Research on Optimization of Passenger Flow Organization in Passenger Transport Stations during Peak Period

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Abstract. In the situation of the rapid development of railway transportation and the growth of people's travel demand, how to improve the transportation capacity of railways under the existing conditions has become a serious problem for railway passenger transportation in China. In view of the characteristics of large passenger flow density and complex composition during the peak period of railway stations, this paper starts from the passenger flow organization during the peak period of the passenger station, optimizes the railway passenger flow organization measures and improves the passenger transportation service quality. Finally, the queuing model is established. Through the combination of the theory and the actual situation of Nanchang Station, the passenger flow organization method adapting to the peak demand of Nanchang Station is finally obtained, so as to achieve the goal of passenger traffic safety and efficiency increase during the peak passenger flow.

Keywords: Passenger flow organization optimization, Passenger streamline, Peak period, Queuing theory.

1. Introduction

China has always attached great importance to the impact and support of the transportation industry on the national economy for a long time, and vigorously developed the rail transit industry, especially the comprehensive construction of several large speed and high-speed railways, bringing China's rail transit industry into a new high-speed era. Along with the rapid development of China's society and economy, the people's living standards are also constantly improving. At the same time as the rapid development of China's railways, the demand for travel is becoming more and more difficult to meet. How to improve the transportation capacity of railways under existing conditions has become a major problem for railway passenger transportation in China.

Fig. 1 National railway operating mileage

The railway passenger station is the passenger-sending node of the railway line. It is a place where passengers gather and flow in large quantities. The main task is to organize passengers to get on and off safely, quickly and orderly, and provide passengers with tickets, waiting, transfer and other activities[1].
The passenger station in China has a wide range of problems, such as complicated and unsatisfactory working procedures, poor design of station streamlines, and insufficient configuration of passenger transportation facilities or insufficient scientific and technological content. Especially in the peak period of passenger traffic, the problem is particularly serious. How to effectively deal with the contradiction between the tight capacity and the huge volume of traffic, and the passenger journey is safe, orderly, comfortable and fast when the peak passenger flow is completed. A difficult situation in front of the railway management department.

2. Research on Passenger Flow Organization of Railway Passenger Station

2.1 Passenger Flow Organization

2.1.1 Passenger Flow Organization Process

From the passengers arriving at the station square by other means of transportation, the passengers will terminate when they take the train. The passenger flow in this period is a typical inbound passenger flow. For ordinary passengers, the pit stop process is as follows:

![Fig. 2 Inbound flow chart](image_url)

Compared to the inbound passenger flow, the outbound passenger flow is simple and clear. It begins with a passenger taking a train to get off at the station and ending at the moment the passenger leaves the square in front of the station. In general, the outbound process is as follows:

![Fig. 3 Outbound flow chart](image_url)

2.2 Problems in Passenger Flow Organization.

1. The ticket checking process is complicated and the method is backward.
   At present, China's railway passenger station still continues the way of centralized ticket checking before driving. Most new stations and a few old stations are equipped with automatic ticket gates, and most old stations still use manual ticket checking. Compared with the automatic ticket checking machine, the speed of manual ticket checking is slow and inefficient, and it is easy to form queues and congestion of inbound passengers.

2. The station is not closely connected to other modes of transportation.
   Some of the stations that were built in the early days are generally located in the urban area, and a fixed commercial circle has been formed around them. Some stations are not connected enough with other modes of transportation. It is necessary to walk a long distance to the station entrance or exit hall, so that the distance and path of passengers are unreasonable[2].

3. Passenger flow guide sign blur
   Most of the passenger stations built in China in the early days have the phenomenon that the passenger flow guidance signs are blurred. When they arrive at the square in front of the station, causing the number of passengers to increase and the walking path to be extended. Increases the intersection of passenger flow lines, greatly extending the passenger's stay time.
3. Passenger Station Streamline Analysis

3.1 Streamlined Organization Principle

The railway passenger station is a distribution center for a variety of streamlines, and is a place for passengers to collect and transfer transportation modes and routes. There are many kinds of streamlines in the passenger station, and the passenger flow has the characteristics of large volume and concentration, unbalanced passenger flow and multi-directional dispersion[3].

1. Take the passenger flow line as the leading factor and try to prevent the mutual interference between the various streamlines. Railway passenger stations should separate multiple streamlines when organizing streamlines.

2. The passengers should be minimized to avoid the crowding and queuing of the passenger flow.

3. The railway passenger station is the distribution center for passengers. It needs to concentrate the passenger flow in different directions to a point, and it needs to disperse the passenger flow in the passenger station to different places. Therefore, there are two completely opposite streamlines in the railway passenger station. When designing the flow line of the passenger station, the two stream lines should be spatially separated to avoid cross interference and ensure the efficiency of the passengers at the railway passenger station.

4. When designing the streamline, the railway passenger station should meet the requirements of simplicity, directness and smoothness. Under the conditions of passenger equipment capacity and passenger flow of the passenger station, the continuity and regularity of the streamline should be guaranteed to provide a direct, fast channel accelerates the time it takes to assemble or dissipate. Avoid confusion at the station due to complex, tortuous streamlines.

3.2 Resolving the Streamline of Railway Passenger Station

1. Physical cutting
   (a) Split the streamline on the same plane
   After a reasonable arrangement of the station house and passenger transportation facilities, the various streamlines are staggered in the same plane to achieve the goal of resolving. At the peak of the passenger flow, you can also use the fence to artificially divide the passenger flow.

   ![Fig. 4 Plane shunt diagram](image)

   (b) Split the streamline from space
   Through the two-layer spatial structure, the inbound streamline and the outbound streamline are spatially divided, the inbound passenger flow passes through the upper layer, and the outbound passenger flow passes through the lower layer, which can be used for most railway passenger stations with double-layer structure.

   ![Fig. 5 Spatial shunt diagram](image)

   (c) Mixed use of plane and space segmentation
The plane and space segmentation method is used to divide the passenger's access points into the second and underground floors of the station, and the first floor serves as the entrance and exit for passengers entering and leaving the station.

Fig. 6 Mixed split flow diagram

(2) Crossover method
The crossover method is to adjust the ticketing window, the bus station and other facilities to cross the streamlines generated in the station or in the square in front of the station to the square in front of the station or outside the station to reduce the intersection of the streamlines.

(3) Source control method
The source control method is to control the flow of the streamline, reduce the passenger flow arriving at the same time, and make the passenger flow more evenly distributed over time to achieve the purpose of dissolving the streamline[4].

4. Queuing Optimization Model

4.1 Division of Passenger Flow Lines
The passenger flow line is the process of passengers entering the ticket office to purchase tickets/picks, and then entering the waiting hall through the check-in and check-in at the entrance. From the point of view of the pit stop process, passengers can be divided into two stages: ticket purchase/voting and check-in ticket security. Passengers' ticket purchase/ticketing can be divided into manual ticket sales window ticketing/tick ticketing and automatic ticket vending machine ticketing/voting according to different equipment. Therefore, we can roughly divide the passenger's inbound streamline into three categories:

(a) First streamline: Station square → Manual ticketing window → Security check → Waiting hall
(b) Second streamline: Station square → Ticket vending machine → Security check → Waiting hall
(c) Third streamline: Station square → Security check → Waiting hall

Fig. 7 Passenger flow line division diagram
4.2 Variables Setting

Make the following assumptions about the passenger's pit stop process:

(1) Passengers arrive in a single way and arrive at a Poisson distribution with an average arrival rate of $\lambda (\lambda > 0)$.

(2) The probability of passengers selecting three streamlines is $x_1$, $x_2$, $x_3$, and $x_1 + x_2 + x_3 = 1$.

(3) The number of security checks is $S_0 (\geq 1)$, and the service time of each passenger is independent of each other, and obeys the fixed length distribution with the parameter $D (> 0)$.

(4) The number of manual ticketing windows and ticket vending machines are $S_1 (\geq 1)$ and $S_2 (\geq 1)$, respectively, and each passenger's service time is independent of each other and obeys the negative parameters $\mu_1 (> 0)$ and $\mu_2 (> 0)$ index distribution.

(5) The queuing rules are FCFS, and the system capacity is infinite, and passengers who leave after ticketing/voting are not considered.

4.3 Modeling

Passengers who choose different ways of entering the pit will have different waiting times. Next we will analyze the waiting time of passengers according to different passenger flow lines.

(a) First streamline

First streamline is composed of a manual ticketing window and a two-stage service station of the inbound ticket gate. The manual ticket window service desk can be regarded as [M/M/s]: $[\infty/\infty/FCFS]$ queuing system, which stipulates that each service station works independently and the service rate is the same, and $\rho_1 = \frac{x_1 \lambda}{s_1 \mu_1}$. According to the reference[5], When $\rho_1 < 1$, the system will not be queued in an infinite queue. By $\sum_{n=1}^{\infty} P_n = 1$, the probability that the captain of the service ticket window can be obtained:

$$ P_n = \left\{ \begin{array}{ll} \frac{x_1^n \lambda^n}{\mu_1^n n!} P_0 & 1 \leq n \leq s_1 \\ \frac{\lambda^n}{\mu_1^n s_1! s_1^{n-s_1}} P_0 & n > s_1 \end{array} \right. $$

(1)

Probability of system idle:

$$ P_0 = \left[ (\sum_{n=0}^{s_1-1} \frac{x_1^n \lambda^n}{\mu_1^n n!}) + \frac{1}{s_1!} \left( \frac{1}{\mu_1} \right)^{s_1} \left( \frac{1}{1-\rho_1} \right) \right]^{-1} $$

(2)

Passenger waiting time in the queue:

$$ W_{q_1} = \frac{x_1 \lambda s_1 \rho_1 P_0}{\mu_1 s_1 (1-\rho_1)^2} $$

(3)

In the formula:
- $\mu_1$—— The service rates
- $\lambda$—— The average arrival rate of passengers
- $x_1$—— The probability of passengers selecting First streamline
- $s_1$—— The number of manual ticketing windows
- $P_1$—— The probability that the captain of the service ticket window

The manual ticket window service desk will output a Poisson flow with the parameter $x_1 \lambda$, which will enter the inbound ticket gate service desk for service. Since the three streamlines will pass through the inbound ticket gate service desk, the waiting time of the inbound ticket gate service desk will be analyzed and discussed in third streamline.

(b) Second streamline

The second streamline is composed of a ticket vending machine and a two-stage service station of the inbound ticket gate. The ticket vending machine service desk can be regarded as [M/M/s]: $[\infty/\infty/FCFS]$ queuing system, which stipulates that each service station works independently and the service rate is the same. When $\rho_2 = \frac{x_2 \lambda}{s_2 \mu_2}$ and $\rho_2 < 1$, the system will not be queued infinitely. By $\sum_{n=1}^{\infty} P_n = 1$, the probability that the captain of the service at any time can be obtained.
Probability of system idle:

\[ P_0 = \left( \sum_{n=0}^{s_2} \frac{x_2^n \lambda^n}{\mu_2^n n!} + \frac{1}{s_2!} \left( \frac{\lambda}{\mu_2} \right)^{s_2} \left( \frac{1}{1-\rho_2} \right) \right)^{-1} \]  

Passenger waiting time in the queue:

\[ W_{q_2} = \frac{x_2 s_2 \lambda^2 \rho_2 P_0}{\mu_2^3 s_2! (1-\rho_2)^2} \]

In the formula:

- \( \mu_2 \) — The service rates
- \( x_2 \) — The probability of passengers selecting Second streamline
- \( s_2 \) — The number of ticket vending machines
- \( P_2 \) — The probability that the captain of the service

The manual ticket window service desk will output a Poisson flow with the parameter \( x_2 \lambda \), which will enter the inbound ticket gate service desk for service.

(c) Third streamline

The three streamlines will enter the inbound ticket gate service desk with a Poisson flow of \( x_1 \lambda \), \( x_2 \lambda \), \( x_3 \lambda \), respectively, so the inbound ticket gate service desk can be regarded as [M/\( \infty \)/\( \infty \)/FCFS]Queueing System. It is stipulated that each service station works independently and the service rate is the same, and \( \rho_3 = \frac{\lambda D}{s_0} \). According to the literature [6], when \( \rho_3 < 1 \), the system will not be queued in an infinite queue. The probability of passengers in the service desk can be obtained.

\[ P_n = e^{-\lambda D} \frac{(\lambda D)^n}{n!} \sum_{k=0}^{s_0} P_k + \sum_{k=n+1}^{s_0+n} P_k \frac{(\lambda D)}{(n-k+s_0)!} \]

Average waiting time of passengers in the team:

\[ W_{q_3} (i) = \sum_{n=0}^{k s_0-1} Q_{k s_0-1-n} e^{-\lambda (k D - \lambda)} \frac{(\lambda (k D - i))^n}{n!}, \quad (k-1)D \leq i \leq kD \]

In the formula:

- \( D \) — The service rate
- \( n=0,1, \ldots \), and \( \sum_{n=0}^{\infty} P_n = 1 \)

5. Optimization of Passenger Flow Organization based on Nanchang Station

5.1 Nanchang Station Overview

There are two squares in Nanchang Station and a large number of passengers in the West Square. The pedestrian-level distribution square is planned in front of the ground floor station building, which is convenient for people to collect and distribute. In the West Square, there are 10 inbound ticket gates, 6 real-name verification gates, and a ticketing hall with 23 ordinary ticket windows and 1 barrier-free window. There is an automatic ticket collection office next to the ticketing hall, including 10 ticket vending machines and 22 automatic ticket vending machines, but the automatic ticket vending machines 17-22 are distributed separately and the number of users is small. Located directly opposite the West Square of Nanchang Railway Station is the East Square of Nanchang Railway Station, which will serve as an auxiliary square. East Square will build a second-floor station on the east side of the railway. The main body is the waiting room, the second floor connects the inbound...
passage to the platform, and the underground floor connects the outbound passage to various vehicle parking lots. In the West Square, a ticketing hall is set up, which contains 18 ticketing windows, 12 ticket vending machines, and 3 inbound ticket gates.

5.2 Current Situation and Problems of Passenger Flow Organization in Nanchang Station

5.2.1 Nanchang Station Passenger Flow Line Status

(1) West Square floor plan and passenger streamline

Fig. 8 Nanchang Station West Square Streamline

(2) East Square floor plan and passenger streamline

Fig. 9 Nanchang Station East Square Streamline

(3) Outbound passenger streamline

After getting off the bus, passengers can choose to go to the East-West Square according to their destination. After exiting via the cross-line tunnel, if they leave the station in the direction of West Square, they can change the taxi directly on the basement level according to the logo, or pass the ladder and automatically.

5.2.2 Analysis of Existing Problems

(a) Passengers entering and leaving the square before the station

Nanchang Station West Square has two entrances and one exit, but the two entrances are generally used as exits, and the exit is too remote and is only a small revolving door, and the number of users is small. As many passengers want to leave the square in front of the station, they often pass through the entrance. When the passenger flow is large, the passenger flow leaving the square in front of the
station will greatly hinder the passenger's inbound stream, reducing the passenger flow at the station. Organizational efficiency.

(b) Passengers entering and leaving the station

The ticket hall and ticket vending machine of Nanchang Station West Square are set on the right side of the square, while the two entrances of Nanchang Station West Square are set on the left and below of the square. Obviously, after the ticket purchase/voting is completed, the passengers will gather in the middle of the pit stop to prepare for the pit stop, and the passengers who have just arrived will enter the station square through two entrances, and go to the ticket/tick or directly station. The ticketing/tick-collecting passengers are completely opposite to the inbound passengers, forming a convection that prevents the two streamlines from obstructing each other.

(c) East Square traffic connection problem

The layout of the square in the East Square is well-separated. The two-story structure separates the inbound and outbound passengers, making the passenger streamline simple and smooth, with no cross passenger flow. However, due to the short construction period of the East Square, there are intermittent and inconsistencies in the connection with other modes of transportation. The lack of access to the East Square by passengers has limited the diversion of the East Square.

5.3 Streamline Optimization

(1) West Square Streamline Optimization

The main problem in West Square is the direct contradiction between the ticket office and the automatic ticket machine setting and the entrance to the square in front of the station. Since the passenger's drop-off area is adjacent to the two entrances, the two entrances are not adjusted, and the ticket office and the ticket vending machine are moved to the left side of the square. The optimized passenger inbound streamline no longer has obvious cross-interference, and the function of the entrance and exit is clarified, so that the passengers can get in and out more smoothly, and there will be no congestion due to someone going backwards.

(2) East Square Optimization

The problem with the East Square is that the construction time is short and the construction of other ancillary facilities is incomplete. Therefore, as soon as possible, the East Square will build a corresponding bus, taxi or even the stop of the subway near the square in front of the station, and improve the connection problem of the East Square.

5.4 Queuing System Optimization

At the peak period, the queuing phenomenon in Nanchang Station was serious, especially during the Spring Festival travel season. The average daily traffic volume of Nanchang Station was as high as 100,000 person-times. In order to alleviate the queuing phenomenon of Nanchang Station and find the bottleneck of the check-in of the inbound station, 8 optimization schemes were set up. The optimization plan and the initial state are analyzed and compared to seek the optimization direction of Nanchang Station.
Table 1. Nanchang station optimization plan (numbers)

<table>
<thead>
<tr>
<th>schemes</th>
<th>Manual ticket window</th>
<th>Ticket vending machine</th>
<th>Inbound ticket gate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34</td>
<td>44</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>37</td>
<td>44</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>34</td>
<td>48</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>34</td>
<td>44</td>
<td>21</td>
</tr>
<tr>
<td>5</td>
<td>37</td>
<td>48</td>
<td>19</td>
</tr>
<tr>
<td>6</td>
<td>37</td>
<td>44</td>
<td>21</td>
</tr>
<tr>
<td>7</td>
<td>34</td>
<td>48</td>
<td>21</td>
</tr>
<tr>
<td>8</td>
<td>37</td>
<td>48</td>
<td>21</td>
</tr>
</tbody>
</table>

The arrival of the passenger flow obeys the Poisson distribution. They are subject to the fixed length distribution, the negative exponential distribution and the negative exponential distribution respectively. The parameters are defined for the service, and the values, parameter meanings and values are defined. Show in Table 2.

Table 2. Parameters and values

<table>
<thead>
<tr>
<th>parameter</th>
<th>Value</th>
<th>unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \lambda )</td>
<td>4166.7</td>
<td>Person per hour</td>
</tr>
<tr>
<td>( D )</td>
<td>220</td>
<td>Person per minute</td>
</tr>
<tr>
<td>( \mu_1 )</td>
<td>30</td>
<td>Person per minute</td>
</tr>
<tr>
<td>( \mu_2 )</td>
<td>60</td>
<td>Person per minute</td>
</tr>
<tr>
<td>( x_1 )</td>
<td>0.3</td>
<td>——</td>
</tr>
<tr>
<td>( x_2 )</td>
<td>0.6</td>
<td>——</td>
</tr>
<tr>
<td>( x_3 )</td>
<td>0.1</td>
<td>——</td>
</tr>
</tbody>
</table>

Average waiting time for manual ticketing windows and ticket vending machines.

\[
W_{q_1} = \frac{x_1 t_1}{\mu_1 s_1 (1 - \rho_1)^2}
\]  \hspace{1cm} (9)

\[
W_{q_2} = \frac{x_2 t_2}{\mu_2 s_2 (1 - \rho_2)^2}
\]  \hspace{1cm} (10)

Average waiting time for inbound ticket gates.

\[
W_{q_3} (i) = \sum_{n=0}^{kD} q_{kD-n} e^{-\lambda(kD-i)} \frac{(\lambda(kD-i))^n}{n!}, \quad (k-1)D \leq i \leq kD
\]  \hspace{1cm} (11)

Total average waiting time.

\[
W_q = 0.2W_{q_1} + 0.6W_{q_2} + W_{q_3} (i)
\]  \hspace{1cm} (12)

Calculate the above 8 schemes by software MCQueue [7].

Table 3. Average waiting time for passengers under 8 options (min)

<table>
<thead>
<tr>
<th>schemes</th>
<th>Manual ticket window</th>
<th>Ticket vending machine</th>
<th>Inbound ticket gate</th>
<th>Total waiting time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.304</td>
<td>0.271</td>
<td>2.507</td>
<td>2.9562</td>
</tr>
<tr>
<td>2</td>
<td>0.118</td>
<td>0.271</td>
<td>2.507</td>
<td>2.6953</td>
</tr>
<tr>
<td>3</td>
<td>1.304</td>
<td>0.040</td>
<td>2.507</td>
<td>2.8176</td>
</tr>
<tr>
<td>4</td>
<td>1.304</td>
<td>0.271</td>
<td>0.139</td>
<td>0.5886</td>
</tr>
<tr>
<td>5</td>
<td>0.118</td>
<td>0.040</td>
<td>2.507</td>
<td>2.5567</td>
</tr>
<tr>
<td>6</td>
<td>0.118</td>
<td>0.271</td>
<td>0.139</td>
<td>0.3277</td>
</tr>
<tr>
<td>7</td>
<td>1.304</td>
<td>0.040</td>
<td>0.139</td>
<td>0.4500</td>
</tr>
<tr>
<td>8</td>
<td>0.118</td>
<td>0.040</td>
<td>0.139</td>
<td>0.1891</td>
</tr>
</tbody>
</table>
Analysis of the table, you can get the following conclusions:

(a) The queuing phenomenon under the initial scheme 1 is more serious and the waiting time is longer.

(b) In the second scheme, when the ticket vending machine and the check-in port are unchanged, the average total waiting time is 8.82% lower than the initial plan. The effect is not good.

(c) In the third scheme of the addition of 4 automatic ticket vending machines in Scheme 3, the average total waiting time decreased by 4.69% compared with the initial plan, and the effect was not good.

(d) In fourth scheme, when two inbound ticket gates are added, and the manual ticketing window and the automatic ticket vending machine are unchanged, the average total waiting time is reduced by 80.09% compared with the initial scheme.

(e) In the fifth scheme of the addition of 4 ticket vending machines and 3 personal ticket sales windows, the average total waiting time decreased by 13.51% compared with the initial plan.

(f) In Scheme 6, when two inbound ticket gates and three personal ticket sales windows are added, and the automatic ticket vending machine is unchanged, the average total waiting time is reduced by 88.91% compared with the initial scheme, and the effect is obvious.

(g) In Scheme 7, when two inbound ticket gates and four ticket vending machines are added, and the manual ticket window is unchanged, the average total waiting time is reduced by 84.78% compared with the initial scheme, and the effect is better.

(h) In the eighth scheme of the addition of two inbound ticket gates, three personal ticketing windows and four ticket vending machines, the average total waiting time decreased by 93.60% compared with the initial scheme, and the effect was excellent.

By comparing scheme 2-8 with the initial scheme 1, we can see that the increase in the manual ticketing window, the ticket vending machine or the inbound ticket gate can reduce the average waiting time of the passenger. However, the increase in revenue from the manual ticketing window and the automatic ticket vending machine is relatively low, and the increase in the revenue of the inbound ticket gate is very obvious. In the case of adding only one service desk, Option 4 is undoubtedly the best solution; in addition, we can also see that the increase in the revenue of the manual ticket sales window is slightly larger than the increase in the revenue of the automatic ticket vending machine, so the number of inbound ticket gates cannot be changed. At the time, we can take the priority to increase the number of manual ticketing windows to reduce the average waiting time of passengers.

(i) Comparing scheme 4 with scheme 6, on the basis of adding 2 invoices at the inbound station, scheme 6 has increased 3 ticket sales windows more than scheme 4, and the average total waiting time has decreased by 44.32%.

(j) Comparing scheme 4 with scheme 7, on the basis of adding 2 invoices at the inbound station, scheme 7 has increased 4 ticket vending machines more than scheme 4, and the average total waiting time is reduced by 23.54%.

By contrast, on the basis of adding a certain ticket gate, the income from the addition of the manual ticket window is still greater than the increase in the automatic ticket gate, which is similar to the effect of adding only one service desk.

By comparing schemes 1, 2, 3, 5 and schemes 4, 6, 7, and 8, respectively, we can find that the average total waiting time of schemes 2, 3, and 5 is reduced by 8.82%, 4.69%, and 13.51%, respectively. The average waiting time of schemes 6, 7, and 8 is reduced by 43.32%, 23.54%, and 67.87%, respectively. Obviously, on the basis of the addition of the inbound ticket gate, the additional ticket sales window and the ticket vending machine will increase the revenue of the manual ticketing window and the ticket vending machine.

We can get a result the check-in ticket is a bottleneck in the passenger flow line is the main factor affecting the average waiting time of passengers. Then it is the manual ticket sales window. The least affected is Ticket vending machine. On the basis of the addition of the inbound ticket gate, the benefits of optimizing the manual ticket window and the automatic ticket gate are even greater. Therefore,
when optimizing passenger flow lines, priority should be given to the inbound ticket gates, and then the manual ticket sales window should be optimized, and finally the ticket vending machines.

6. Conclusion

The article briefly describes the passenger flow organization process of the railway passenger station. At present, the ticket checking procedures existing in the passenger flow organizations of most passenger stations in China are complicated, the stations are not closely connected with other traffic modes, and the passenger flow guidance signs are complicated.

The article also classifies the streamlines of China's railway passenger stations, and analyzes the main two types of streamlines: passenger flow lines and vehicle flow lines, and puts forward the principles to be followed when designing streamline organization. And analyzed the streamline situation of the East-West Plaza in Nanchang Station, and proposed corresponding improvement suggestions for the streamline problem in front of the West Square Station and the supporting facilities of the East Plaza. This paper constructs a queuing system consisting of M/M/C and M/D/C. By substituting the actual passenger transportation facilities data of Nanchang Station and the passenger flow data of the Spring Festival of 2018, the bottleneck of the passenger flow organization of Nanchang Station is found. Optimization is carried out, and finally it is a bottleneck in the passenger flow line when the ticket is checked in, which is the main factor affecting the average waiting time of passengers. Followed by the manual ticket sales window, the least affected is the automatic ticket vending machine, and on the basis of adding the inbound ticket gate, the conclusion that the manual ticket window and the automatic ticket checking machine are optimized is more profitable. The article concludes that when optimizing the passenger flow organization in the peak period of Nanchang Station, the ticket gates should be optimized first, then the manual ticket sales window should be optimized, and finally the ticket vending machine.

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