SPACE DEMAND OF HIGH-SPEED RAILWAY TICKET HALL BASED ON INTERNET TICKET BOOKING

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ARTICLE DETAILS

ABSTRACT

As the railway ticket booking on internet becomes popular, the demand for physical ticketing has reduced sharply, which leading to redundancy in the ticket office. With the background of internet ticket booking, tickets fetching has become the main function of high-speed railway ticket hall, and physical ticketing, self-service ticketing and refunding service have become the auxiliary function. With the service functions considered as multiple M/M/1 service systems, based on the queuing theory, the number of service counter, which can be used to calculate ticket hall space, could be calculated backward from peak hours' passenger flow. A case study with a 10,000-peak -hour-flow shows that the maximum space of ticket hall is 70.2% of the current one and minimum is the 48.4%. Therefore, this research has significance on space utilization improvement of high speed railway ticket hall.

1. INTRODUCTION

Since the "Medium and Long-term Railway Planning" was promulgated in January 2004, a large number of high-speed railway projects were under construction and put into operation. By the end of 2015, Chinese high-speed railway operation mileage has reached 19,000 km. At the same time, high-speed rail travel demand was released, passenger traffic increased year by year. From 2007 to 2014, the total number of high-speed train passengers to send 3.16 billion people, accounting for the proportion of the total volume increased from 4.8% to 38.5%.

To meet the needs of travel ticket purchase, China Railway Passenger Service Center in 2011 to operate 12,306 website. The site can be achieved online booking, payment, refund, change sign and other functions, the official railway ticket into the network era. During the Spring Festival in 2014, the railway sector to make further adjustments to the way ticket, an increase of smart phones 12306 official APP applications, and authorized Alipay online settlement fare and other new initiatives. Statistics show that during the Spring Festival in 2016, the network ticket sales volume has reached 60% of the total. In the context of the development of network ticketing, high-speed railway passenger station ticket office window of a large-scale manual vacant phenomenon. How to make efficient use of the high - speed railway ticketing hall space and reduce the wastage of passenger station resources is of great theoretical and practical significance for improving the economic benefits of high - speed railway.

2. Problems in ticketing office of high - speed railway passenger station in china

2.1 The first design then has the specification

China's high-speed railway network plan was promulgated in 2004. The first high-speed railway opened in 2008. Although China's "Code for Design of Railway Passenger Station Buildings" promulgated in 2007 (in 2011 to do a minor revision of the norm, but did not modify the ticket office part) [1]. However, according to the design and construction process of the railway project, it can be deduced that the design of the ticket office of the high-speed railway passenger station is earlier and the specification has not been able to guide the design of the ticket hall of the high-speed railway passenger station.

2.2 Ticket office design has not fully considered the changes in the way ticket sales

With the China Railway Passenger Service Center 12306 site put into operation, the application of mobile client APP, the Internet ticketing policy tilt. And the Internet ticketing convenient payment, change, refund and other characteristics, the Internet ticket sales counted for more than 60% of the total ticket sales, ticket sales beyond the window to become the largest way. In the past during the Spring Festival, the crowded scene of the ticket office no longer exists, while the code is still the traditional window-based ticket, supplemented by automatic ticket design can not meet the diversification of ticket sales development. In addition, the Beijing-Tianjin inter-city, Beijing-Shanghai, Wuhan-Guangzhou high-speed railway lines have been achieved brush ID card travel function, and further eliminate the need for tickets to the ticket office space scale needs to further reduce.

2.3 The ability of different ways of service in the ticket office is not uniform

In the code, the manual ticket booking is mainly based on the window, and the design of the ticketing hall, which is supplemented by automatic ticket sales, has decided to set up a large number of manual ticketing windows, using traditional manual ticket sales. With the development of the Internet ticketing, ticket office there a lot of self-help ticket demand, the current capacity of the ticket office layout is not suited to the development of the current Internet ticketing situation. Site research shows that during the spring season, the length of the Internet self-service ticket device has exceeded the ticket window, and appears to the artificial ticket window to take the Internet booking phenomenon. In addition, the research on the new high-speed railway passenger terminal in Tianjin, Jinan, Wuhan, Guangzhou, Xi'an and other places found that, with the network of ticket sales, the vacancy phenomenon of the manual ticket window is very serious.

3. Analysis on the Service Function of Ticketing Office under the Background of Ticket

Internet ticket sales to the high-speed railway passenger station ticket office are mainly reflected in its service function changes and service

process compression. Tickets before the implementation of the network, the main ticketing hall using the traditional way of manual booking, passengers do not know when the expected date of purchase, trips more than votes and seats, need to repeatedly communicate with the conductor can purchase the required tickets. In the settlement, whether it is cash or credit card, will take a long time to complete. Traditional manual ticket sales process is shown in Figure 1.
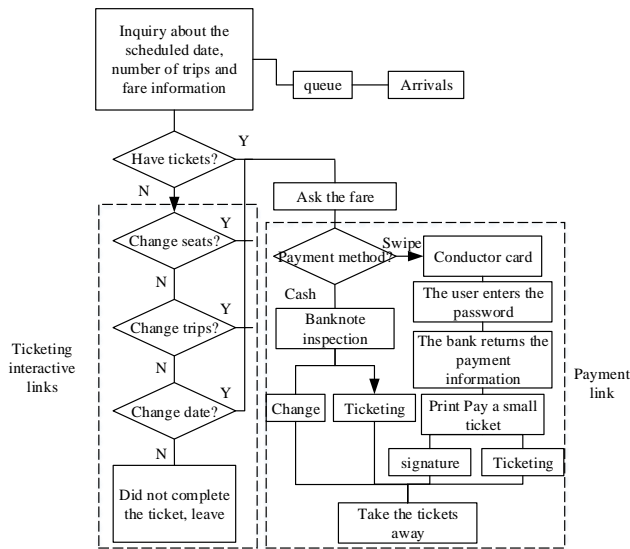

Figure 1: Ticket Office traditional manual ticketing process

For the traditional manual ticket, the most time-consuming is the user booking trips without the interaction link with the conductor, followed by the payment link.

In the spring, Golden Week and other ticket peak period, a large number of users to buy the same date, the same train tickets, one-time ticket success rate is often low. Artificial window ticket efficiency will be greatly affected, as well as appear in the Spring Festival, National Day Golden Week and other travel ticket peak period ticket office crowded state.

Ticketing is different from the ticket office. Internet ticketing tickets will be more time-consuming interaction and payment links scattered to the user's computer, mobile phone, the user to complete the online booking and payment, just before departure to the ticket office to get tickets. Therefore, the Internet ticketing, the ticket office a large number of ticket service needs. Using self-service ticket collection process is shown in Figure 2.
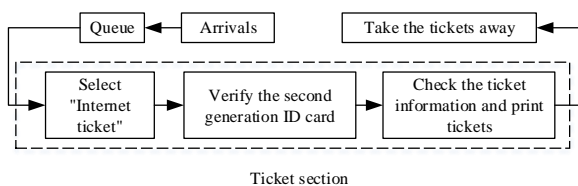

Figure 2:Self-help ticket handling process

By comparing Figure 1, Figure 2, can be seen in the context of ticketing network, the functions of the ticket office and operating processes have changed from the more time-consuming manual ticket-based shift into efficient self-help ticket-based. Greatly simplifies the operation, greatly increase the operating efficiency, and the operation process without human intervention, easy to use self-service equipment. The change of business function and operation process of the ticket office will bring about the new change of the space demand. Although the predecessors have done a lot of research on the ticket office [2-6], they have not considered the significant influence brought by the ticketing network. Some studies have not adapted to the new development situation.

In addition, with the completion of the future high-speed railway network, a substantial increase in transport capacity, the passenger market will be "seller's market" to "buyer's market"; convenient way to improve the competitiveness of the market is an important factor.

Railway management has begun to ticketing services from the station ticket office extended to the subway station, shopping malls, supermarkets and other places. Passenger station ticket office in the future as the railway

sector for the non-Internet ticketing, it can not use self-service equipment and other special populations to provide services to the place, its size will be further reduced.

4. Calculation Model of Space Scale for Ticketing Office of High - speed Railway Passenger Station

4.1 Analysis on the Influencing Factors of Ticket Space Size

The size of the ticket office space depends mainly on the peak hours of the station to send the amount of different ways to sell ticket sales, ticket office services and service levels. Among them, the peak hourly delivery volume refers to the maximum number of passengers per day in the peak hours of the maximum number of passenger arrivals per year. This is China's current high-speed railway passenger station ticket office design used by the main parameters, which determines the station during peak hour's ticket and ticket demand scale.

Different ticket sales method determines the ticket sales service speed. The function of the ticket office determines how many types of service windows or facilities should be set up in the ticket office, and the service level determines how many ticket windows or equipment are required to meet the peak queue length less than the set value. At present, the railway mainly is Internet (including mobile APP), the station window, self-service ticket machines, telephone booking, outlets and other five kinds of ticket sales. Among them, the Internet ticketing and telephone booking needs to the station window, self-service ticket machines, and outlets for tickets.

In these five kinds of ticket sales, the outlets located in the station, do not take up the station ticket hall space; telephone booking due to shorter ticket time, the user usually choose near outlets, off-site self-service sale (take) Close to the ticket, do not take up ticket hall space; Although the Internet ticket sales process will be transferred to the station, but most passengers still need tickets. As a certain service charge to take a ticket outside the station alone to take a longer time to take the station, the majority of passengers usually leave the station when the arrival of the ticket, which tickets the ticket office capacity needs. To this end, most of the stations set up a special Internet ticket self-service terminal. In summary, the ticket office for the main source of tickets for the Internet ticketing users, the window manually purchase users, self-service station ticket users and users to change back. Each ticket way and its demand to the ticket hall is shown as in Fig3.
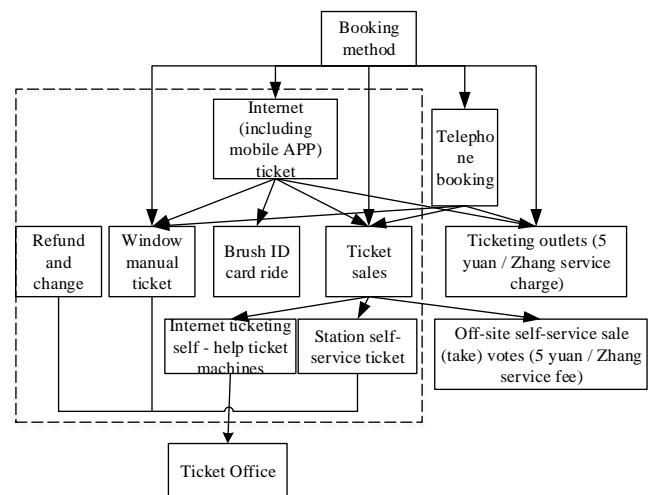

Figure 3 Ticketing Office needs of different ways of booking

In theory, the ticket office can be seen by a variety of services, each service has multiple service stations, multi-service, multi-queue composed of special queuing model. In the same service mode, when a queue is short in the same service queue, the other queues can wait for the customer to exit the queue and change to the queue. However, the peak arrival rate is high, and the shortest queue is selected. The probability is smaller. Therefore, the ticket office can be approximated as a plurality of service systems. According to the customer arrival distribution, service time distribution and set the service level to counter the introduction of different ways to sell the window or the number of devices, and then calculate the space requirements of the ticket office space.

4.2 Calculation Model of Ticket Office Space

Model assumptions: After the customer arrives, chooses the shortest

queue corresponding to the service according to its purpose, once enters the queue until the service completes, halfway does not leave, and the customer does not change the queue in the middle of the queue.

Reference design code, ticket office in the design to meet the peak hours to send the amount of conditions, the number of customers queuing does not exceed the set value, namely:

$$L_s = \frac{\lambda_i}{\mu_i - \lambda_i} \leq L_s^s \qquad (1)$$

Get:

$$\lambda_i \leq \frac{L_s^s \cdot \mu_i}{1 + L_s^s} \qquad (2)$$

Based on peak hourly delivery, λ_i can be obtained from the following equation:

$$\lambda_i = \frac{Q_p \varphi_i r_i}{60 s_i} \qquad (3)$$

(3) Into the formula (2) obtained:

$$s_i \geq \frac{Q_p \varphi_i r_i (1 + L_s^s)}{60 L_s^s \cdot \mu_i} \qquad (4)$$

Take the minimum Q value; calculate the size of the ticket office space:

$$T_s = (L_s^s \cdot L_p + B_c) \cdot B_p \cdot (\sum s_i) \qquad (5)$$

In the formula, L_s is the average captain, L_s^s is to set the captain, λ_i for the i type ticket arrival rate (person / min), L for the S-type ticket arrival rate (person / min), μ_i for the i type of ticket sales unit time service (person / min), Q_p is the passenger station peak hour sending volume (person), φ_i is the proportion of the i type ticket sales. s_i is the number of service stations for the type i ticket, T_s is the ticket hall area (m^2), L_p is the customer standing length (m), B_c is the reserved channel length (m), and B_p is the service desk width (m).

5. Case Analysis

A high-speed railway station, the design of long-term peak hours can send the amount of 10,000 people. There are 84 artificial ticket windows and 40 self-service ticket machines, with an area of 2901.6m^2. The negative exponential distribution of the window is 0.97 *person / min*, and the average time is 1.49 *person / min*. The self-service ticket is 0.85 *person / min*. Negative exponential distribution, self-service ticket machine obey 2.73 *people / min* negative exponential distribution. The customer arrives subject to the Poisson distribution and other parameters are taken from the design specification.

Taking into account the 2016 Internet ticket sales accounted for 60.1% of the total ticket sales [7]. Assuming 70%, 75% and 80% of the Internet ticket sales in the future, the proportion of the tickets in the station ticket booths is 70% and 90% respectively. Taking into account the context of the development of the Internet ticketing outlets and telephone booking business is shrinking, and self-service equipment in the subway station, shopping malls, supermarkets and ticket sales to the station to extend the growth factor. Assuming the future outlets, telephone booking and off-site self-service ticket share of a total of 7%, 8%, 9%. Assuming that the demand for refund service is 1%, the proportion of self-service ticket purchase will be kept at 5%. Respectively, calculate the proportion of different Internet ticket sales and tickets under the ticket office, the number of service desks, function area and the size of the ticket office. As shown in Table 1 and Table 2.

Booking method	proportion (%)		Number of service desks	Functional area (m2)
The Internet	70%	70%	32	748.8
		90%	41	959.4
Station window	18%		33	772.2
Station self-help	5%		11	257.4
Back / change	1%		2	46.8
The Internet	75%	70%	34	795.6
		90%	44	1029.6
Station window	12%		22	514.8
Station self-help	5%		11	257.4
Back / change	1%		2	46.8
The Internet	80%	70%	36	842.4
		90%	47	1099.8
Station window	6%		11	257.4
Station self-help	5%		11	257.4
Back / change	1%		2	46.8

Table 1: The number and area of service counters in different ticket offices and ticketing stations

Internet ticket sales	70%		75%		80%	
	70%	90%	70%	90%	70%	90%
Ticket Office Size ($10^3 m^2$)	1.825	2.036	1.615	1.849	1.404	1.661
Contrast with original design (%)	62.9	70.2	55.6	63.7	48.4	57.3

Table 2 Tickets for different Internet ticketing and station under the ticket office area

From Table 1, Table 2 can be seen, with the network ticketing, high-speed railway passenger station ticket office functions from the original manual window ticket-based Internet-based ticket. With the increase in the proportion of the Internet ticket sales, station ticket office is also gradually reduced in size. It is suggested that the railway management department should consider the development trend of ticketing network and reduce the space scale of the ticket office reasonably so as to improve the economic benefits of the high-speed railway passenger station.

For medium and small high-speed railway passenger station, the need to consider the quality of the differences in passenger groups and other factors, appropriate adjustments to the network ticket and self-service sales, the proportion of votes. You can refer to the method of this paper, according to the actual situation to determine their reasonable ticket space requirements.

6 Conclusions

Based on the study of the space scale demand of ticket office in the high-speed railway passenger station under the background of ticketing network, we draw the following conclusions:

(1) There are high-speed railway passenger station ticket office after the first standard design, the ticket office design can not fully take into account changes in the way ticket, ticket sales between different capacity inequality issues;

(2) In the context of network ticketing, the service function of the high-speed railway ticket office is changing from the traditional window to the Internet self-service ticket collection, simplifying the operation process and operating more efficiently.

(3) Peak hourly period has the characteristics of high customer arrival rate and small queue replacement probability. The service functions of the ticket hall can be regarded as multiple M / M / 1 queues, and the number of service stations is calculated according to the queue length. Ticket Office Space Size;

(4) A peak hour to send the amount of 1 million high-speed railway stations as an example. Calculate the proportion of different Internet ticket sales, tickets from different stations under the ticket office space scale. With the increase of Internet ticket sales, 70% of the ticket office space occupied 70% of Internet ticket sales, 80% of Internet ticket sales accounted for 70%, 70% of the ticket of 48.7%, a more pronounced decline. For small and medium-sized high-speed railway passenger station, the factors such as the differences in the quality of passenger groups should be taken into account, and the proportion of network ticket and self-sale tickets should be adjusted appropriately. The reasonable ticket space requirement should be determined according to the actual situation.

It is expected that with the further development of the network of ticket sales and the layout of the self-service ticketing equipment in the subway stations, shopping malls and supermarkets, the ticket office will become a place for Internet ticketing, non-Internet ticketing and self-service ticketing. , Ticket office space will be further reduced.

Acknowledgements

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