Design of Tianjin Baimiao Passenger Station

Ning Wang\textsuperscript{1,a}

College Of Transportation & Communication, Shanghai Maritime University, Shanghai, China
\textsuperscript{a}e-mail: 202030610063@stu.shmtu.edu.cn

Abstract: The purpose of this design is to carry on the reconstruction planning to the present Baimiao passenger station, in order to improve its passenger flow and service quality, improve the residents' travel experience. In this paper, the passenger volume of Tianjin from 2010 to 2019 is taken as the research object, and the passenger volume of Baimiao Passenger Station is predicted by exponential smoothing method from 2021 to 2028. Then, the passenger volume of Baimiao Passenger Station is predicted according to the proportion of total passenger volume in Tianjin. Then make reasonable planning for Baimiao passenger station. Finally, some constructive suggestions are put forward.

1. Introduction

Highway passenger station is the external traffic gateway of the city, and its main function is to collect and disperse passengers, organize transportation, provide services, manage and operate, and transmit information [1]. It turns out that highway passenger station is one of the main modes of transportation for people to travel. More than the previous bus passenger stations construction in urban areas, but in recent years many cities to alleviate the increasingly serious traffic congestion, are outside the car bus moved to within the urban area, passenger bus inconvenience, passenger decline, all kinds of illegal taxis to fly up into the passenger transport market, low utilization rate of car bus [2]. Baimiao passenger station, which is located in hebei district of tianjin city, bears the heavy burden of short and medium distance travel of citizens in beichen, hongqiao and hebei district because of its special geographical position, so it can be said that it has an irreplaceable position in the economic culture and transportation of surrounding counties of Tianjin city. Baimiao passenger station is also an important central organization connecting Tianjin with towns and villages, and it is also the first choice of transportation means other than high-speed trains in long-distance travel. Due to the density of population in the surrounding area, it is required that the Baimiao Bus Station provide extra capacity during holidays to ensure that the surrounding traffic can remain normal during rush hours. However, the existing scale of the passenger station can not meet this requirement, and congestion occurs from time to time during peak hours [3]. Therefore, it is necessary to undergo a comprehensive transformation design to improve its capacity, so that it can meet the needs of the public travel. Based on the data of the past ten years, the passenger volume of Baimiao Passenger Station is predicted in this paper, so as to carry out the reconstruction planning.
2. Materials and Methods

2.1. Forecast of passenger volume and construction of passenger station

2.1.1. Passenger volume forecast

In this paper, the exponential smoothing method is used for prediction calculation, and the basic data are shown in the table:

| Year | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Value (ten thousand) | 21883 | 22054 | 24483 | 14556 | 14530 | 14219 | 13741 | 12538 | 12259 | 12206 |

2.1.2. Exponential smoothing method

The exponential smoothing method is a time series estimation method, which is based on the actual number and forecast number of the current period of an index. The smoothing coefficient is introduced as a simplified weighting factor to calculate the average. In other words, it is a special weighted average method, which endows relatively small weights to the historical data far away from the forecast period, and relatively large weights to the historical data close to the forecast period [4]. The weights decrease exponentially from near to far.

Set the prediction object as $Y$, the original highway passenger volume as $\{Y_1, Y_2, Y_3, \ldots, Y_n\}$, time $t$, let the first exponential smooth be $S_t^{(1)}$, then the exponential smoothing formula is:

$$S_t^{(1)} = \alpha Y_t + (1 - \alpha)S_{t-1}^{(1)} \quad (1)$$

Let $S_0^{(1)} = Y_1$, If the above formula is smoothed again, let the quadratic exponential smoothing value be $S_t^{(2)}$, then the quadratic exponential smoothing formula is:

$$S_t^{(2)} = \alpha S_t^{(2)} + (1 - \alpha)S_{t-1}^{(2)} \quad (2)$$

Then the quadratic exponential smoothing prediction model is,

$$Y_n + T = a_n + b_n T \quad (3)$$

In this formula, $Y$ is the predicted value of the T period after n period; N is the last phase;

$$a_n = 2S_n^{(1)} - S_n^{(2)} \quad (4)$$

$$b_n = \left[ \frac{1}{1 - \alpha} \right] \times S_n^{(1)} - S_n^{(2)} \quad (5)$$

The weight of $\alpha$ should be selected in conjunction with the current data weight, where $\alpha$ is 0.3

If $S_0^{(1)} = S_0^{(2)} = (Y_1 + Y_2 + Y_3)/3 = 9970$, the smooth data table can be obtained.
2.1.3 Model parameters

\[ a_{t0} = 2S_9^{(1)} - 2S_9^{(2)} \]  
\[ b_{t0} = \frac{1}{1-\alpha} \times (S_9^{(1)} - S_9^{(2)}) \]  

Set the predicted value as the highway passenger volume in 2019, take \( m \) as 1, and use the above parameters to predict by quadratic exponential smoothing

\[ Y_{t0} = a_{t0} + b_{t0}T \]  

As can be seen from the data in the table, the passenger volume in 2019 is 122.06 million person-times, while the predicted passenger volume in 2019 is 111.96 million person-times. The error value is 10.1 million person-times, and the error rate reaches 8%. Passenger traffic is forecast to decline, in line with the results. By using the quadratic exponential smoothing forecasting model, the predicted value of passenger volume can be obtained

| year       | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|------------|------|------|------|------|------|------|------|------|------|
| Highway passenger volume (ten thousand) | 13713 | 12593 | 12033 | 11473 | 10913 | 10353 | 9793 | 9233 | 8673 |

According to the data of the National Bureau of Statistics, the road passenger transport volume of Tianjin is 122.06 million person-times in 2019, and the station has undertaken 5.3% of the city passenger transport volume in this year. As predicted above, the annual passenger volume of Baimiao passenger station in 2028 will be 2.738 million personages, so the Baimiao passenger station knows that the predicted daily passenger volume of Baimiao passenger station in 2028 will be 7,500 people. According to the relevant provisions in the Classification and Construction Requirements of Bus and Passenger Stations (JTT 200-2004), the daily passenger transport capacity of Baimiao Passenger Station is predicted to be 7,500 persons/day, which should be designed in accordance with the standard of the second-class station.

2.2 Station scale calculation

2.2.1 Daily delivery volume of passengers

The scale of the passenger station is mainly determined by the daily delivery volume of passengers. According to the above prediction, it can be known that Baimiao Passenger Station is expected to deliver 7,500 passengers per day in 2028, denote by \( F \)

2.2.2 Maximum number of passengers gathered

The maximum number of passengers gathering refers to the average value of the maximum number of passengers in the station, which determines the planning of the functional area in the passenger station and is generally taken as the date
The percentage of passenger volume is calculated and converted into the formula: 
\[ D = \gamma \times F \]

The daily passenger transport volume of the passenger station is 7500, where the percentage \( \gamma \) is 11%, and the maximum passenger aggregation number \( D = 7500 \times 11\% = 825 \). Therefore, the maximum number of passengers gathered at this station is 825, denoted by \( D \).

### 2.2.3 Effective number of departures

Refers to the number of departures that can be sent at the same time in a passenger station. The number of starting cars depends on the car and the maximum number of passengers to gather is determined. The formula is as follows:

\[ M = D(1 - \xi)K/\eta \mu \]

In the formula:
- \( M \) -- the number of starting places
- \( N \) -- the average number of cars in each starting space per hour, take 3
- \( D \) -- Maximum number of passengers congregated
- \( \xi \) -- Passing bus rate, usually 10%
- \( K \) -- In consideration of the coefficient of increasing parking Spaces for the arriving passenger cars, 1.2 is generally taken
- \( P \) -- the average occupancy of the passenger car. Let's take 45
- \( \mu \) -- Reasonable ride rate of departure station, 70% here

After calculation, the effective number of departures is 10, represented by \( M \).

### 2.2.4 Daily departures

The project is mainly determined by the passenger car occupancy and passenger daily delivery volume. The average seat of the bus was determined to take 30 seats after a field study. Known formula:

\[ N = \beta \times F \left(1 - \xi\right)/\mu \]

In the formula:
- \( N \) -- average daily departures
- \( F \) -- passenger throughput
- \( P \) -- Average passenger car occupancy, take 45
- \( \xi \) -- transfer coefficient, taking 10%
- \( \mu \) -- Reasonable bearing rate, take 70%
- \( \beta \) -- disequilibrium coefficient is 1.15

The number of daily departures is 50, which is expressed by \( N \).

### Passenger station scale value

| indicators | The numerical | unit |
|------------|---------------|------|
| Average annual passenger volume | 7500 | M/day |
| Maximum number of passengers congregated | 825 | m |
| Daily flights | 50 | shift |
| Start digits | 10 | a |

### 3. Results & Discussion

#### 3.1 Passenger station streamline analysis and design

The streamline analysis and design of the passenger station is the most important part of the reconstruction planning project [5]. Only in the process of production process design, can we make full use of the functions of the equipment to improve the operating efficiency, ensure the effective operation of the passenger production activities of the passenger station, and provide satisfactory...
services to the passengers. According to the present situation of Baimiao passenger station, the general flow diagram under ideal condition is planned.

Fig.1. Schematic diagram of Baimiao Passenger Station streamline

3.2 Give other suggestions for the problems shown in the diagram

Based on the field investigation of the present site of Baimiao Passenger Station and the reconstruction scheme given in this design, the following suggestions are put forward:

(1) It is recommended to set up a separate consultation room at the entrance to provide convenience for the passengers to consult questions and avoid the long stay caused by the unfamiliar structure of the station.

(2) Streamline organization must be reasonably planned [6]. There are serious conflicts between the existing inbound and outbound streamlines, which is one of the important reasons for congestion during peak periods; Although it is impossible to set up an exit due to the limitation of site conditions, corresponding management should be carried out to isolate passengers entering and leaving the station.

(3) Although drinking water room is equipped in the passenger station, disposable paper cups are not supplied, resulting in low utilization rate of drinking water room; At the same time, the drinking room only has the function of supplying cold water, but does not have the condition of providing warm boiled water, so it is more inconvenient when the weather is cold.

(4) The disordered arrangement of the square in front of the station, the occupation of road by street vendors and the random parking and placing of taxis should be improved in time. The best solution would be to set up special functional areas for taxi parking and vendors' stalls, but this cannot be achieved due to the small size; Here, it is suggested to set up a duty guard to guide the evacuation of the corresponding personnel and ensure the stability of the square in front of the station.

4. Conclusions

Highway bus station is one of the most important transportation modes in urban population flow and plays an important role in the national transportation network. In this paper, the passenger volume of Baimiao Passenger Station is predicted and improved, so that the reconstructed Baimiao Passenger Station can fully bear the passenger transport in the surrounding area, and achieve the purpose of
improving its own service quality and passengers' travel experience.

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