evaluation

High efficiency is the efficiency for passengers to take rail transit; efficiency is mainly focus on the time from the race field walk to station entrance and step to the train for passengers on the peak hours during the large-scale events. So this part includes the walk time for passengers to walk from the race field to station entrance and the time of purchase ticket which contains the queuing time.

a. The average walk time (T3) refers to the time passengers spent from the race field walk to the station entrance on the peak hours after the end of the events. It includes the simple walk time (Tw), limiting queuing time (Tq), and congestion delay time (Tc).

$$T3 = T_w + T_q + T_c$$

b. Rail transit passenger ticketing time (T4) refers to the queuing time (Tu) to purchase ticket and the time (Tt) to purchase ticket on the peak hours during the large-scale events. From the view of passengers, the less time, the better.

$$T4 = T_u + T_t$$

3 Determine the Weight

The weight of index determines the accuracy of evaluation results. Considering the special event of urban rail transit operations security work, in general, just one scheme is chosen to implement among many schemes, so it is not realistic to evaluate each security work after implement. Therefore, this paper selects the method suitable for single security work assessment. Here, the paper chooses the improved analytic hierarchy process (AHP) to determine the weight of each index, using fuzzy comprehensive evaluation method to judge the operation security work during the large-scale events.

3.1 The Improved AHP

The members of expert group give the relative important degree according to the important degree matrix, using the improved analytic hierarchy process to calculate the weight [8,9].

The important between B_i and B_j	equal	Little important	important	Very important	Absolutely important	Intermediate values
B_{ij}	5/5	6/4	7/3	8/2	9/1	5.5/4.5,6.5/3.5,7.5/2.5,8.5/1.5

The weight vector of judgment matrix obtained by each expert is called expert individual weight vector, denoted as $U=(U_1,\ U_2,\ \ldots,U_m)$, $U_i=(U_{i1},U_{i2},...,U_{in})$, U_{ij} is the weight of the expert i evaluation to the index j, m is the number of the expert, n is the number of the index. The weight vector of each expert processes the cluster analysis. According to the results of cluster analysis, by some calculations, respectively to determine the weight of each expert, then multiply the above two weight to acquire the relative weight between any two indexes.

3.2 Fuzzy Comprehensive Evaluation

The establishment of fuzzy evaluation matrix R:

$$R=\begin{bmatrix} R_1 \\ R_2 \\ \cdots \\ R_q \end{bmatrix}=\begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} & \cdots & \gamma_{1n} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} & \cdots & \gamma_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \gamma_{q1} & \gamma_{q2} & \gamma_{q3} & \cdots & \gamma_{qn} \end{bmatrix}$$

q is the number of comment, γ_{ij} means the degree for index j belonging to the review i. Fuzzy evaluation set includes five level, respectively is not very satisfied, not satisfied, general, satisfaction, much satisfaction, the corresponding weight is 0.1, 0.3, 0.5, 0.7, 0.9.

The weights established by improved analytic hierarchy process multiples the evaluation matrix R is the evaluation result B, then normalization the B can get the final evaluation result.

4 Conclusions

Evaluation of a large-scale event's urban rail transit operational security work is a complex work, which involves three stakeholders, including passengers who are the operational security work experience directly, operators who carry out the operational security work, and government. For operators and government, it is particularly important to assess the security work by standing on the passengers' position. It is the best and direct way to find insufficient of security and do some relative improvements. This paper aims to provide a framework and method for urban rail transit security work during the large-scale events or activities.

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